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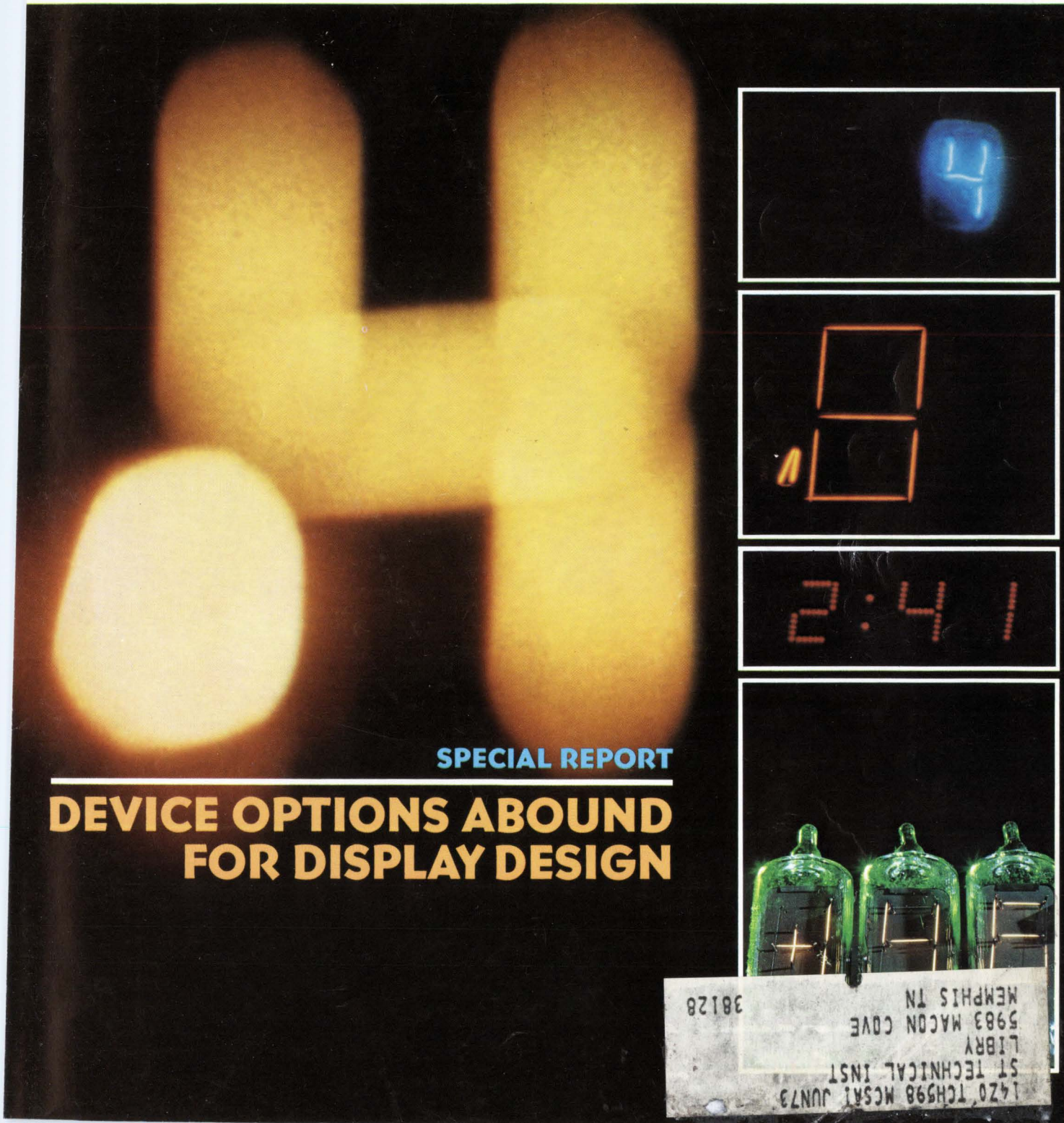

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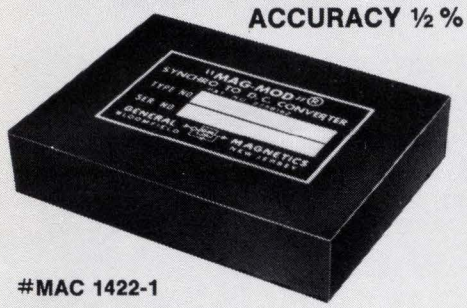

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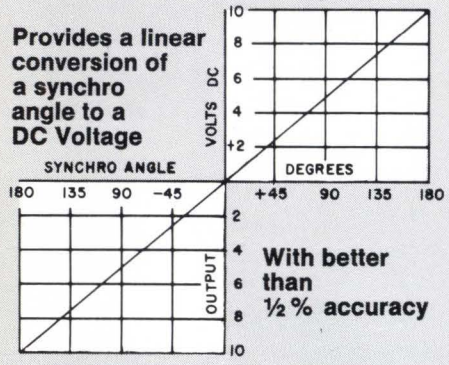

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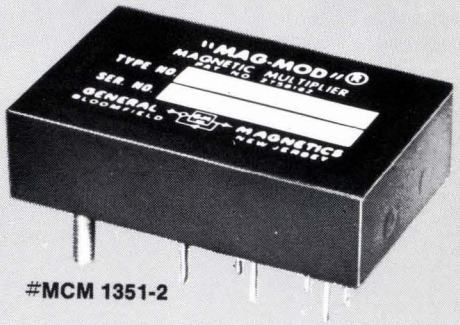

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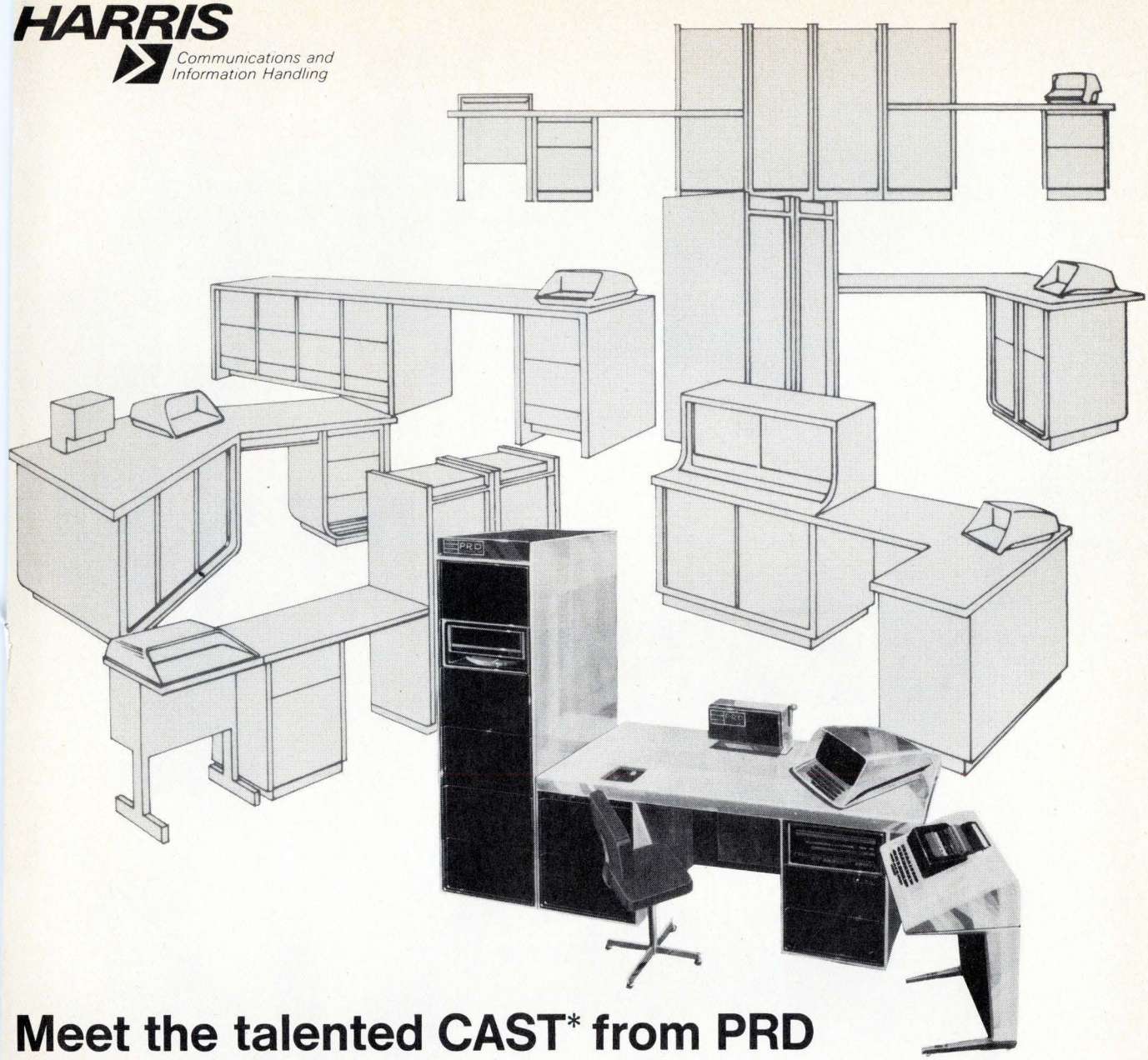

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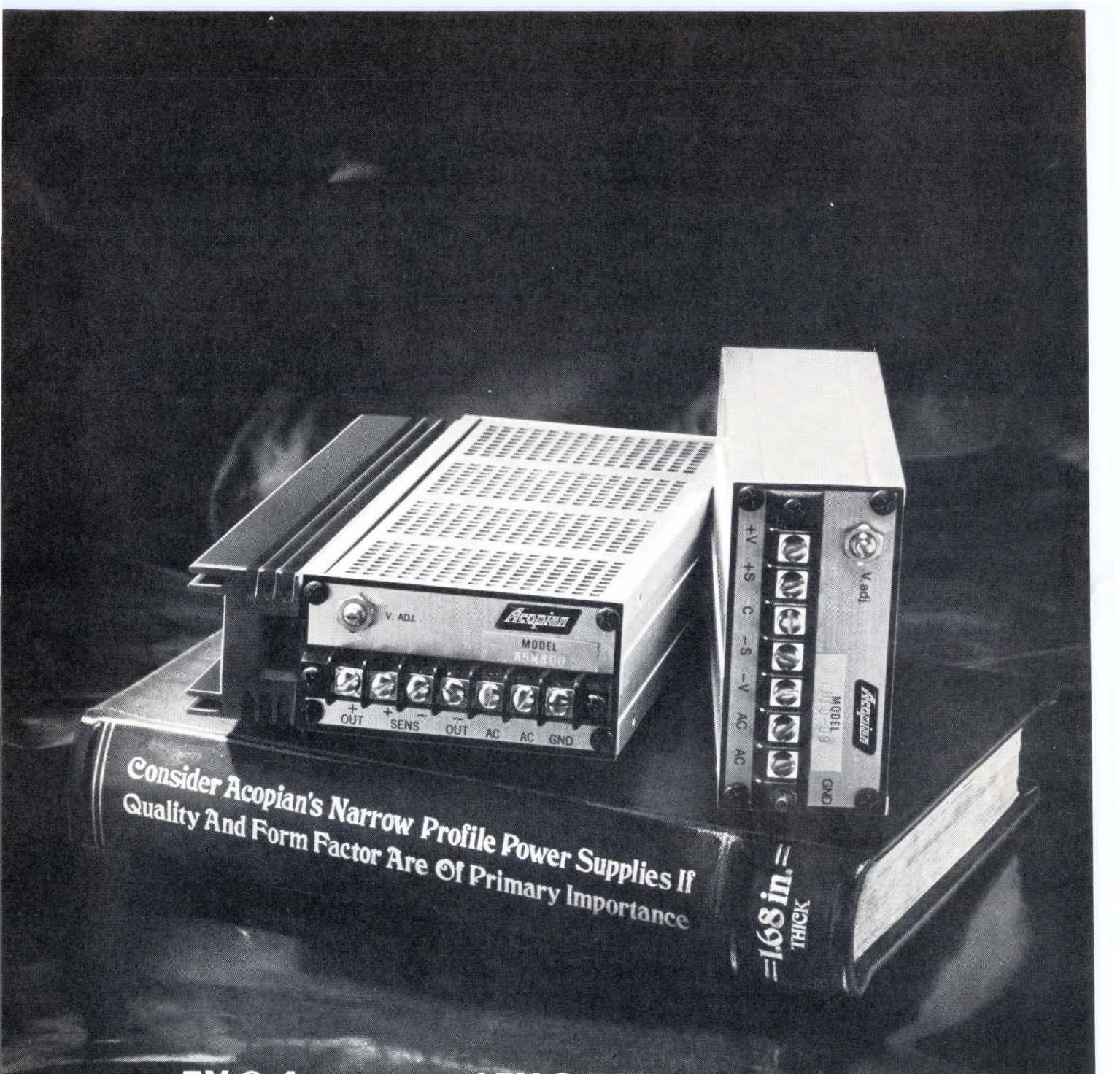

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Electronics
The International Magazine of Electronics Technology

Vol. 46, No. 8 • April 12, 1973

Highlights

The cover: Displays showing now, 91
From planar gas-discharge types to liquid crystals, the variety of displays available today is greater than ever before. Each has rather different application parameters. On the cover, counterclockwise from bottom right, are shown: RCA's Numitrons, H-P's light-emitting diodes, and three directly viewed filament devices from Pinlites.

The battle of the 4,096-bit RAMs, 75
Over a half-dozen manufacturers of metal-oxide semiconductors must soon finalize designs for random-access memories of the highest bit-density yet. A large market in computer main memories will open up to those who make the right design decisions.

Hardwired NC controllers give way to software, 109
Minicomputers have always been the most flexible means of running numerically controlled machine tools. Now their declining prices also make them far more economical than using a different hard-wired controller for each task. This is the second article in the series, "Minicomputers in action."

Polysilicon-filled notch smooths bipolar chip, 117
Etching a notch around the active elements on a bipolar memory isolates them with little waste space. Restoring the chip's smooth surface by filling in the notch then restores simplicity of metalization.

And in the next issue . . .
Special report on discrete semiconductors...product development profile: the Intel 1103...how to select a display.

Electronics

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Publisher's letter

Displays—and how to make the best use of the new varieties—are the subject of the special report that begins on page 91. There, you'll find a lot of details on pinpointing the display that best fits an application's over-all requirements. Be it planar gas-discharge, directly viewed filament, vacuum fluorescent, light-emitting diode, or liquid crystal, the pros and cons of each display type—and the tradeoffs between them—are presented.

Mike Riezenman, our Instrumentation Editor, put together the report after visiting many device makers around the country. "One curious thing about the display field right now," Riezenman says, "is the sense of hard-driving competition you get when you talk to the manufacturers of these new displays. It's a classic case of 'ours is best, theirs is no good.'"

"But what makes the cutthroat competition so curious," he adds, "is that it's a sellers' market. Some companies have already sold out their full capacity for the rest of the year, backlogs in some devices are six months long, and for one of the displays quantity sales in the U.S. won't start till fall."

"Behind it all is a remarkable enthusiasm, brought about largely by the seemingly insatiable demands of the electronic calculator market. And with the watch and clock market beginning to open, it's no wonder they are enthusiastic."

Speaking of backlogs, sometimes what isn't is just as big a story as what is. Take, for example, the Probing the News story on page 79. It examines what has become a new problem for electronics suppliers and vendors alike: a shortage of devices ranging from discrete parts to transistor-transistor logic. In some cases, delivery delays of a year have been reported—a stretchout that would have been incredible a mere six months ago.

In case anyone still doubts that time whizzes by in electronics, consider the case of one executive who remembers wistfully when his company could deliver an order for a million resistors in 48 hours. To him, those were the good old days. How long ago were they? Why, last summer.

It has become a tradition with us each year during IEEE week in New York to invite product planners from Texas Instruments to update our staff on TI's latest views of the semiconductor market. The story that resulted from this year's "technology update" appears on page 82 and represents the combined efforts of several staffers to pick out the trends TI is tracking most closely.

Eight planners made presentations this year on topics ranging from a general market overview to specific product lines, such as ICs, power semiconductors, small-signal discrete products, and optoelectronics.

We believe that this interpretation by an industry leader will help crystalize for you, as it did for us, what's happening in an exploding semiconductor growth period.

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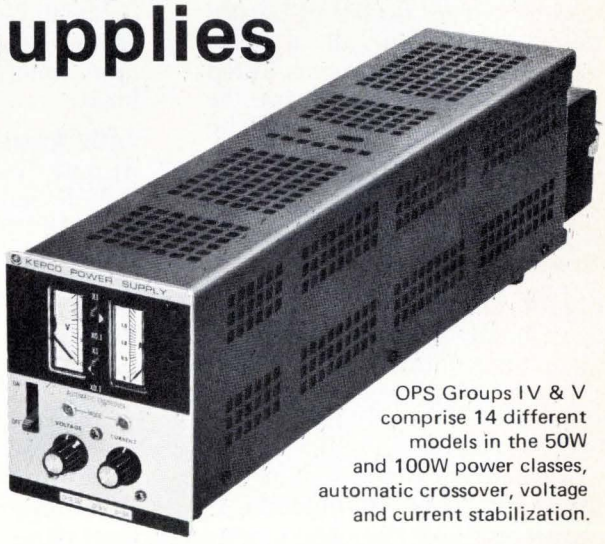

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Readers comment

Pushdown stack rises again

To the Editor: The article by Rod Burns and Don Savitt, "Microprograming, stack architecture ease minicomputer programer's burden," [Feb. 15, p. 95] contains a customary but inappropriate sample of logic in a conventional single-register machine (Fig. 4).

If the example were rewritten as

LOAD	C
ADD	D
STORE	TEMPORARY
LOAD	A
SUBTRACT	B
DIVIDE	TEMPORARY
STORE	X

then the advantage of stack logic seems to disappear. Most programers and many compilers would implement the example in this way. The rewritten example is still about 8% longer than for the stack machine; the execution time advantage may lie with the conventional machine, depending on the depth of electronic registers at the top of the stack.

Stack logic is indeed often highly advantageous, but I don't believe I have ever seen it clearly illustrated in a popular technical magazine.

L. C. Corey
Mitre Corp.
Bedford, Mass.

■ *The authors reply: Mr. Corey is correct. The examples were stacked in favor of the stack computer by utilizing a simple left-to-right expression compiler. More complex compilers could produce better code. Mr. Corey has shown how object code for a division operation might be more effectively rearranged.*

But if the variables A, B, C, and D were themselves expressions, the compiler would become more complex. While compilers for large computers do perform complex optimizations, most compilers on small computers do not. One of the beauties of the stack architecture is the elimination of the need for some classes of optimization.

Also, while the stack computer excels in generalized expression-processing, it is also advantageous in other functions that are more difficult to illustrate. With regard to the execution-time advantage, Mr. Corey's

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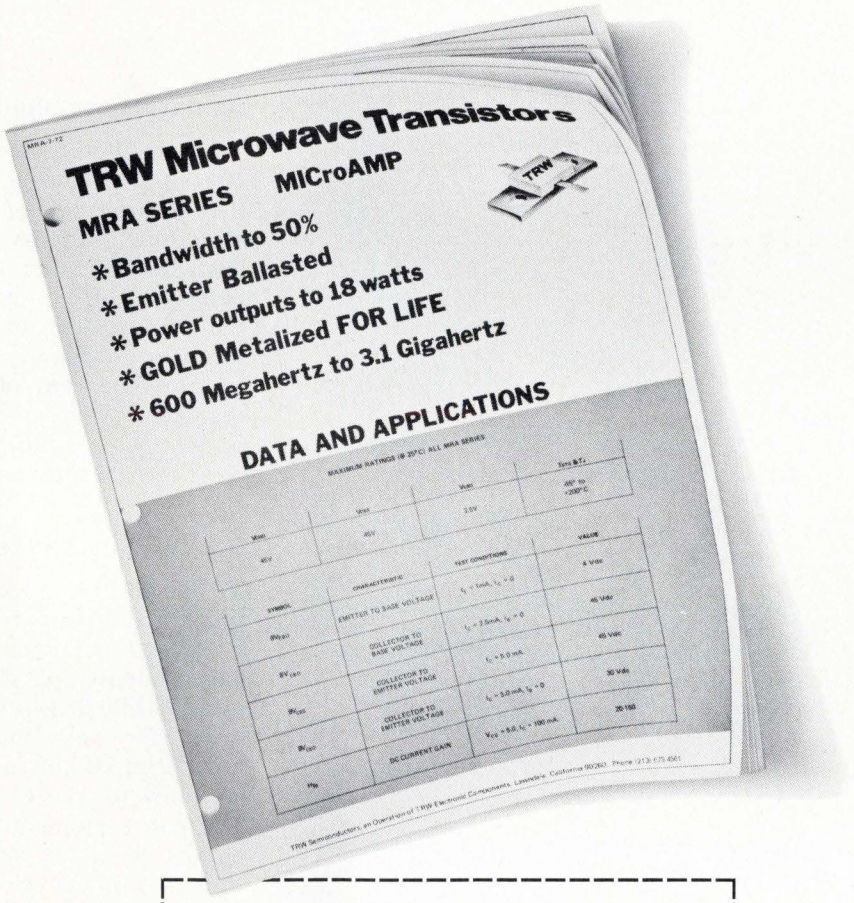

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Readers comment

example requires seven memory accesses for data, while the stack-computer example requires only five.

More on the stack

To the Editor: We concur with the authors' contention that stack hardware does ease minicomputer programing; however, the example chosen was unfortunate. The real advantage of stack architecture is in interrupt handling and nested subroutines.

Ronald E. West
Arun Sheth
Honeywell Inc.
Denver, Colo.

Acronyms accumulate

To the Editor: The recent addition of CCD (charge-coupled devices) to the growing list of acronyms for electronic systems and products leads me to inquire if it isn't time to halt this growth of abbreviations. If the proliferation continues at the rate now prevailing, we may soon be lost in a wilderness of letters exceeding that of Government agencies.

Julian Loebenstein
General Instrument Corp.
Hicksville, N. Y.

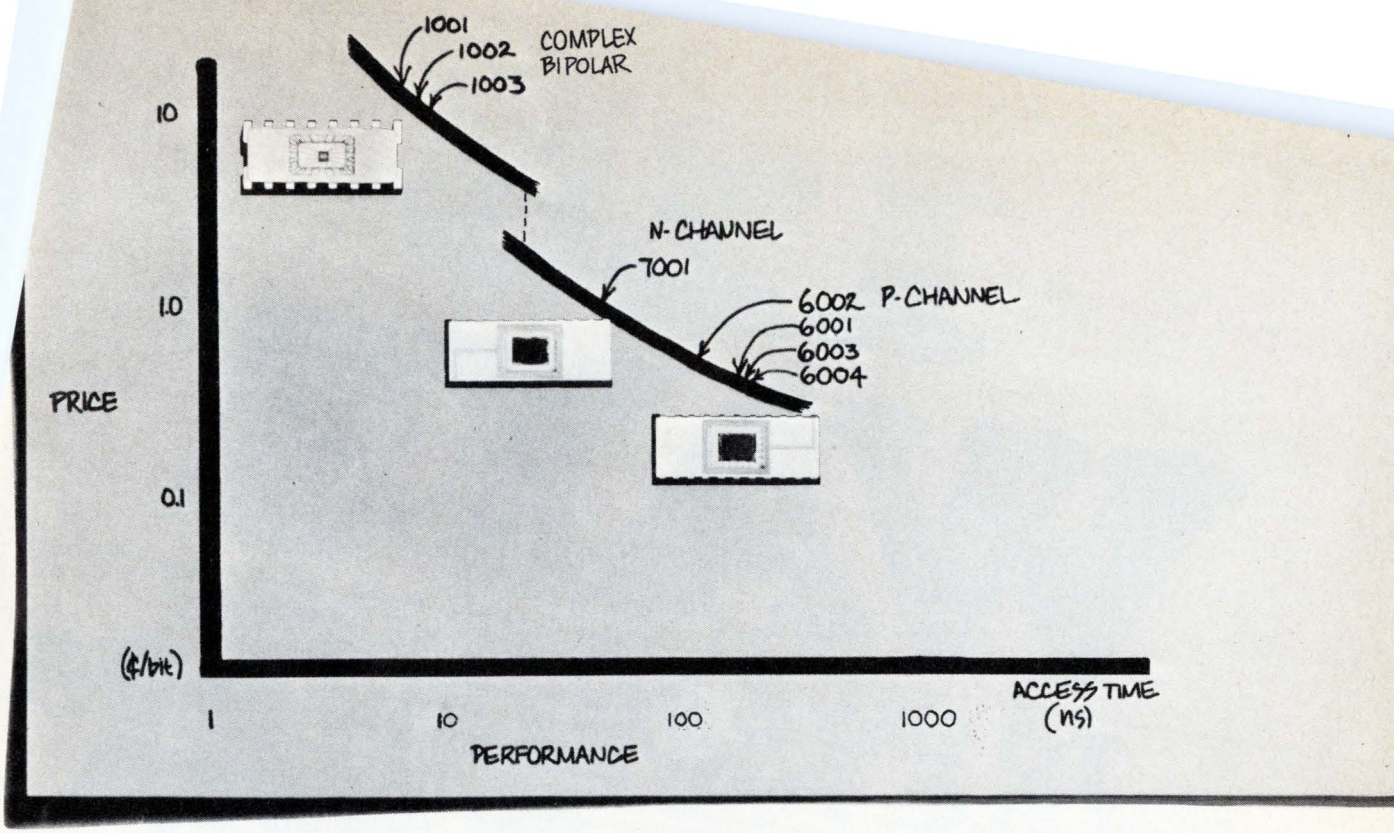
Bandwidths changed

To the Editor: A couple of minor typographical errors crept into my Engineer's notebook, "Filter bandwidth nomograph gives sweep-rate limits," [March 1, p.102]. The sweep width for both examples should have been 70 kHz instead of 7 kHz, as stated for the 41-Hz sweep rate. The entire numerator of the right-hand side of the bandwidth equation should have been under a square-root sign.

Roger T. Stevens
The Mitre Corp.
McLean, Va.

Correction

In "Minicomputers go into action in a myriad of applications," [March 29, p. 73], sales of minicomputer-based data-processing systems priced below $50,000 should have been projected at $418 million for this year, compared with $333 million in 1972. In 1976, sales in this category are projected at $802 million a year. The corresponding figures printed were erroneous.



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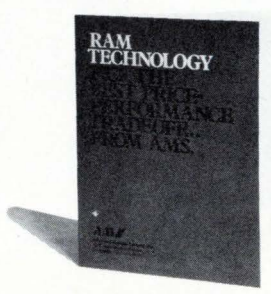

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	* 2K5, 15D	5V, 3.0A or 6V, 2.5A	12V, 1.5A or 15V, 1.3A	NA	
	* 2K5,24D	5V, 3.0A or 6V, 2.5A	18V, 1.0A or 20V, 1.0A or 24V, 1.0A	NA	
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2R TRIPLE OUTPUT Depth: 2.87 Width: 11.00 Height: 4.88	2R-70T	+12V, 1.5A or +15V, 1.3A	−12V, 1.5A or −15V, 1.3A	5V, 6.0A or 6V, 5.0A	$89.00
	* 2R-72T	5V, 3.0A or 6V, 2.5A	12V, 1.5A or 15V, 1.3A	5V, 6.0A or 6V, 5.0A	
	* 2R-74T	5V, 3.0A or 6V, 2.5A	18V, 1.0A or 20V, 1.0A or 24V, 1.0A	5V, 6.0A or 6V, 5.0A	
	* 2R-76T	12V, 1.5A or 15V, 1.3A	18V, 1.0A or 20V, 1.0A or 24V, 1.0A	5V, 6.0A or 6V, 5.0A	
2S TRIPLE OUTPUT Depth: 4.00 Width: 15.00 Height: 4.88	2S-140T	+12V, 3.0A or +15V, 2.8A	−12V, 3.0A or −15V, 2.8A	5V, 12A or 6V, 8.0A	$149.00
	* 2S-142T	5V, 6.0A or 6V, 5.0A	12V, 3.0A or 15V, 2.8A	5V, 12A or 6V, 8.0A	
	* 2S-144T	5V, 6.0A or 6V, 5.0A	18V, 2.0A or 20V, 2.3A or 24V, 2.3A	5V, 12A or 6V, 8.0A	
	* 2S-146T	12V, 3.0A or 15V, 2.8A	18V, 2.0A or 20V, 2.3A or 24V, 2.3A	5V, 12A or 6V, 8.0A	

All outputs can be connected in any common configuration. Other voltages and currents available, consult factory for price and delivery.
* Non-stocked. ** Contact factory for quantity discounts at 25, 50, 100 units and others.

If you don't see the exact model on the chart, we'll build an OEM from stocked sub assemblies in any voltage/current combination. Let us know and we'll quote within 24 hours Stay within the same size and power rating and the price won't change.

Write for Powertec's new 44 page catalog and you'll find a lot more than 128 ways to save money and solve all your power supply problems.

POWERTEC INC. an Airtronics Subsidiary
9168 DeSoto Ave., Chatsworth, California 91311 • (213) 882-0004 • TWX (910) 494-2092

POWERTEC

How do you become a top military RF power transistor supplier?

It takes guts.

With us, it means outdoing yourself. Providing the ultimate in power at HF, VHF and UHF. Just last year our BM80-28 monolithic chip delivered a guaranteed 80 Watts at 200 MHz. Now we have developed the S150-28—over two times larger with twice the power of its predecessor. And it dissipates over 400 Watts.

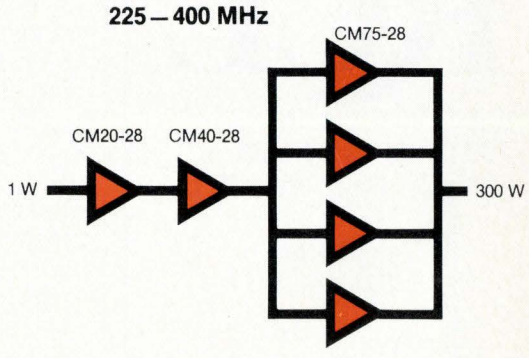
All of our VHF and UHF devices are designed and characterized for easy broadbanding. With applications assistance and circuit schematics available in every frequency range. We make them easy to use.

Since day one, we have kept ahead of the power transistor state of the art. It's vital when you're powering ECM, telemetry and point-to-point systems for the military. Or satisfying the hunger of the biggest aircraft radios.

All CTC products are capable of working into severe load mismatches. And all our high power transistors are emitter ballasted—they can be operated in Class A, B, or C. Which helps to make them easier to design around.

Reliability? Our exclusive, long-life metal system and glass passivation set the norms for reliability in our field. Hermetically sealed of course. For in military, it's not only guts, but guts you can count on.

You're ahead when you specify CTC. For complete information and product now, write or call.



Communications Transistor Corporation, 301 Industrial Way, San Carlos, California 94070 (415) 591-8921

Circle 13 on reader service card

People

Burns takes the long view of Burr-Brown's technologies

"In the '60s," says Jim Burns, new vice president and general manager of Burr-Brown Research Corp., "you could run an electronics company like a grocery store, making things and putting them on the shelf. But in the '70s and '80s, you won't survive unless you take a longer-range view."

Burns is now bringing that kind of longer-range view to the Tucson, Ariz., company, which has been best known as an operational-amplifier company, but which is now changing rapidly as it adds new products, goes after new markets, and revamps its manufacturing structure. Burns will seek product opportunities that meld the company's new and varied technologies—thin- and thick-film hybrids and monolothic ICs—with its traditional discrete product line.

Burns, 43, joined the firm two years ago after managing Motorola's linear-circuits marketing. His first job, as director of new business development, was to extend Burr-Brown's relatively limited technological base. One result was the acquisition of Sloan Microelectronics, adding thin-film and monolithic capability.

What's to come? Next, as director of marketing, Burns identified the markets and products Burr-Brown should pursue, with emphasis on the industrial and process-control fields. For the future, he has his eye on subsystems with their higher complexity, as well as increased downward integration into components. For example, the firm will introduce a complete, inexpensive, monolithic 8-bit digital-to-analog converter before the end of the year and will introduce its first subsystem in May.

As general manager, Burns is now also out to improve productivity. Burr-Brown has concentrated on high-priced, low-volume parts, but now is introducing products with higher-volume potential. "If we're to fuel a 25% growth rate—our goal—we have to have a lower cost structure."

To survive. Jim Burns says electronics firms must expand their technological base to survive in the '70s and '80s.

He points out that in a year the company has redirected its plans so that almost all products being developed use monolithic or hybrid technology.

All this leaves Burns little time for outside interests, but he does get in a little hiking and fishing and jogs every morning to stay in shape. With his wife and four boys, he lives in an area of Tucson rugged enough to force him to commute to work via one of the four-wheel-drive pickups.

Hartke expects KSW to profit from defunct KEV's errors

Rarely does a survivor from a bankrupt firm get an opportunity to reenter the same field, but Jerome L. Hartke is the exception. As president of the infant KSW Electronics Inc., he is once more marketing ion-implanted diodes, but this time, he pledges to avoid the errors of his former employer, KEV Electronics.

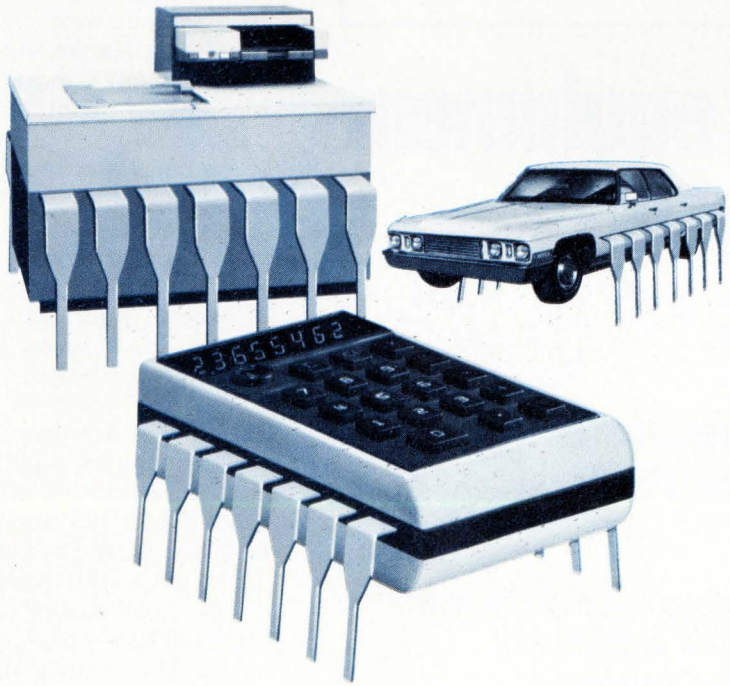
Hartke should be able to run his own show. He managed KEV's semiconductor division and earlier led semiconductor research at the Xerox Corp. At High Voltage Engineering, he performed some of the earliest ion-implantation work. He even studied for his doctorate under Nobel laureate John Bardeen, one of the inventors of the transistor.

Now defunct, KEV was formed just before the recession of the early 1970s. But, KEV spread itself too thin, says Hartke. Expenses ate into cash as the company successively developed lines of implanted microwave and electro-optical semiconductors, and then invested more in ion-implantation equipment. But even during the darkest periods,

We've developed more than 50 custom ICs in the last 18 months

More than 50 times in the last 18 months, customers have brought us IC problems that couldn't be solved with standard circuits. In every case we've developed a custom circuit that filled the bill. Our circuits are now in TV sets, watches and clocks, electronic organs, calculators, automobiles, office copiers and a host of other applications. We've delivered samples in as little as 8 weeks ARO; few problems have required more than 20 weeks to solution. Shouldn't a semiconductor company with a record like that get a shot at your custom circuit requirement?

We're doers, not talkers!



semiconductors

ITT Semiconductors is a division of International Telephone and Telegraph Corporation, 3301 Electronics Way, West Palm Beach, Florida 33407. Phone 305/842-2411.
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ITT

says Hartke, his semiconductor manufacturing division broke even or made money. Hence his resolve to get back into the business.

After finding financial backing, Hartke purchased the assets of Ion Physics, three implanting accelerators, large amounts of semiconductor research and plant equipment, and 11 of the earliest patents issued on ion implantation.

Ion implanter. Jerry Hartke, head of KSW looks to technical skill, awareness of customer needs, and smart marketing.

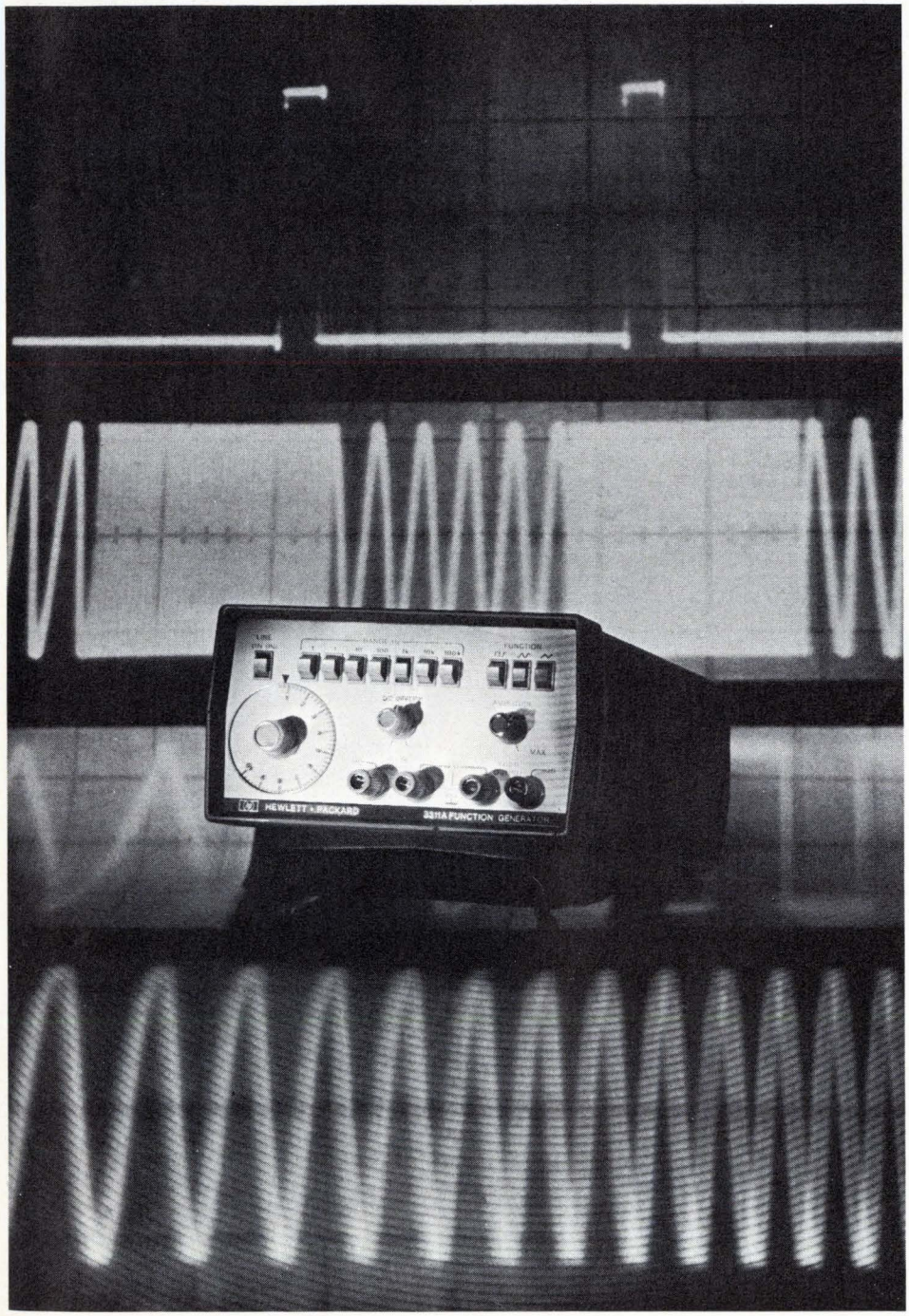
Moving in. "Instead of moving the assets out, we moved into the assets," says Hartke, referring to his new company's location in former Ion Physics plant space in Burlington, Mass. Hartke says that KSW's range of custom implantation skills may be among the widest in the industry. Its three machines offer a voltage range from 100 kiloelectronvolts to 2 megaelectronvolts at currents from 1 microampere to several milliamperes. Also KSW can implant more than 20 "exotic" ions.

KSW will move in response to client needs. Hartke says, "we have several hundred standard products already gained through purchase of KEV's masks, but we aren't moving further until we have identified paying products and customers."

The same conservatism is reflected in KSW's pricing. "There will be no loss leaders or missionary product lines here," says Hartke. "We will be geared to customer needs."

MEASUREMENT NEWS
innovations from Hewlett-Packard

APRIL edition



in this issue

New low-cost way to generate basic waveforms

Square, triangle or sine waves—new signal source provides all three.

Don't be fooled by small size or low price—the 3311A function generator has sine, square, triangle and positive pulse outputs, plus many features not generally found in low-cost instruments. A TTL-compatible pulse output provides current sinking for up to 20 loads, and an external VCO input is provided for phase-locked loop FM and swept-frequency applications.

Merely push a button to select the frequency, from 0.1 Hz to 1 MHz. Dial accuracy is ±5% of full scale. A variable attenuator adjusts the output over > 30 dB range. Pulse risetime is better than 25 ns, so the 3311A can be used to clock logic breadboards or to synchronize signals.

To learn more, check E on the HP Reply Card.

Graphic plotter enhances your time-share terminal

A graph is often more useful, easier to understand and easier to interpret than long lists of numbers.

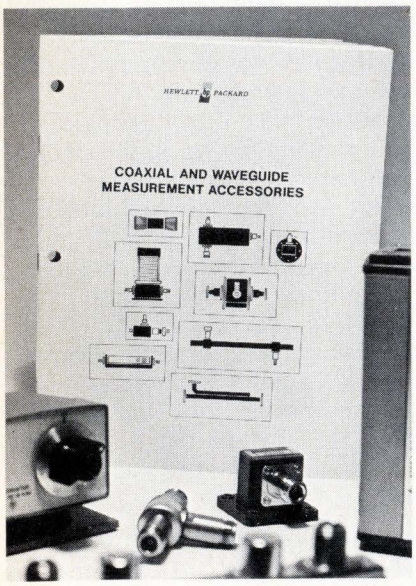
Using data directly from a time-sharing terminal, the HP 7200A graphic plotter draws points, irregular curves, circles, straight lines, ellipses, contours, bar graphs and pie charts. Now, you can quickly review a graphical solution to your problem instead of interpreting long lists of numbers or wrestling with bulky printouts. And no special software is required; you can use either BASIC or FORTRAN source language.

The plotter accepts standard EIA ASCII inputs from the teleprinter and draws vectors between the points to form smooth curves. Graphs may be any size up to 11 by 17 inches (28 by 43 cm). Static accuracy is ±0.015 in. (±0.38 cm), and resolution is 1 in 10,000. HP utility routines are available to handle scaling, axis and curve generation, curve synthesis, formatting, coordinate transformation, and contour mapping (including three-dimensional plotting).

A picture may well be worth a thousand numbers. If you already have a time-share system and terminals, the cost of adding plotter capability is minimal .

For more information on the 7200A plotter, check N on the HP Reply Card.

Send for this useful microwave catalog



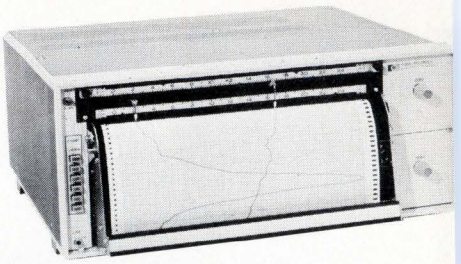
A new 64-page catalog features our extensive selection of precision coaxial and waveguide instrumentation. Complete specifications are presented for such items as:

- Directional couplers
- Slotted-line equipment
- Attenuators
- Frequency meters
- Detectors
- Mixers
- Filters
- Modulators
- Terminations

This book lists all the hardware you might need to make accurate microwave measurements.

For your copy, check Q on the HP Reply Card.

New OEM recorder offers more than 50 options



You can customize this strip-chart recorder by choosing the speed, frequency, span, etc. that are right for your application.

Now, there's a two-pen strip-chart recorder truly designed for OEMs. It starts with a durable mainframe, 10-inch (25 cm) writing width, modular construction with plug-in PC boards for easy servicing, and a trouble-free servo system that doesn't use gears or clutches. Instead, the pens are driven by a plastic belt that's quieter and more reliable than conventional servo systems. Recorder response time is < 0.5 sec., and accuracy is ±0.2% of full scale.

You take over from there and select what you need from over 50 options. Choose one of six chart speeds from 6 in. (15 cm) per minute to 1 in. (2.5 cm) per hour. And you're not limited to just one speed; choose two, four or eight. Both 50 Hz and 60 Hz recorders are available. One of six input spans from 1 mV to 100 V on each channel may be specified. Other options include remote controls, chart on-off, pen lift, retransmitting potentiometer, limit switches, and a rear control connector.

To learn more, check M on the HP Reply Card.

ew RF spectrum analyzer low cost, easy to use

Economy is now coupled with gh performance in the new P 8558B spectrum analyzer—an scilloscope plug-in that makes ccurate measurements over a 0.1 1500 MHz frequency range. It's xtremely easy to operate; most ieasurements are made using only iese three controls:

Tuning—Set the center or start-of-sweep" frequency which is splayed on the 3½ digit LED readout.

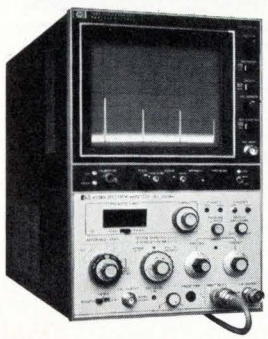
Frequency Span—Examine equency sweeps as wide as 00 MHz and as narrow as 50 kHz. ie analyzer automatically selects ptimum sweep time and resolution andwidth. If required, you can asily override the automatic inction to select any combination f sweep time and resolution. With andwidths from 1 kHz to 3 MHz, ou can resolve close signals, nalyze pulsed RF, and recover omplex modulation.

Reference Level (amplitude ontrol)—Measure the absolute ower level of displayed signals from 115 dBm to +30 dBm. The control lso indicates maximum and ptimum input signal levels for 70 dB purious-free display. This minimizes ie chance of erroneous ieasurements or overload damage.

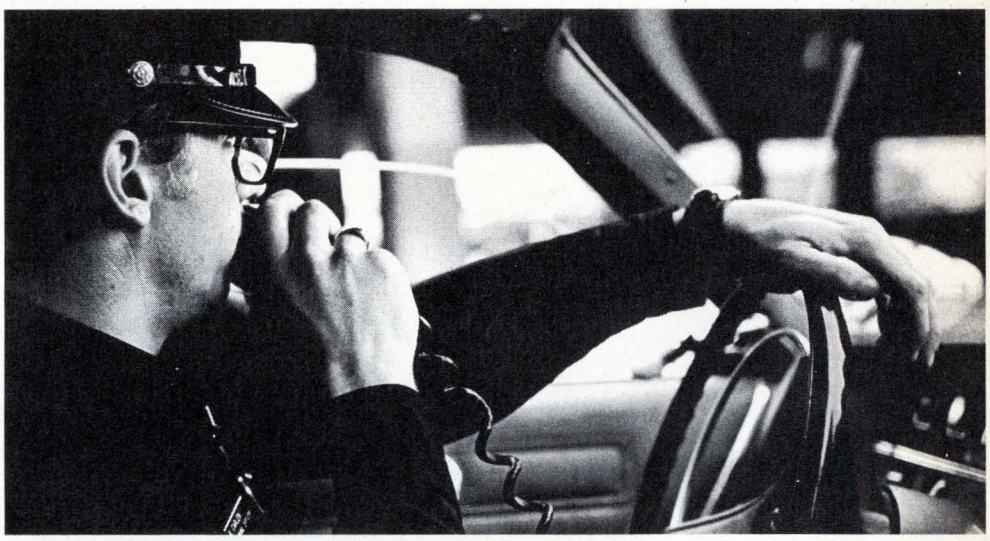
You can use the 8558B spectrum nalyzer with any HP 180 series scilloscope. The 182A scope, with large 10 by 13 cm. CRT display, is deally suited for bench use; while he 181A scope, with variable ersistence and storage CRT, is iseful for high-resolution analyses nd signal comparisons.

or more information, check P on he HP Reply Card.

lake wide range frequency-domain ieasurements with the new 8558B RF pectrum analyzer.

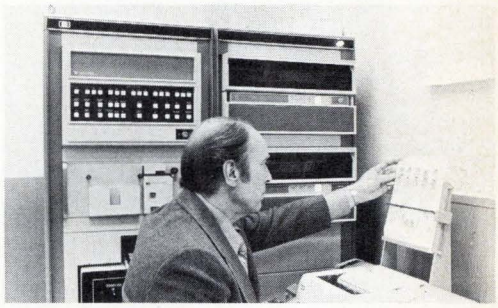


Police search vast data files quickly with an HP computer



The patrolman radios a description back to headquarters.

The computer flips through its file of offenders and identifies the suspect.



Later, a fingerprint search is performed.

The Oakland, California, police department has a new "detective"—a low-cost HP 2120A disc operating system. The computer system helps identify criminals by comparing known physical characteristics and methods of committing crimes with information in police arrest files. The system can identify the vehicle involved in a crime—given a partial license number and the automobile make, model, year or color. It also matches fingerprints found at the scene of a crime with those on file. A fingerprint search that used to take 4 to 5 hours is now completed in only 15 or 20 minutes with the HP system.

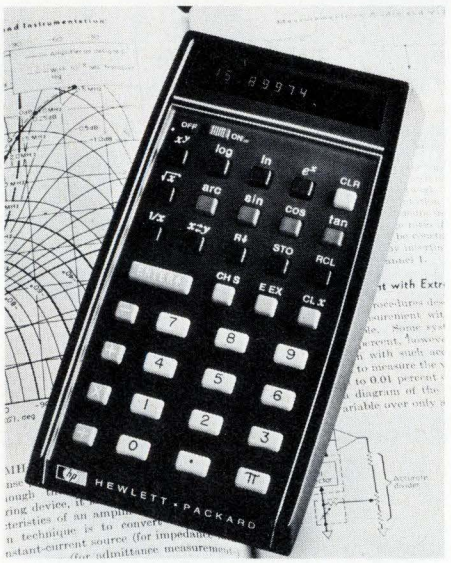
The computer interfaces with two microfiche viewers. One displays photographs so that police and witnesses can identify offenders; the other displays fingerprints. During the first few weeks of testing, eight burglars were identified and arrested through computer-directed fingerprint searches, while six robbery suspects were identified from photos.

You don't have to be a law enforcement agency to have the same problems that the Oakland police did: voluminous files, inadequate information retrieval, and time-consuming manual search techniques when you need the answer immediately. The solution: an HP disc operating system that holds vast amounts of data, automatically analyzes it, and presents the information in seconds rather than hours.

For more information, check D on the HP Reply Card.

The HP-35: a better way to solve problems like these

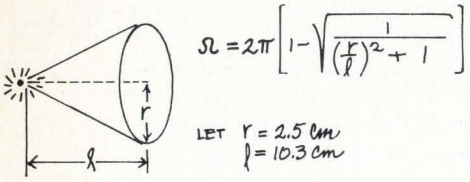
Unlike your slide rule, the HP-35 automatically positions the decimal point.



Are you still using your old college slide rule? Step up to an HP-35, the 9 ounce computer calculator that handles logarithms, exponents and trigonometric functions within seconds. Four registers and a solid-state memory hold intermediate solutions to problems, then automatically bring them back later for further processing. Answers are shown to ten significant digits.

Just for the fun of it, we compared the HP-35 with a slide rule. Here are two problems that show the relative time advantage and the significant advantage of greater accuracy.

Problem 1: Collection solid angle from a point source.



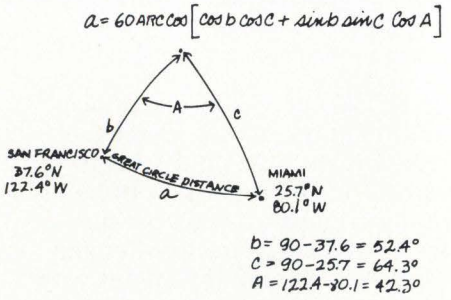
HP-35 solution:

2.5 ↑ 10.3 ÷ ↑ x 1 + 1/x √x CHS ↑ 1 +
2 x π x → .1772825509

Slide rule solution: .1776

Time on the HP-35: 20 seconds
Time on slide rule: 3 minutes, 15 seconds

Problem 2: Great circle distance between San Francisco and Miami



HP-35 solution:

52.4 cos 64.3 cos x 52.4 sin 64.3 sin x
42.3 cos x + arc cos 60 x → 2254.093016

Slide rule solution: 2255 nm.

Time on HP-35: 65 seconds
Time on slide rule: 5 minutes

The HP-35 consistently performed computations in 10%-20% of the "slide rule time." Isn't your time worth it?

For more information, check A on the HP Reply Card.

Three in one: counter, D/A converter, DMM

A multimeter and a D/A converter are the most recent in a growing line of "snap-on" modules for the 5300 counter.

When is a counter more than a counter? When it's a multimeter and a digital-to-analog converter as well. Now, you can get two new snap-on modules—a five-digit multimeter and a D/A converter—to increase the versatility of HP's 5300 Measuring System. Time interval and frequency (10, 50 or 525 MHz) modules and a battery pack are also available.

The 5306A multimeter module measures frequency to 10 MHz; ac and dc voltage, from 1 mV to > 99V; and resistance, from 0.1Ω to 10 MΩ. Accuracy depends on what and where you are measuring; for example, accuracy of the lower dc ranges is 0.03% of reading +0.003% of scale. Two sample rates let you trade off between speed and resolution.

The 5311A D/A converter fits between the counter display and any function module. You can make expanded-scale analog recordings of frequency, period, time interval, ratio, dc and ac volts, or ohms.

There's more. Check K on the HP Reply Card.

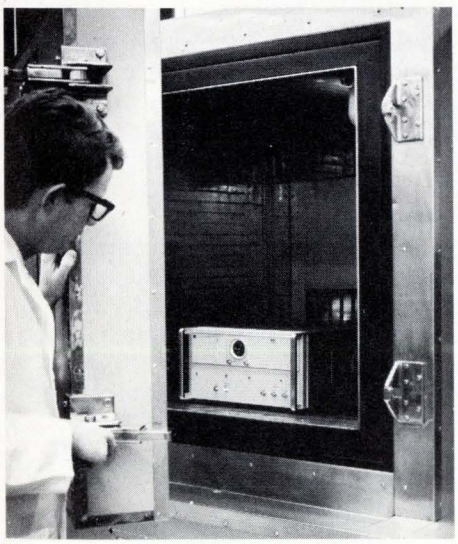
Cesium beam standard now more accurate than ever

The HP cesium beam standard has long been recognized as the world's most accurate commercial instrument. Now, the 5061A cesium beam primary frequency/time standard is even more accurate—±7 parts in 10^{12} —thanks to a new optional high-performance tube that took five years to develop.

Short-term stability of the 5061A was ±5 x 10^{-11} (1 sec. average); the new tube improves that stability by a factor of ten. It's the only instrument with the long-term stability of a primary standard and the excellent short-term stability associated with rubidium standards.

We've also further improved immunity to the effects of external magnetic fields and reduced sensitivity to acceleration, vibration, rotation and temperature change. No wonder HP's cesium beam standards are used for navigation, communications, and tracking satellites.

For more information, check H on the HP Reply Card.



HP cesium beam standards undergo extensive environmental testing. Here, one is being tested at high altitude and high and low temperatures.

Multi-faceted new tape drive for OEM and end-user alike

The versatile 7970E tape drive features fast data transfer —up to 72,000 characters/second.

HP's new digital magnetic tape drive can handle virtually any recording problem—200, 556 or 800 cpi NRZI; any speed from 25 to 45 ips; or 1600 cpi phase-encoded recording that is ANSI/IBM compatible. You get 7 and 9 track, multi-density, NRZI and PE capability—*all* in one read-only tape drive, model 7970E.

The 7970E is simple, reliable, and accurate. There are no gears, belts, or complex linkages. Direct drive motors handle the tape precisely and gently. Yet, all major transport assemblies are easily accessible for service, and all data electronics are on plug-in cards. Many of these features are usually found only in higher priced and more complex tape drives.

For the end-user, complete 7970E subsystems include the tape drive, interface controller, and all software required for operation with either HP 2100 or 3000 series computers. For the OEM, several configurations and options customize the tape drive to any application. (OEM discounts are available.)

For more details, check O on the HP Reply Card.

New bit error rate test set for digital communications

Besides testing PCM equipment, the 3760A/3761A tests computer memories, disc storage, digital recorders, and high-speed logic circuits.

Now, there's a new bit-error-rate test set to check the performance of digital communications systems, particularly those that use pulse-code-modulation. The test system consists of a 3760A data generator and a 3761A error detector. Using psuedo random binary sequences (PRBS) with bit-by-bit comparison, the system measures bit error rate and total error count at rates from 1.5 to 150 megabits/sec. The bit error rate is automatically ranged on the LED readout, and the test set catches both random and systematic errors.

It's extremely flexible. Data and clock outputs and their complements have adjustable levels and offsets; synchronization and gating are compatible with almost any PCM system condition; and PRBS length is variable. Data delay and phasing controls let you equalize the effects of cable length. Attach a printer, and you can let the system run unattended. The system also checks itself through deliberate introduction of errors.

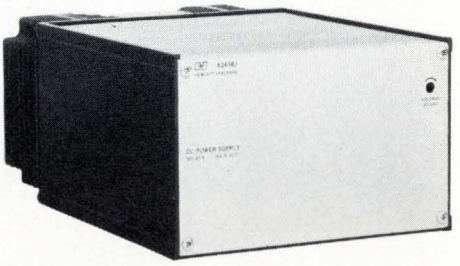
To learn more, check F on the HP Reply Card.

Switch to HP's new high efficiency power supplies

Nine voltage outputs most often used in system, computer and buried OEM applications are available in the 62600J series of switching regulated power supplies. Output voltage ratings range from 4V, 160W to 28V, 300W. The 5V, 40A model is especially popular for TTL logic power applications.

The supplies feature an advanced 20 kHz transistor switching design with up to 80% efficiency. You get more power in a smaller, cooler-operating package, with 0.2% combined line and load regulation, 20 mV rms/30 mV p-p ripple and noise (20 Hz to 20 MHz). And, HP thinks ahead to give you all the built-in protection you need: overvoltage, overcurrent, overtemperature, reverse voltage, and protected remote sensing.

For systems applications, the overvoltage protection circuit can be tripped by an external trigger pulse. The circuit will also generate an output pulse when activated internally. Turn-on and turn-off sequencing of several supplies can be accomplished by external contact closures.

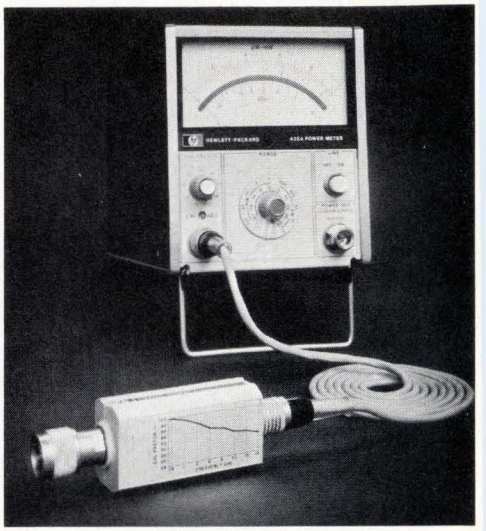


These regulated power supplies are packaged in half-rack width cases.

OEM and quantity discounts are available.

For more information, check L on the HP Reply Card.

Now, measure microwave power more accurately



For microwave power measurement, this system has high accuracy with wide dynamic range and broad frequency coverage.

Mismatch uncertainty, usually the largest single source of error in microwave power measurements, is now greatly reduced when you use our new thermocouple power meter. The HP 435A power meter/8481A power sensor measures power levels over a 55 dB range from 0.3 μ W to 100 mW in the frequency range from 10 MHz to 18 GHz. The thermocouple sensor boasts a VSWR $<$ 1.2 for 30 MHz to 12.4 GHz, and $<$ 1.3 for 12.4 GHz to 18 GHz—less than half the reflection specified for most other microwave power detectors.

The thermocouple power sensor is unique: it's a silicon-integrated device that is sensitive yet rugged, small yet precise. Advanced silicon technology accounts for the sensor's low VSWR and broadband performance.

Other important features include:

- Built-in precision RF power reference which permits the user to verify calibration anytime, anywhere.
- Optional internal battery for field applications.
- Sensor can be placed up to 200 feet from the meter for remote power monitoring.

For details, check G on the HP Reply Card.

New limiter protects microwave instruments against overload

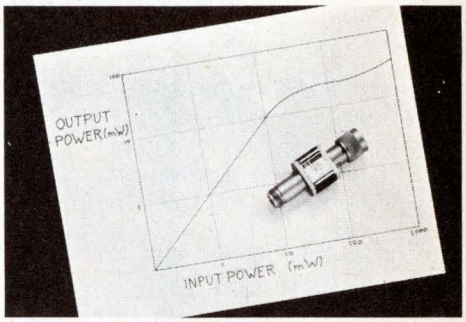
Now, you can protect sensitive instruments from external signal overloads—without affecting lower-level measurements or inhibiting the dynamic range. HP's new 11693A microwave limiter typically introduces less than ±½ dB variation in frequency response from 0.1 to 2.4 GHz.

Limiting action begins around 1 mW. Even if 1W CW or 75 W peak power is applied, the microwave limiter's output stays well below 100 mW.

Use it to protect amplifier front ends, mixer diodes, and sampling circuits. The limiter is especially valuable if connected to a receiver or spectrum analyzer input when an antenna could be picking up strong signals, unbeknownst to the operator.

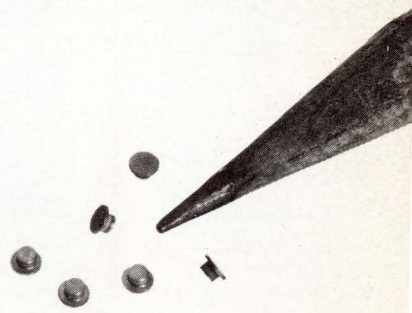
For details, check C on the HP Reply Card.

The unobtrusive 11693A limiter can help protect your microwave instrument investment.



HEWLETT-PACKARD COMPONENT NEWS

New fast-switching PIN diodes



The 3305 comes in a ceramic pill-type package (shown here); the 3306, in a ceramic double-stud package.

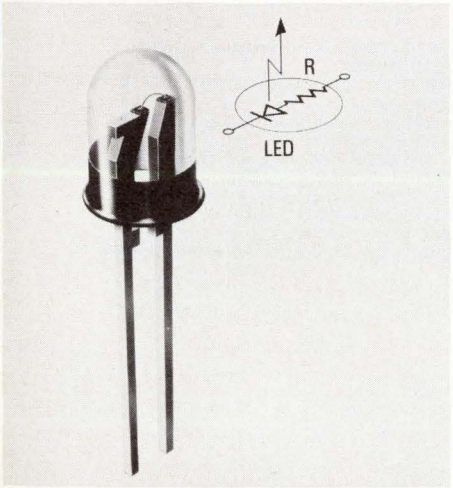
Two new PIN diodes provide the unusual combination of fast RF switching (< 5 ns, typical) and low residual series resistance (< 1 Ω). At the same time, the 5082-3305/3306 series have high power limiting capability (50W peak power).

The new diodes control and process microwave signals up to Ku band. You can use them in single and multi-throw switches, pulse modulators, amplitude modulations, phase shifters, duplexers, diplexers, TR switches and limiters.

For complete specifications, check I on the HP Reply Card.

HP's new combination: resistor and LED

This new 5082-4860 resistor-LED is ideal for panel-mounting.



Now, HP has added two resistor-LEDs to its popular line of LED lamps. Because of the integral current-limiting resistor, the new LED can replace 5 V lamps directly.

Choose model 5082-4468 with clear diffused lens and .125 in. (.3 cm) diameter, or model 5082-4860 with red diffused lens and .200 in. (.5 cm) diameter. The latter has long leads for easy wire-wrapping.

Both resistor-LEDs are TTL compatible with a typical forward current of 16 mA at 5 V. Luminous intensity is .8 mcd typical.

For more information, check J on the HP Reply Card.

A fast, efficient way to troubleshoot digital circuits

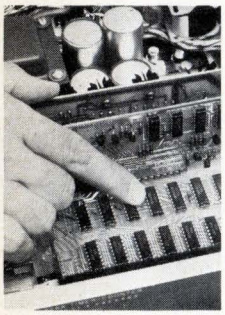
One major difficulty in troubleshooting digital circuits is observing the results of long, complex waveforms on several nodes simultaneously and detecting a single shot or intermittent error. HP offers the 10529A logic comparator to do this task. Using a component comparison technique, it makes in-circuit functonal tests of suspect ICs. By paralleling the IC under test and a reference IC, the comparator checks the responses of both ICs to the system's operating waveforms and indicates differences as errors. Intermittent errors as short as 200 ns are "stretched" to a 0.1 sec. indication on the LED display.

This portable, hand-sized instrument is ideal for field service and production tests where you have to repair complex circuits rapidly. By focusing attention on the area of malfunction, the comparator eliminates time-consuming tests on areas that are operating properly. You thus apply your skills solving the problem, not looking for it.

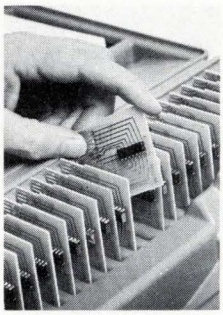
Another challenge in digital testing is large feedback loops. The only effective method is to see that each component in the loop responds properly to the signal received, *regardless of signal validity*. By looking for bad components instead of expected waveforms, the comparator eliminates wasted time and energy chasing around the feedback loop.

An HP logic comparator soon pays for itself through decreased repair time and increased user efficiency.

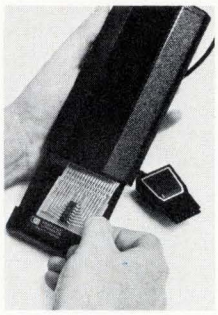
For more on digital troubleshooting, check B on the HP Reply Card.



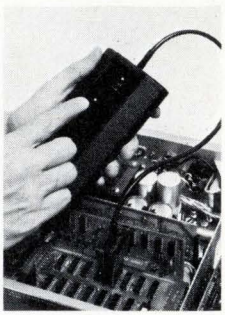
To use the logic comparator, merely select the IC to be tested.



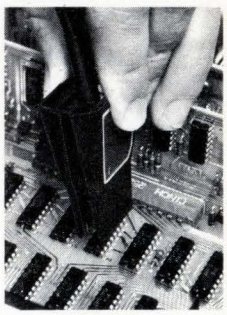
Select a reference board with a good IC that has the same type number.



Insert the reference board into the logic comparator.



Attach the clip to the suspect IC and check the comparator display.



The suspect and reference IC are compared automatically. Indicator lights signal which pins are faulty.

HEWLETT hp PACKARD

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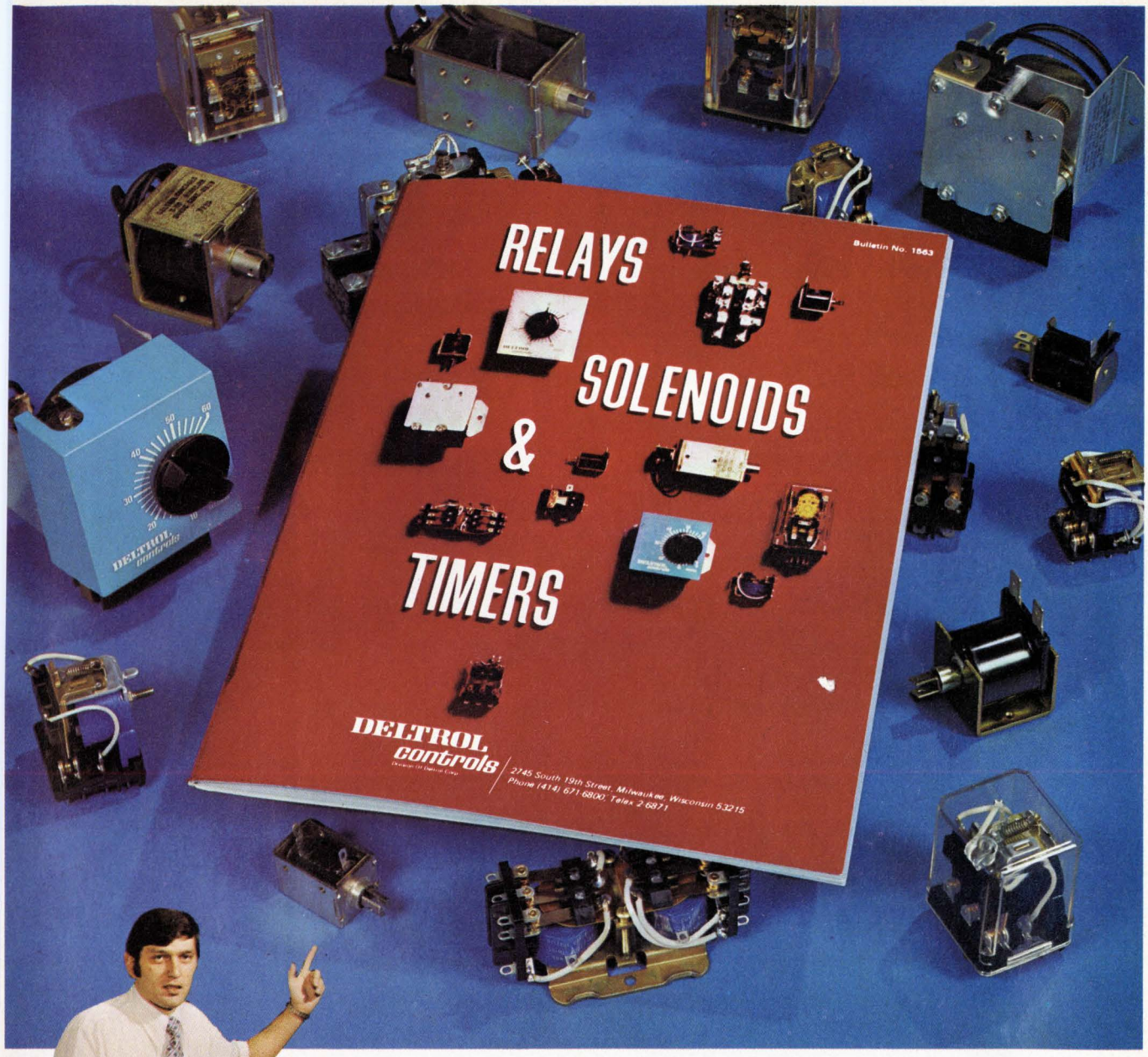
East—W. 120 Century Road, Paramus, N.J. 07652, Ph. (201) 265-5000.
South—P.O. Box 2834, Atlanta, Ga. 30328, Ph. (404) 436-6181.
Midwest—5500 Howard Street, Skokie, Ill. 60076, Ph. (312) 677-0400
West—3939 Lankersheim Boulevard, North Hollywood, Ca. 91604, Ph. (213) 877-1282.
Canada—275 Hymus Boulevard, Pointe Claire, Quebec, Canada, Ph. (518) 561-6520.
Mexico—Adolfo Prieto 622, Col. del Valle, Mexico 12, D.F., Mexico, Ph. 543-4232 or 523-1874.



Deltrol's New catalog lists 1570 relays, 232 solenoids and 218 timers . . . and it's yours, free!

One of Deltrol's relays, solenoids or timers may be just what you're looking for. You'll find engineering specs and prices for 5, 10, 15 amp AC and DC general purpose relays, including the popular new 160/165 series...25 amp heavy duty power relays with or without auxiliary switch...magnetic latching relays up to 6PDT...low, medium and highpower intermittent and continuous duty solenoids with optional buzz trimmer that eliminates AC hum...medium and heavy duty clappers with adjustable stops...and interval, pushbutton, repeat cycle, fixed or adjustable automatic reset timers. We'll send you this catalog **free** if you circle the number below or write to...

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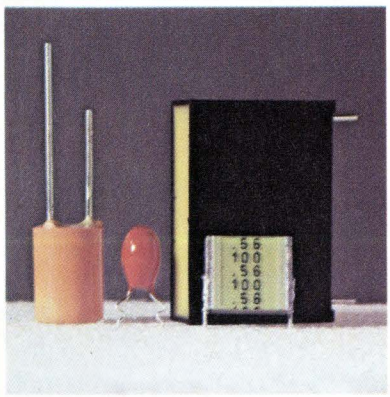
Research and development. Siemens spends over one million dollars every day on R & D, much of it in the component field. It's no wonder, then, that 90% of the components we offer today were unknown 10 years ago.

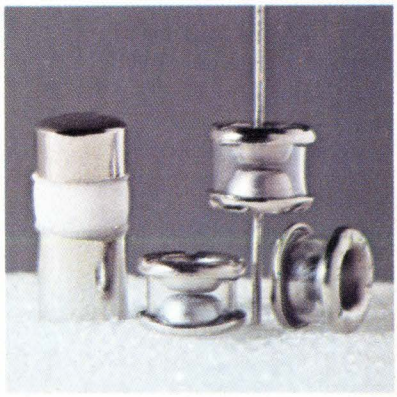
Wide product spectrum. Last year Siemens produced over 700 million components in more than 50,000 different shapes and sizes. These included capacitors, ferrites, transistors, diodes and microwave tubes. Plus a large variety of relays and surge voltage protectors.

Siemens Corporation, 186 Wood Avenue South, Iselin, New Jersey 08830. (201) 494-1000.

Relays



Capacitors



Surge voltage protectors

Circle 29 on reader service card

Meetings

International Magnetics Conference (Intermag): IEEE, Washington Hilton Hotel, Washington, D.C., April 24–27.

Electro-Optics Principles and Applications: SPIE, OSA, Sheraton, Boston, April 30–May 1.

Electron Device Techniques Conference: IEEE, United Engineering Center, New York, May 1–2.

National Relay Conference: NARM, Oklahoma State U., Stillwater, Okla., May 1–2.

Electronic Components Conference: IEEE, EIA, Statler-Hilton, Washington, D.C., May 14–16.

Naecon: IEEE, Sheraton, Dayton, Ohio, May 14–16.

International Symposium: SID, Statler-Hilton, New York, May 15–17.

Electron, Ion, and Laser Beam Technology: MIT and IEEE, MIT, Cambridge, Mass., May 21–23.

Aerospace Instrumentation Symposium: ISA, Frontier, Las Vegas, Nev., May 21–23.

National Aviation System Planning Review Conference: FAA, Washington Hilton, Washington, D.C., May 21–23.

Electronic Component Show: RECMA, Olympia, London, England, May 22–25.

Conference on Laser Engineering and Applications: IEEE, OSA, Hilton, Washington, D.C., May 30–June 1.

International Microwave Symposium: IEEE, U. of Colorado, Boulder, June 4–6.

National Computer Conference and Exposition: AFIPS, New York Coliseum, June 4–8.

International IEEE G/AP Symposium and USNC/URSI Meeting: IEEE, U. of Colorado, Boulder, Aug. 21–24.

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5 ranges dc volts
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$1995, complete DMM

Both instruments use Fluke's patented recirculating remainder a-to-d converter for low parts count, low power consumption and boast a calculated MTBF of at least 10,000 hours. ● Either instrument gives you more multimeter for your money. **Now isn't that an offer you can't refuse?**

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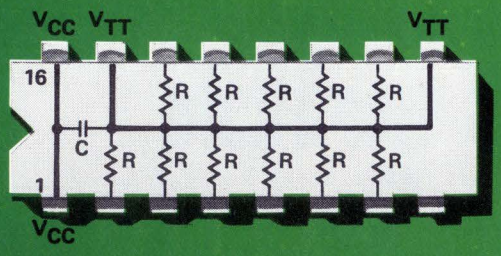
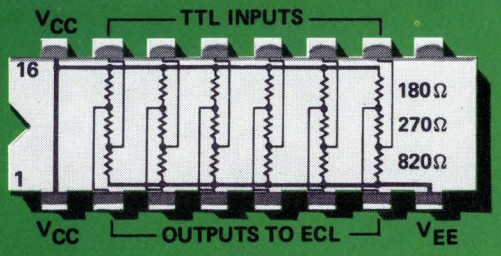


SERIES 898-41 −2.0 VOLT TERMINATORS contain eleven resistors for ECL line termination to a −2.0 volt bus. Each unit includes a 0.01 μF decoupling capacitor to bypass the −2.0 volt bus. Standard R values of 50, 75, and 100 ohms are available and are designated 898-41-R50, 898-41-R75, and 898-41-R100.
Price (1,000-4,999) $1.25

SERIES 898-42 −5.2 VOLT TERMINATORS contain twelve resistors for pull-down to the −5.2 volt bus. Each unit contains a 0.01 μF decoupling capacitor to bypass the −5.2 volt bus.
Price (1,000-4,999) $1.25



SERIES 898-45 TTL TO ECL TRANSLATOR contains six identical three-resistor sections for direct translation from TTL to ECL, both operating between a +5 volt supply and ground.
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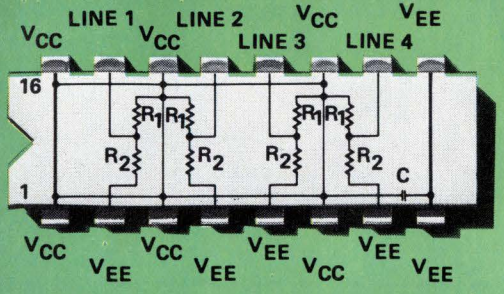
Butterfly
Diurnal insect of the order *Lepidoptera*, characterized by clubbed antenna, a slender body, and large, broad, often conspicuously marked wings. Often found fluttering about the design engineer's stomach.

Our Bugs will get rid of your Butterflies

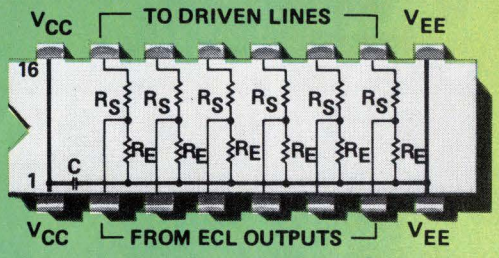


SERIES 898-43 THEVENIN EQUIVALENT TERMINATORS contain four Thevenin equivalent terminator sections. Each terminator section consists of two resistors connected as a divider from the ground bus to the −5.2 volt bus providing a Thevenin equivalent voltage of −2.0 volts. Each unit contains a 0.01 μF decoupling capacitor to bypass the −5.2 volt bus. Series 898-43 units are available with Thevenin equivalent impedances of 50, 75, and 100 ohms.

Series 898-43 R_1 and R_2 Values

Model	R_1	R_2
898-43-Z50	81Ω	130Ω
898-43-Z75	121Ω	195Ω
898-43-Z100	162Ω	260Ω

Price (1,000-4,999) $1.25



SERIES 898-44 SERIES LINE TERMINATORS contain six series terminator sections. Each section is designed for terminating a line at the driven end with a series resistor value equal to the line impedance minus the 7 ohm output impedance for 10,000 series ECL. The second resistor in each section is a pull-down resistor to the −5.2 volt bus. Each unit contains a 0.01 μF decoupling capacitor to bypass the −5.2 volt bus.

Series 898-44 R_S and R_E Values

Model	R_S	R_E
898-44-S43	43Ω	457Ω
898-44-S68	68Ω	682Ω
898-44-S93	93Ω	907Ω

Price (1,000-4,999) $1.25

ECL Terminator Collection

Dependable Beckman ECL terminator networks are specifically designed for, and compatible with, the following Emitter Coupled Logic families:

- Motorola MECL 10,000 Series
- Signetics 10,000 Series ECL
- Fairchild 95K and F10K Series ECL
- Texas Instruments Series SN10000 ECL
- National Semiconductor 10,000 Series ECL

Each Beckman ECL terminator network utilizes thick film resistor materials with layouts specifically designed for low inductance and the high speed requirements of ECL systems. Where possible, the terminator networks include 0.01 μF decoupling capacitors.

Each network is capable of operating in a +85°C still air environment at standard ECL voltage levels and tolerances without heat sinking.

For complete technical data, contact your local Beckman/Helipot representative or write to Beckman Instruments, Inc., Helipot Division, 2500 Harbor Blvd., Fullerton, Calif. 92634.

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Uniform manufacturing process results in consistent quality that lowers your installed cost. And cuts down unnecessary after-purchase expenses. As a result, some of our customers have been able to discontinue incoming inspection. The unique Allen-Bradley hot-molding process minimizes the variations that make ordinary resistors noisy, thermally sensitive, and poor on power handling ability. If you think all resistors are the same, read: "7 ways to tell the difference in fixed resistors." Free from your A-B distributor, or write to: Allen-Bradley Electronics Division, 1201 S. 2nd St. Milwaukee, WI 53204. Export: Bloomfield, NJ 07003. Canada: Allen-Bradley Canada Ltd., Cambridge, Ontario. U. K.: Jarrow, County Durham NE32 3EN.

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Circle 34 on reader service card

Electronics newsletter

IR thermal tester finds auto market

Infrared thermal monitoring, a technique developed to improve the quality of IC wire bonds, already is beginning to justify the promises made for it late last year [*Electronics,* Jan. 4, p.36], and in markets far removed from ICs. **Vanzetti Infrared and Computer Systems Inc., Canton, Mass., has delivered eight specialized infrared-radiation-detection systems to the Cadillac division of General Motors for use in controlling induction heat-treating of valve seats** in automobile engines. The firm also has completed the first of an anticipated 10 sales of dual monitoring units to Chevrolet's Vega assembly plant, where the systems will monitor induction-heating of camshafts. **Chrysler has also purchased two units to monitor the small welds made in the windings of fraction-horsepower motors such as those used in power equipment and windshield wipers.** A minimum system is priced at about $2,000.

Rockwell to build n-channel RAM on sapphire

The Microelectronics division of Rockwell International Corp., going a step beyond the silicon-on-sapphire read-only memories it has announced [*Electronics,* March 15, p. 25], will soon enter the fast-moving random-access memory market with **a 1,024-bit n-channel RAM on a sapphire substrate. First evaluation devices are scheduled for late spring availability, says Robert L. Doty, vice president for engineering.** Rockwell officials are conservative about performances at this time, saying that access time will be less than 100 nanoseconds with power dissipation of about 250 milliwatts. **It's no secret, though, that an SOS RAM could be specified at twice that speed.** To date, the only SOS RAM on the market is Inselek Co.'s 256-bit complementary unit, although Inselek soon plans to add a 1,024-bit device as well. RCA and Motorola also have developmental efforts in SOS.

Consumers Union sued for microwave safety stand

Reversing the usual roles, **Amana Refrigeration Inc., Amana, Iowa, has filed a complaint with the Federal Trade Commission against Consumers Union, publishers of "Consumer Reports,"** concerning statements in the current issue about microwave-oven safety. The action also names Ecometrics, charging that a microwave-emission-measuring device made by the California-based firm has been found unreliable by the Bureau of Radiological Health for oven-compliance testing.

The complaint against Consumers Union alleges that the oven report [*Electronics,* March 29, p.62] falsely holds CU to be an expert in microwave-oven technology; indicates that the U.S. standard permits 500 times as much microwave leakage as the USSR standard; and it states that most ovens have one-year parts and labor warranties, plus an additional year of magnetron-replacement coverage, less labor costs.

H-P opens retail sales offices in major cities

Hewlett-Packard Co., the Palo Alto, Calif., instrument house, has opened combination sales-showrooms in the business districts of New York, Chicago, and San Francisco. **The company expects to begin selling pocket calculators over the counter in about two weeks.** The full H-P calculator line—including the 9800 series—will be on display. Stanley Pedaris, district manager of the New York office, explains that the company's latest marketing effort is aimed principally at the business community, as H-P tries to add to its engineering-customer base.

Electronics newsletter

Multiwire market claimed to increase at 30% a quarter

Now that conventional circuit-board deliveries are stretching out, **multiwire—a point-to-point wire system that looks like a printed-circuit board but is fabricated with speed and flexibility approaching wire-wrap—is taking off.** Shipments are climbing at the rate of 30% each quarter, says Allison (Duke) Danzig, marketing manager for the Photocircuits division of Kollmorgen, Glen Cove, N. Y. Multiwire has also been helped by the user who stays with multiwrap even though his production has passed the crossover point where the conventional pc board becomes cheaper (anywhere from 20 to 200 boards, depending on complexity), Danzig adds. The manufacturer can be assured of fast delivery, and he can make circuit changes inexpensively. **Multiwire deliveries can be made as quickly as six weeks, Danzig says, while a comparable multilayer board would require 18 to 26 weeks.**

Seamans seen healing engineers after split with NAS

Outgoing Air Force Secretary Robert Seamans faces a new challenge when, as expected, he becomes **the new president of a separately incorporated National Academy of Engineering,** now that NAE's governing council has recommended to its membership that it split with the National Academy of Sciences. **Seamans will have to revitalize the image of the organization,** upset over losing its long civil war with the NAS over influencing National Research Council policies. First fireworks are set for May 3, when NAE members vote on separating, but the battle will be long: if they vote to separate this spring, they must vote again Oct. 24 to make it stick under NAE by-laws.

DEC wins bid to automate tolls on Ohio Turnpike

Digital Equipment Corp., Maynard, Mass., has beaten IBM—originally expected to be a sole source—in competition for automating toll collection on the Ohio Turnpike. DEC staked its PDP-11/05 against unspecified small IBM computers, and prime contractor Electron Inc., Cleveland, picked DEC for the $2.6 million installation. **Two DEC minis will go into each of 17 toll plazas with one unit on-line and one in a back-up mode.**

Electron is making toll-booth terminal equipment, which includes a magnetic-card reader and a 16-character alphanumeric display. Toll data is to be stored in local disks and dumped daily into a central computer at turnpike headquarters. All toll plazas are to be automated by early 1974.

Addenda

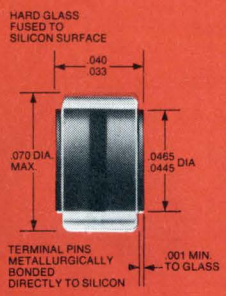
Watch for a bargain-basement-priced Naked Mini to come soon from the people who coined the term. Computer Automation Inc., Irvine, Calif., has dubbed the 16-bit computer the Naked Mini 16/LSI. **It will include a central processor, 4,000 words of memory and some options on a single board, and it is expected to sell for about half the price of the company's present Naked Mini 16,** priced at about $1,995 in OEM quantities. The 16/LSI will use MOS in the CPU. . . . Meanwhile, Applied Computing Technology Inc., also of Irvine, has offered a 4-bit 1,280-word one-board processor for $695, and Motorola Semiconductor Products division expects to introduce an n-channel silicon-gate microprocessor chip kit in early 1974.

PIN diode "Micro Pills"

A CURE FOR STRIPLINE AND MICROSTRIP HEADACHES

RUGGED, HERMETICALLY SEALED PIN DIODES ALSO PROVIDE CONTINUOUS RELIEF FROM MICROWAVE CHIP PROBLEMS.

They're immune to shock, dirt, moisture, scratches and other handling hazards, because they're voidless, metallurgically bonded and fused-in-glass for optimum reliability. Though small enough to use like ordinary chips, Unitrode "Micro Pills" can dissipate 15 watts of average power and 60 kilowatts of peak power. And they can withstand thermal cycling from −195°C to +300°C without permanent degradation. Carrier lifetimes exceeding 2.5 μ sec assures low distortion performance. They're ideal for stripline and microstrip applications. Used as switches, duplexers, phase shifters, attenuators, amplitude modulators, or receiver protectors, they operate as a variable resistance controlled by a self generated or externally applied bias circuit. The unique construction allows remarkable assembly flexibility, withstanding temperatures up to 400°C when soldering or brazing "Micro Pill" PIN diodes to various circuit media. They're as low as $4.00 each in 10K quantities. Switch to UM7900 series "Micro Pills" and feel better all day long.



For free samples, call or write Howard Kaepplein at (617) 926-0404 collect, Unitrode Corporation, Dept. 3Y , 580 Pleasant St., Watertown, Mass. 02172. For the name of your local Unitrode distributor or representative, dial (800) 645-9200 toll free, or in New York State (516) 294-0990 collect.

UNITRODE

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☐ Please send technical data on the following PIN diode "Micro Pills"

Type	Voltage Rating (volts)	Series Resistance @ 100 mA (ohms)	Total Capacitance (pf)
UM7901A	100	1.0 MAX	0.8 MAX
UM7902A	200		
UM7904A	400		
UM7906A	600		
UM7910A	1000		

NAME: _____ TITLE: _____

CO.: _____

ADDRESS: _____

CITY: _____ STATE: _____ ZIP: _____

TELEPHONE: _____

See EEM Section 4800 And EBG Semiconductors Section for more complete product listing.

Circle 37 on reader service card

We cut one diode's delivery time 50% so an OEM could meet his deadline.

Fighton, Inc., Rochester, N. Y., makes electrical power supplies and transformers. Production schedules are tight. Their suppliers weren't always able to deliver the thyrector diode they needed on time. Until General Electric Sales Assistant Kathy Calkins heard about it from one of our industrial distributors.

She began phoning Fighton and offering our services. They're not a huge company. In fact, they're minority-owned and managed, and fairly young. At first they seemed a little skeptical about GE's direct interest in them.

But Kathy kept at it. Finally she convinced them to give us a try. Our delivery schedules looked good. Prices were fine. Best of all, we seemed sincere.

Kathy then began to get things moving for Fighton. Normal delivery time for the diodes was 8-12 weeks. Our plant cut it to four weeks. And GE got the order through the distributor.

Fighton got their components on time. And GE gained a good customer. As Kathy said, "If I can identify what a customer really wants and solve his problems, then I've got an order."

Kathy and others like her at GE want to keep you happy. Because you're a customer. And keeping customers happy by providing better service is how to keep our business healthy. 690-13

GE won't leave you alone.

OUR NO. 1 GOAL:
TO MAKE
GENERAL ELECTRIC
YOUR BEST BUY

BEST BUY
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QUALITY · SERVICE · VALUE

GENERAL ELECTRIC

White House halts political screening of East-West trade advisors

Commerce Department exempted after appeal of obstacle to forming of new committees

The Commerce Department has gained an exemption from political screening by the White House of industry candidates for six new advisory committees set up to reduce export controls. The committees, mandated by Congress last year, include one on semiconductors, another on semiconductor-manufacturing and test equipment, two on computers, and groups on telecommunications and machine tools.

The exemption, obtained March 28 by former White House aide Jeb Stuart Magruder, now a Commerce Department official, was disclosed the same day to a Washington meeting of top-management members of WEMA, the California-based association of electronics and information-technology companies.

The disclosure was made by the Commerce Department's Steven Lazarus, director of the Bureau of East-West Trade, who noted that until the White House exemption, the "whole process had been agonizingly slow" in getting the committees formed and active.

EDP tops. The two semiconductor groups conducted their first meetings on March 26 and 27, and Lazarus said he expects to have the remaining committees formed by the end of April. The first meeting of the computer committees is scheduled for April 23, said Lazarus, who expects their 16 members to be equally divided between makers of central processors and peripheral equipment. "The computer committees are of maximum importance to me," he told WEMA, "as is the committee on telecommunications."

After the session, in corridor conversation with Tektronix president Earl Wantland, Lazarus listened to an appeal for what Wantland later said is an effort led by his company and Hewlett-Packard to set up a similar technical advisory group on electronic instrumentation.

Members of the semiconductor panel include Ray M. Brown, Rockwell International; J. Fred Bucy Jr., Texas Instruments; Roger C. Damm, Motorola; James V. Diller, National Semiconductor; John C. Hey, General Electric; and Harry Sello, Fairchild Camera and Instrument. The semiconductor manufacturing and test equipment group include TI's Bucy; Vito Di Mucci, Fairchild; Frederick T. Van Veen, Teradyne Inc.; Ewald R. Werych, Sola Basic Industries, and Burton T. Wheeler Jr., GCA Corp.

Controls. Lazarus told the WEMA executives that his Bureau of East-West Trade is "here to help you make deals." The aim of the committees is to accelerate the shipment of exports of electronics to Eastern Europe, Russia, and China as a means of countering the mounting U.S. trade deficit. Among the priorities outlined by the young and articulate Lazarus is a reduction in the number of U.S. unilateral export controls to between 25 and 50 by the end of May. The unilateral lists—separate from those imposed by the Paris-based Coordinating Committee (Cocom) for Strategic Western Export Controls, of which the U.S. is a member [*Electronics*, Oct. 9, 1972, p. 76]—has already been "scrubbed down" from 550 items to 190 items.

Citing complaints of semiconductor manufacturing and test-equipment makers that they have been unable to obtain licenses for overseas shipment of trade-show exhibits, much less salable hardware, Lazarus said he wants "to do away with that [licensing process] entirely." Eventually, he said, he expects to make U.S. licensing procedures no different from those of other Cocom countries. He called on the WEMA membership to assist in furthering the elimination of controls by submitting documented examples of export-license denials to Communist countries where comparable electronic products can be shown to have been obtainable on the open market from other free-world countries.

Lazarus indicated that Cocom controls are beginning to diminish

China traders meet

Besides helping to set up the East-West trade committees, the Commerce Department's Steven Lazarus recently attended the first meeting of those organizing the new National Council for U. S.-China Trade. Expected to hold its first formal meeting in May, the Council will be private and self-sustaining, with membership open to interested companies. Westinghouse Electric Corp. chairman Donald Burnham heads the Council, which already has 19 top U.S. industry leaders on its executive committee.

in their effectiveness, noting that "the U.S. is now the heaviest submitter of waiver applications." □

Government electronics

Study shows rise in Federal R&D funds

Electronics companies can take heart from trends on Federal research and development funding documented by the National Science Foundation. Estimates covering fiscal 1971 to 1973 indicate that, despite budget-cutting pressures, the Federal R&D dollars are growing slightly. This is mainly due to an increase in applied research that overshadows a so-so performance in basic research and a downward trend in development programs.

Preliminary estimates of $17.4 billion in total R&D for fiscal 1974 show "continuation of a slight increase," says Ben Olsen, study director of the foundation's Government studies group. Defense programs show the biggest absolute gain, and NASA has dropped a bit, according to projected spending levels, Olsen says.

Measured in 1967 dollars to account for inflation, Federal R&D funding established an upward trend during 1971 to 1973, following the downturn in the late 1960s. Basic research grew 11% annually, applied research and development 6%. In fiscal 1973 basic research is slated for a record $2.6 billion, applied research for an all-time high of $4.7 billion, and development for $10.5 billion. However, there is some bad news. Taking inflation into account, Federal R&D for fiscal 1972, for example, is 18% below 1967's $16.5 billion and about equal to 1963.

The Department of Defense will use about $400 million of the planned $950 million R&D increase for fiscal 1973 for missile programs, aircraft development projects, the Airborne Warning and Control System (Awacs), and sensor and surveillance systems. NASA, a large contributor, is holding its own.

Electronics managers who believe that development hardware contracts stem from applied research will be interested in a significant trend: during the 1963–1973 decade, funds for all research increased strongly, whereas development monies did not. As the chart below shows, applied research is where most of the money goes. It uses all but $30 million of total fiscal 1973 research funds in electronics-related engineering categories. □

FEDERAL ENGINEERING RESEARCH SUPPORT
In electronics-related fields by biggest agencies
(in millions of dollars)

TOTAL RESEARCH				APPLIED RESEARCH		
Aeronautical	Astronautical	Electrical		Aeronautical	Astronautical	Electrical
334 (219)	76 (88)	174 (257)	DOD total	332 (217)	69 (81)	159 (243)
27 (24)	–	50 (50)	Army	26 (23)	–	46 (46)
16 (14)	–	37 (35)	Navy	15 (13)	–	37 (35)
290 (180)	74 (84)	48 (126)	Air Force	290 (180)	67 (77)	38 (116)
305 (288)	186 (192)	48 (64)	NASA	279 (248)	182 (187)	45 (55)
24 (31)	–	23 (24)	DOT	24 (31)	–	23 (24)
2 (2)	–	17 (15)	NSF	–	–	5 (5)
665 (539)	263 (282)	278 (371)	All government	635 (496)	252 (269)	247 (334)

Note: Figures are FY 1973 estimates, FY 1972 figures are in parentheses.
Source: National Science Foundation

Companies

Lockheed division moves to diversify

The introduction of a data-entry and management system designed for business applications takes Lockheed Electronics Co., until recently a defense-oriented contractor, another step toward its goal of diversification. With the new LEC 3200 system, Lockheed hopes to build "a company within a company," asserts a high-level executive.

At the center of the data-management system is Lockheed's own MAC-16 minicomputer which, with some 1,500 in the field, has already helped expose the company to the industrial-commercial marketplace. With 32 kilobits of core, the LEC 3200 is one of the largest and most flexible systems on the market for formatting, verifying, sorting, printing, storing, and transferring information to and from a central computer, says James P. Scheer, general manager for data-management systems in the Products and Systems division.

Altogether, the system accommodates as many as 31 data-entry stations plus a typewriter-equipped supervisory terminal. A 24-station system, for example, is priced in the $185,000 range. Both a cathode-ray-tube terminal and a simpler keyboard replacement unit employing gas-discharge tubes are available. Also included from outside vendors are a 5-megabyte disk, magnetic-tape drives, an 1,100-line-per-minute printer, and a cassette for loading diagnostics and formats.

At Lockheed's helm during this diversification effort is William A. Stevenson, a 54-year-old veteran of the nation's missile program who became acting president in June, 1971, and president a year later. His goal is a 50-50 split between defense and commercial-industrial business; right now, Lockheed's $100-million per year business is 60% military.

Systems and software are strong Lockheed suits. For example, the company is building the sophisticated Mark 86 gunfire control system for the Navy and has just received a follow-on $31 million contract for more. In addition it has been marketing an air-traffic-control system suitable for most of the world's airports [*Electronics*, July 31, 1972, p. 24] and offering it on a turnkey basis.

But Scheer was brought into the picture precisely because of his application experience with similar systems as a regional manager at Mohawk Data Sciences Corp.

As for the company's other products, business is good although there is heavy pressure on prices in two prime areas—minicomputers and add-on core memories. Lockheed's printed-circuit business is running at capacity, and the company is expanding its capacity for computer memory cores. Also getting started is an electronic system that monitors sales at gasoline pumps.

But to implement Lockheed's diversification plans will be no mean feat, since the company has been pegging away at a steady $100 million sales level since 1968—even before the recession struck the electronics industries. □

Adding a commercial line. A major step in Lockheed's goal of product diversification is its new LEC 3200 data-entry management system designed for business applications.

Meetings

IEEE's Intercon called a success

IEEE's Intercon, held this year on two floors of New York's Coliseum, was probably more successful than the raw statistics of attendance and exhibit space would suggest. Be-

Rockwell adds SOS and watches to line

The consumer-calculator market has been good to the Microelectronics division (formerly NRMEC) of Rockwell International Corp., but while continuing to expand their calculator business, officials are beginning to put some eggs in a few other baskets.

R.S. "Sam" Carlson, division president, points out that calculators "have been a great base to build on, and they're still growing great, but by 1976, they'll account for less than half our business." The division's two newest business commitments are to silicon-on-sapphire products [*Electronics*, March 15, p. 25] and solid-state-watch development.

Robert L. Doty, vice president for engineering, says the Microelectronics division is shooting to have evaluation quantities of a 1,024-bit n-channel read-write random-access memory on a sapphire substrate late this spring (see p. 35). The device will have an access time of less than 100 nanoseconds and a specified power dissipation of 250 milliwatts. It will also be compatible with bipolar input and output logic levels.

Charles V. Kovac, vice president for marketing, indicates that both the SOS and solid-state-watch efforts "are solid business plans with large commitments." Kovac says that, "with the promise of a two-times markup, the watch market looks attractive, and we want to be selling at $25 for a retail price of $50. What attracts me to the watch market is the distribution channels offered by a Lloyds or Sears." Both those companies buy the division's calculators. The Microelectronics division will probably sell watch components, in addition to complete watches.

Meanwhile, there's no de-emphasis on calculators. These products are nearing the market:

- A single chip that calculates fractions for stockbrokers will probably be used in machines selling for $150.
- A four-function eight-digit machine, using a transmissive liquid-crystal display that is illuminated by ambient light focused behind the display, will probably sell for $69 and be marketed first by Lloyds; it will have a guaranteed continuous operating life of 40 hours on two 9-volt batteries.
- An eight-digit, four-function machine, combined with the division's teaching calculator, could be on the market this summer at under $200.
- A single-chip and a complete calculator that are electronic slide rules. The chip will begin moving to customers by June, and the complete machine, by September.

With all this activity, it's no wonder Rockwell Microelectronics is running at a sales level of $5 million a month, and Carlson predicts that by the end of September it will top $50 million in sales for the fiscal year.

cause exhibitors were confined to two floors, there was a bit more bustle—a welcome contrast to last year's roomy empty spaces.

Also, those attending the conference (25,000, compared with 24,300 in 1972) were potential customers, rather than lookers. Milton J. Lichtenstein, vice president of Ballantine Laboratories Inc., Boonton, N.J., says his only regret is that he didn't take a bigger booth. A Hewlett-Packard Co. spokesman says that H-P received 2,500 requests for additional data and that company officials are well pleased. A Burroughs spokesman called the show a success, and he said it was attended by more knowledgeable people than in the past. Burroughs had twice as many inquiries as last year.

Generally, the show's businesslike atmosphere was applauded by many who felt that the festive holiday aura of the big shows of past years had done more harm than good. However, a number of exhibitors contended that big shows like the IEEE can no longer serve industry's needs best. The electronics marketplace is rapidly becoming a meeting place for experts, and the big show is giving way to the smaller, specialized conference.

While attendance figures are about 700 higher than last year, the number of exhibitors dwindled from 268 to 226 and the total area of exhibit space went from 48,300 to 43,000, according to the IEEE. □

Show time. IEEE's Intercon '73 was more businesslike with attendance up over '72.

Computers

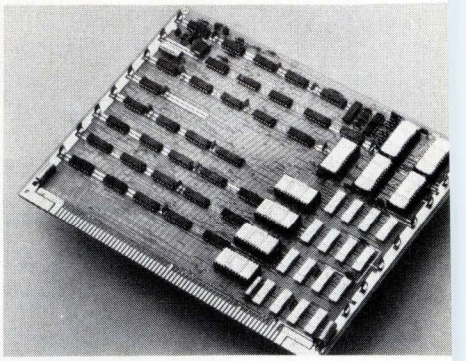
Now National's put computer on card

Until now, designers of systems for industrial monitoring, control, or data collection often had only two alternatives: to build a system around a minicomputer, or to "haywire it," starting at the component or printed-circuit-card level. Such systems are usually dedicated, meaning that neither system, once installed and operating, is ever loaded with a new program, except for debugging and maintenance. Since minicomputers, even in such dedicated applications, are nevertheless general-purpose machines, much of their capability is wasted. The other alternative, a custom design from scratch, requires large sums of money and long design and development times.

Now a third choice is available: the IMP-16C microprocessor from National Semiconductor Corp. Basically, it is a single printed-circuit card measuring 8½ by 11 inches—the size of a magazine page. It includes a 16-bit microprocessor, a 256-word read-write memory, a 512-word read-only memory (which may be programable or not, depending on the application), input-output bus drivers, and a clock system. All the integrated circuits on the card are standard off-the-shelf components except those that make up the microprocessor.

The microprocessor has at least one of each of two types of ICs; a register and arithmetic-logic unit (RALU) and a control read-only memory (CROM). Each RALU is a complete four-bit processor; the 16-bit data path of the IMP-16C is made of four RALUs working in parallel. All four RALUs are controlled by one CROM, which implements the 42 instructions and can address up to 65,000 words of memory, most of which, if used, would be packaged on a separate pc board. The RALU and CROM, taken as a pair, are called the general-purpose controller/processor (GPC/P). The name is somewhat misleading because it is not general-purpose at all, but GPC/P is more easily and inexpensively tailored to a specific purpose than a minicomputer can be. The company also plans to announce microprocessor boards of larger and smaller capacities than the 16C, and a complete system, consisting of the 16C, a chassis, power supply, console, and enclosure.

The system is microprogramed, and the customer can specify his own microinstruction set for his particular application. The RALU and CROM are not yet separately available, although National will announce them later this year. The IMP-16C is priced at $1,380 in single units. □



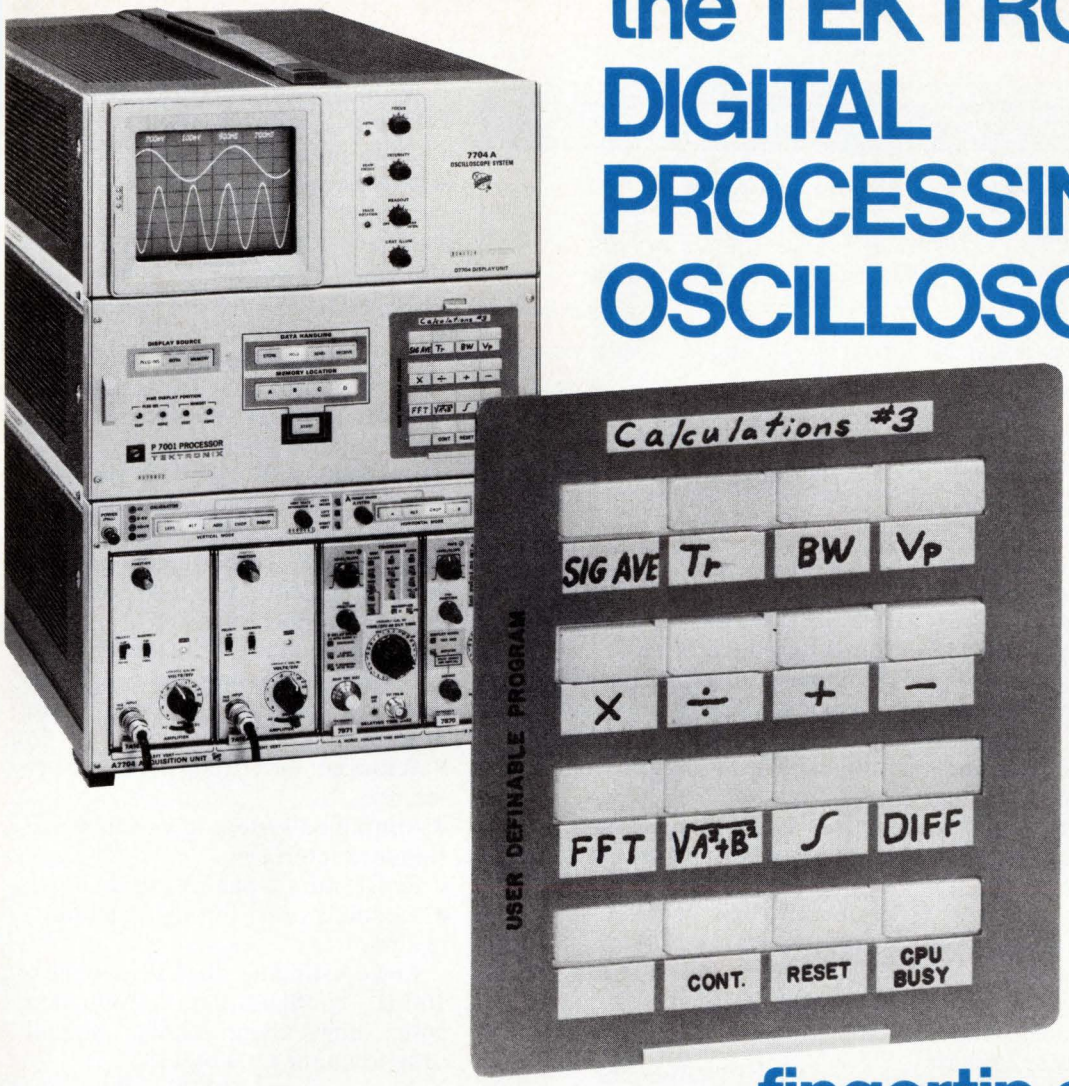
Card exposed. National Semiconductor's IMP-16C is the size of a magazine page.

Markets

U.S. sales hit peak in 1972, up 9.6%

Total U.S. sales of domestic and imported electronics climbed to nearly $30.6 billion in 1972, a 9.6% in-

the TEKTRONIX DIGITAL PROCESSING OSCILLOSCOPE...



...fingertip selection of entirely new waveform measurements.

The popular 7704A laboratory oscilloscope now has digital processing capability. The Acquisition unit A7704 and Display unit D7704 have a new look with a P7001 Processor unit inserted between them forming the APD unit. The Processor together with a PDP-11/05 minicomputer brings the power of computer processing to the signal display and acquisition capabilities of the Type 7704A.

The A7704 accepts more than 25 7000-Series plug-ins. Signal dimensions range from microvolts to kilovolts in amplitude, and from picoseconds to seconds in time, with bandwidths from DC to 14 GHz. The Digital Processing Oscilloscope is more than just a computerized oscilloscope. It is offered in packages complete with PDP-11/05 computers, computer terminals, computer peripherals and measurement software. TEKTRONIX offers two software packages APD BASIC I for the PDP-11 with 8 k core memory and APD BASIC II for 16 k core machines.

Using APD BASIC you store desired measurement programs in the computer. You may then fill in the User Definable Program overlay as shown above and your routines are available at the press of a button. The range of possible measurements is almost unlimited. You may have measurement operations which range from simple addition or multiplication to sophisticated integration, FFT and many more. A complete program involving many operations is easily stored and assigned to a desired push-button.

To learn the complete Digital Processing Oscilloscope story write for a copy of "The Digital Processing Oscilloscope", and "The 7000-Series Oscilloscope Catalog", or check the reader service box.

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U.S. FACTORY SALES OF ELECTRONICS
(IN MILLIONS OF DOLLARS)

Year	Consumer products*	Communications and industrial**	Government products	Replacement components	Total
1972	6,610	12,270	11,000	710	30,590
1971	5,525	11,063	10,700	634	27,922
1970	3,940	11,051 (7,996)	11,295	667	26,953 (23,998)
1969	4,829	10,843 (7,913)	12,287	718	28,677 (25,747)
1968	4,619	9,941 (6,693)	12,563	675	27,798 (24,550)

*Entries for 1971 and 1972 include production and purchases by U.S. manufacturers plus dealer and distributor imports for resale. Prior years exclude foreign-label imports. Statistics for imports are adjusted to U.S. factory values, including duties, freight to the U.S., and insurance.

**Parenthetical values represent totals prior to inclusion of telephone-equipment sales in communications and industrial-products category.

Source: EIA

crease on the $27.9 billion recorded the year before. The new record exceeded the previous high of $28.6 billion set in 1969. Sales turned out to be slightly higher than the year-end estimate of $29.8 billion for 1972 by the Electronic Industries Association, Washington, D.C., but very close to the $30.2 billion *Electronics* predicted in its annual market forecast [Jan. 4, p. 69]. The figures are contained in EIA's "Electronic Market Data Book," to go on sale near the end of April.

Part of the surge in the EIA figures can be attributed to the inclusion for the first time of distributor imports of consumer products and telephone equipment for resale. U.S. Commerce Department data shows, for example, that the country recorded its first electronics trade deficit in 1972. Imports of selected electronics and related products reached $3.5 billion last year—or $1.3 billion more than the $2.2 billion in exports. In 1971, the situation was reversed: U.S. exports were $3.5 billion and imports $2.5 billion.

Industrial tops. Communications and industrial electronics sales reached nearly $12.3 billion last year, up 10% from 1971 levels and topping Government business as the leading U.S. market for the second straight year. Nevertheless, sales of Government products rebounded slightly, rising 2.8% from 1971 to reach $11 billion, ending a four-year decline from the 1968 high of $12.5 billion.

Consumer electronics scored the largest percentage gain in 1972 from the year before. At $6.6 billion, the total of domestic and imported consumer products rose 19.5% from 1971. Sales of replacement components of all types also improved during 1972, expanding by 12% to $710 million. This is slightly under the 1969 record of $718 million. By percentage shares, the communications and industrial category led with 40% of the total, followed by the Government's 36%, the EIA says. The consumer market accounted for 22%, while replacement components accounted for the remaining 2%. □

Peripherals

Northrop moves to 'smart' sensors

"Smart" computer terminals, which include minicomputers for partial processing to reduce necessary communications and machine time on the host computer, have begun to make a big impression in commercial applications. Now it looks as though the military may adopt an analogous technique—"smart" sensors. Northrop Electronics has developed a family of fast microprocessors that occupy less than 10 cubic inches and weigh 11 ounces. These can be placed throughout an aircraft, reducing the load on a central computer, and especially reduce the software problem, says research engineer Rodger R. Lowe at the company's Hawthorne, Calif., plant.

Typical applications for the task-oriented processing systems (TOPS) include preprocessors for electronic countermeasures (ECM), navigation computers, fire-control processors, and use with aircraft multiplex controllers. Unlike many other small processors, TOPS has bipolar memories and uses Schottky TTL for high speed—600-nanosecond execution time. With optional hardware multiply/divide, Lowe says the unit can perform about 1 million operations per second with 4% of its time devoted to multiplication and division. This compares to under 400,000 operations per second for popular small minicomputers now used in airborne applications.

Other advantages of TOPS include:

- Minimized cabling and weight reduction analogous to savings from multiplexing,
- Reduced electromagnetic interference,
- Simplified system integration and standard interfaces,
- Self-testing capability, and
- Reduced price through standardization.

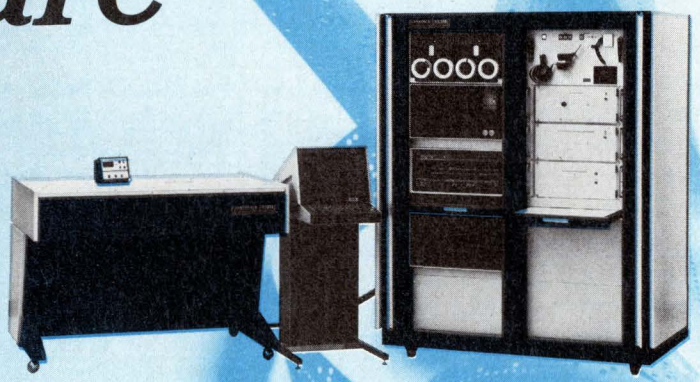
Lowe estimates that in a typical 16-bit configuration, production costs, now about $1,800, should drop to under $300 by 1980.

As the name indicates, TOPS consists of microprogramed modules that can be adapted to different uses by choosing appropriate elements. Two basic configurations have been developed. One uses a few small circuit cards compatible with the standard aircraft air transport rack (ATR) system; a complete computer fits in a half-ATR unit, and the other uses a single-card hybrid version.

The hybrid packaging uses Northrop's beam-lead interconnect package, which puts the leads on the substrates, rather than on the chips, making any standard IC chip usable. This overcomes the problem of obtaining an appropriate range of beam-lead circuits.

Lowe says the TOP/20, the basic microprocessor, uses about 1,200 gates, compared with 2,000 to 5,000 gates for a typical minicomputer. The 8-bit machine is expandable to 16, 24, or 32 bits, and uses 16-bit instructions. Typical programs use 512

Automated Systems Software



The TEKTEST™ III Software operating system developed for the Tektronix S-3260 Automated Test System is designed to enable **maximum device throughput** while permitting engineering studies when required. TEKTEST III is a new test language written by Tektronix Software Engineers. The language was designed to be **easily understood by systems engineers** yet **powerful** enough to control the full hardware testing capabilities of the S-3260.

The TEKTEST III Executive disc operating system permits interactive test program preparation. Other features permit *on line editing, on line debugging* and *functional test pattern editing.*

All commands are as descriptive as practical and are entered in English language format. For more information on TEKTEST III and the S-3260 contact your Tektronix Field Engineer and ask for a copy of *S3260 Automated Test System Control Through TEKTEST III Software* and the *S-3260 Brochure.*

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SCIENCE/SCOPE

A domestic satellite system for Brazil which would provide substantially greater telephone, teletype, TV, educational TV, and commercial broadcast communications services has been proposed by Hughes. The satellite antenna's beam would be shaped to serve vast regions whose populace is separated by dense jungle and mountainous terrain. International communications traffic with Western Europe, Canada, Africa, and the U.S. has more than doubled in the four years since Hughes designed and built Brazil's first satellite ground station at Itaborai, near Rio de Janeiro.

A corona pulse counter for high-voltage components, developed by Hughes, provides a far more sensitive method of measuring corona intensity than previously achieved. It makes quantitative measurements of the corona spectrum under DC or AC voltage possible for the first time. Corona, commonly observed as the faint glow around the surface of a high-voltage conductor in air, is the most important cause of internal degradation of transformers, capacitors, and cables. By accurately measuring the corona discharge energy, manufacturers will be able to improve the energy density, reliability, and lifetime of high-voltage components.

A new data terminal display console developed by Hughes to monitor and control the Naval Tactical Data System (NTDS) computers was delivered to the U.S. Navy recently. Designed to make functional changes in NTDS equipment assignments as required, the Monitor Control Console (MCC) combines a data terminal with a CRT display and typewriter keyboard. It is one of more than 1700 varying types of NTDS consoles built by Hughes. The MCC is the first to incorporate microprocessing techniques made possible by MSI/LSI technology. NTDS uses radars, computers, and communications equipment to gather, process, and exhibit action within tactical combat zones instantaneously on the display consoles.

A prototype series of portable ground stations which Hughes is developing for the U.S. Dept. of Health, Education and Welfare will be used in experiments designed to relay TV for medical assistance and educational programs via satellite to isolated areas of Alaska and the United States. The 300 lb. stations, using 10-foot-diameter dish antennas, can be carried by small van or helicopter and easily erected by two men. They are forerunners of low-cost stations that could be used for television distribution and two-way telephony by developing and emerging nations.

Hughes has immediate openings for Field Engineers. Qualifications include U.S. citizenship, BSEE degree, willingness to travel, and experience in any one of the following systems: electro-optical, infrared detection, laser ranging and target designation, or low-level-light TV detection. Please write: Professional Staffing, Hughes Aircraft Company, Field Service & Support Division, P.O. Box 90515, Los Angeles, CA 90009. Hughes is an equal opportunity M/F employer.

Quicker turn-arounds for jetliners and substantial improvements in aircraft and manpower utilization are being achieved by Eastern Airlines on aircraft circuit tests made with a Hughes-built Flexible Automatic Circuit Tester (FACT). Based at Miami International Airport, Eastern's FACT system is housed in an air-conditioned van which rolls up to the jetliner, where technicians attach cables from the aircraft's connectors to the six portable remotely-operated FACT switch modules. Tests are performed automatically by computer-generated punched-tape programs.

Electronics review

16-bit instructions in bipolar read-only memories, with 256 16-bit scratchpad bipolar random-access memories. The TOPS system is expandable to 65,536 words of main MOS or core memory.

One consequence of distributed microprocessing like TOPS, points out L. (Roy) Kaufold, vice president and manager of Northrop's Avionics department, is that systems will start being viewed as sensor-front-ends and digital processors. For example, an Omega system will be an rf front end with a computer. Kaufold goes on to say, "We'll see a whole new line of smart sensors and also be able to solve problems you couldn't approach with a shared real-time system." □

Production

Stitch-welding ready for commercial use

Stitch-welding, although well accepted in military programs as an alternative to multilayer boards or wire-wrapping, hasn't had much commercial use because of higher costs incurred by the need for special terminals. But that situation may be changing fast. A new technique, called planar stitch wire (PSW) developed by APAC (Accra-Point Arrays) in Santa Ana, Calif., makes possible welding directly to a circuit board and the choice of either soldering in ICs or using standard low-profile sockets or socket pins.

The new PSW boards, permit stitch-welding to compete with both multilayer boards and wire-wrap systems in breadboarding, as well as of the prototyping and production of many complex boards, says G.N. (Mike) Beck, vice president of marketing at APAC.

He says that PSW is an attractive alternative to hand-soldering or wire-wrapping for etched circuit breadboards because it is three times faster, permits ICs to be plugged in, and has the same card-to-card spacing as etched boards. For short runs using double-sided boards, PSW eliminates the need for artwork, and configurations are easily modified. Beck says that users find PSW most economical for fewer than 30 boards, and for 30 to 75 boards, smaller companies prefer double-sided, larger PSW.

The planar-stitch-wire approach uses a special glass-fiber-epoxy board with stainless-steel pads to permit welding to nickel wire. Copper, of course, cannot be welded. The boards are supplied by APAC with appropriate pads and mounting holes for ICs and other components. They are manufactured by applying layers of a proprietary stainless steel 5 mils thick to each side, drilling holes, copper-plating the hole after a nickel flash, then selectively etching to leave steel pads of 80 by 100 mils connected to solder pads for the components.

ICs can be wave-soldered before wiring, or sockets or socket pins can be wave-soldered in place for later IC-insertion after wiring. Packing densities are comparable to circuit boards of six to eight layers, and the completed boards are much thinner than wire-wrap boards. The wire is resistance-welded by pressing a wire against the pad through its Teflon insulation, then applying a pulse of current. A big advantage over multilayer boards is the ease of making changes; modifications can even be made with a soldering iron in the field.

The wires are run point-to-point with minimum length, and they lie close to the ground planes on the boards. Beck says they are suitable for TTL, Schottky TTL, DTL, and ECL with frequencies up to 80 megahertz. The weld is typically 85% of the strength of the wire. □

Communications

Exxon developing low-priced fax

Exxon Enterprises, the venture-capital arm of Exxon Corp., New York City, is developing what promises to

be the lowest-priced facsimile unit on the market. When it becomes available, the unit will lease for about $20 to $25 a month, says an industry specialist. This is about half the price of present units.

The man now behind the facsimile push at Exxon is Peter S. Philippi, formerly vice president and general manager of Magnavox Systems, Fort Wayne, Ind., who joined Exxon last month. His charter, says Richard Nelson, vice president of Exxon Enterprises, is to "manage market studies in data communications, including facsimile."

Harrington Research of Florida Inc., in Orlando, is carrying out the technical and product development of the facsimile unit. Using a basic concept developed at Exxon, Harrington is building prototype machines for initial testing at Exxon installations.

The Exxon facsimile is expected to be compatible with all machines of other manufacture. Its low price will result from the use of improved low-cost modems and elimination of most optional features. The machine's basic task will be to scan and produce in six minutes a single copy in shades of gray.

Exxon is itself a major user of facsimile for both domestic and international traffic. Success with its first units and the company's own experience and needs could herald later development of faster facsimile machines that would transmit digital data, that could store data signals in mass memory for delayed transmission, and that could cryptographically scramble data to preserve its security. At Magnavox, Philippi was an advocate of the one-minute fax and had an interest in special fax scramblers. □

Packaging

Low-melting glass seals hybrid circuits

Usually, all components that form a hybrid assembly—active and passive devices—are bonded to a substrate

News briefs

AT&T applies for its domsat

AT&T plans to build five earth stations and lease three stationary satellites from the Communications Satellite Corp. for a domestic communications-satellite system that could be operating as early as 30 months after Federal Communications Commission approval [*Electronics*, Jan. 4, p. 33]. The system would serve all the U.S., Puerto Rico, and the Virgin Islands with a capacity of 43,200 telephone circuits. AT&T estimates the system will cost $70 million, plus $272 million in payments to Comsat over seven years for the two operational satellites and one backup in space and one spare on the ground. Comsat says its investment will only be $150 million.

Pertec's printer hammers down price

With its new low-priced medium-speed line printer for the OEM market, Pertec Corp. has branched out of its line of magnetic-tape drives and disk storage units. The P7330 sells in quantities of 100 for $3,990 to $4,370, depending on options selected. It prints 300 lines per minute when using a full 64-character set in a 132-column format. At the touch of a button, it can be slowed to 160 lines per minute for higher resolution. Technical novelties include the use of a steel-band font with the characters embossed on its surface and stored energy to drive the hammers.

'Total' banking system goes on line

While automated bank terminals have been installed at many banks [*Electronics*, March 27, 1972, p. 64], the impact of the cashless and checkless society has only just begun. Now nine Illinois banks and six Korvette stores are linked so that as soon as a customer makes a purchase, his account is automatically debited. The banks are equipped with TRW's automated banking systems that maintain checking and credit-card accounts on line and use 100 teller terminals serviced by Heritage Bank Corp. of Chicago. At the stores, 120-point-of-sale terminals and four Docuteller automatic terminals have been installed.

Leadless packages to get standards

Manufacturers of leadless packages and connectors for integrated circuits, undaunted by the lack of large-volume sales as yet, met in New York in late March to establish standards for leadless packages and their companion sockets. Robert Foster of Xerox Corp. and Max Peel of Texas Instruments initiated the project under auspices of the IEEE manufacturing technology committee. Their goal is to develop a working standard within the year.

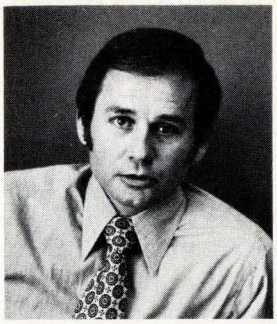
H-P calculator can analyze data

Any engineer who has waded through a series of statistical calculations to evaluate test data will welcome the data-analysis calculator being introduced by Hewlett-Packard Co. The 9805A desktop calculator operates on the same principles as the company's popular HP-35 and HP-80 pocket machines, which execute fairly complex computations at the press of a single button. The 9805A sells for $1,295 to $1,975, depending on options.

The machine can generate histograms, calculate means and standard deviations, and fit curves. It can also drive a small X-Y plotter.

Data General's 840 features upward mobility

With its introduction of the Nova 840, Data General Corp. says it is marketing a machine that incorporates more hardware and software capabilities than any other model. An expanded version of the Nova 800, the 840 provides those features necessary for building larger computer systems. The computer chassis can hold up to 64,000 16-bit words of core, and expand to 128,000 words. The cycle time is 800 nanoseconds. A basic Nova 840 costs $16,530; but Data General expects the average system prices will be from $40,000 to $70,000.



"Putting a minicomputer inside your new product? You've got problems."

1. You've got to get your product on the market as fast and economically as possible.
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3. Your product (and all components) must be reliable.
4. You have to deliver on time.
5. You have to start out and stay price competitive.
6. You don't want any surprise problems when Version II is ready.
7. You want the right internal hardware, software, and all the rest.
8. You have to have good technical service back-up when you need it.
9. You're getting into bed with your major suppliers and want to play it as safe as possible.
10. You need all the help you can get from your vendor.
11. You don't want suppliers who end up competing with you.

Big problems. And we have some unique solutions proven by some of the biggest minicomputer buyers in the country. Our customers ran us through some of the toughest competitive bidding you ever saw. Against every name competitor you can mention.

We solved their problems. Partly, because we're not newcomers. Five years and thousands of minicomputers later, we're still solving problems. Successfully. And economically. How about yours?

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President

COMPUTER AUTOMATION, INC.
the naked mini™ company

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and the whole assembly is sealed under a metal lid or in a flatpack. This can be expensive, and substrate space is often wasted. To cut costs, increase circuit density, and provide additional advantages, Composite Microcircuits Inc., Waltham, Mass., has developed what it calls Blak-Pak—a black ceramic lid coated with glass having a low melting temperature—enabling a designer to seal the components he selects.

The sealing glass was originally investigated by researchers at Sylvania's microelectronics facilities in Waltham. Composite completed the development when it bought the facility three years ago. The company won't reveal the composition of the glass, but president William A. Strauss Jr. says the major problem with glass that melts at a low temperature is its excessive expansion and contraction with temperature change.

Strauss says Composite was able to get glass with a low melting point that expands and contracts at the same rate as ceramics. Blak-Pak forms a hermetic all-glass package. The seal exceeds MIL-STD-883 requirements.

A different approach to the same problem has been taken by Epoxy Technology Inc. of Watertown, Mass., which has developed a new epoxy system that does not outgas, fill the cavity with corrosives, or cause dermatitis. It, too, exceeds MIL-STD-883 requirements. Neither system requires compliant coatings.

How much? The cost of the Blak-Pak is 20 to 40 cents per unit, depending on size, configuration, and quantity. A circuit can be sealed on a hot plate, Strauss says, or conventional machines can be used. A final hermetic seal is formed in about 30 seconds at 400°C to 425°C.

Blak-Pak can be used both in thick- and thin-film hybrid circuits and Strauss says they are especially useful when resistors must be trimmed actively. The hybrid can be lidded, and the resistors can be left outside to be adjusted without damage to the active device.

Options to the Blak-Pak include a palladium-silver coating for electrical shielding and an uncoated lid surface for epoxy-bonding. Blak-Pak is also offered with a clear-glass lid for use with light-emitting diodes and liquid crystals.

Commercial electronics

Super phone set for 900-MHz band

The land-mobile radio promised by Motorola Inc. for the newly allocated 900-megahertz frequency band [*Electronics*, Feb. 1, p. 36] was unveiled last week. It's a portable telephone that weighs less than two pounds and "plays" into the conventional switched telephone network.

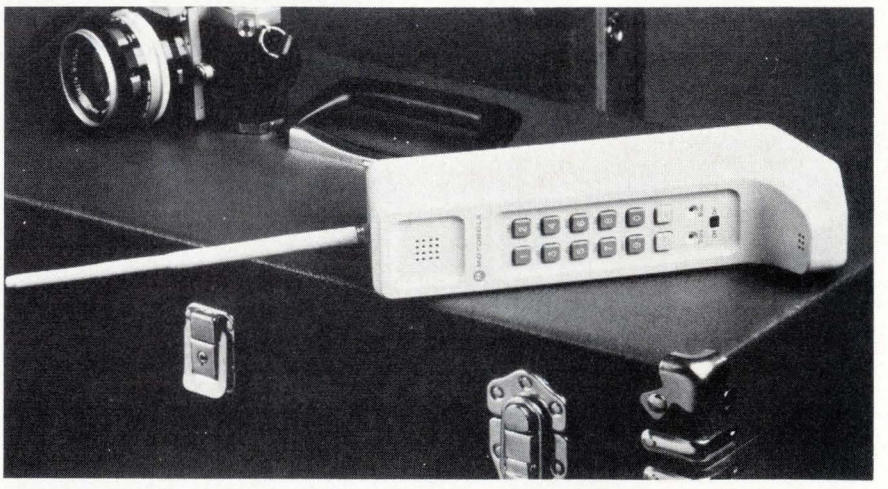
Motorola calls the new system Dyna Tac, and it includes, in addition to the portable units, a computer-directed control network for coordinating the operation of the remote phones and providing the tie-in to the phone net. The user within range of the system, like the user of the conventional car telephone, could therefore place calls to and receive them from virtually anywhere.

The portable Dyna Tac phone set is probably the most unusual part of the system. It combines in a 28-ounce package the control and transmit-receive electronics that in an ordinary car radio weigh some 45 pounds. A 14.4-volt rechargeable nickel-cadmium battery powers the unit and provides 1-watt rf output over any of 380 duplexed channels. Extensive use is made of both standard and custom complementary-metal-oxide semiconductors to keep battery drain down, points out Martin Cooper, vice president of systems operations for Motorola's Communications division, Schaumburg, Ill. Altogether, the battery will last for 12 three-minute calls and, with a standby drain of 10 milliamperes, 12 hours of standby operation.

Frequencies are generated with a digital synthesizer referenced to a quartz-crystal oscillator. However, which 25-kilohertz-wide channel is actually used for the frequency-modulated voice transmission is set automatically by the central computer. The computer system picks up the phone signals via a network of receivers placed strategically throughout the service area. It then selects the frequency for the next call that is least likely to interfere with other users. Transmitters also dispersed through the service area relay the conversations to the appropriate portable units. A 380-channel system in a city like New York could handle 100,000 subscribers and permit as many as 4,000 simultaneous phone conversations, estimates Cooper.

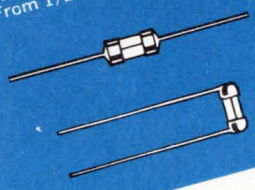
Right now the signalling and dialing is done over a separate channel with conventional tone signalling in

Portable. Carry it anywhere within range of its computer-controlled network and dial up anyone in the world. Motorola's 28-ounce electronic telephone fits in a briefcase.

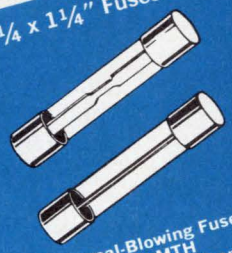


FUSES OF ALL SIZES
FUSE HOLDERS OF ALL TYPES
FUSE BLOCKS FOR ALL REQUIREMENTS
FUSE CLIPS FOR ALL MOUNTING APPLICATIONS

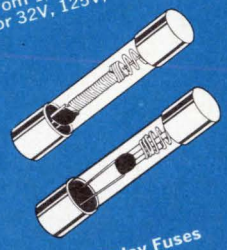
TRON Subminiature Fuses
From 1/200 to 15 amps



1/4 x 1 1/4" Fuses



Normal-Blowing Fuses
AGC GLH MTH
From 1/500 to 30 amps
for 32V, 125V, or 250V



Time-Delay Fuses
MDL MDX
From 1/100 to 30 amps
for 32V, 125V, or 250V

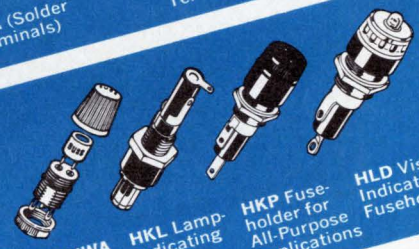
Visual Indicating Fuse
GBA
(red indicating pin)
From 3/4 to 5 amps, 125V

Space-Saver Fuseholders

HTA (Solder Terminals)

HTA-HH (1/4" Quick-Connect Terminals)

HTA-DD (3/16" Quick-Connect Terminals)



GMW/HWA Subminiature Fuse and Holder

HKL Lamp-Indicating Fuseholder

HKP Fuseholder for All-Purpose Applications

HLD Visual-Indicating Fuseholder

Fuseblocks

Bakelite, phenolic, and porcelain types — signal-indicating types — solder or screw type terminals, or 3/16" and 1/4" quick-connect terminals available.

Fuse Clips

Clips for printed circuit boards and other applications — available without terminals or with solder or screw terminals

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BUSS QUALITY FUSES

the Motorola prototypes; future units will employ frequency-shift keying.

Conversations are fully duplexed as a result of the wide separation between each transmit/receive pair that is possible at the 900-MHz band, points out design engineer Don Linder. Thus, the transmit/receive frequencies are in 9.5-MHz bands each 40 MHz apart and, incidentally, separated by a band allocated for microwave ovens.

Motorola has applied to the Federal Communications Commission for a license to establish a $5 million experimental system in New York City—a tough place to design a system for because of its many massive buildings, Cooper says. An operational system could go on line by 1976. Cooper estimates rentals could initially range from $60 to $100, about the same as for a car telephone. Or the portable unit could be sold for about $900. □

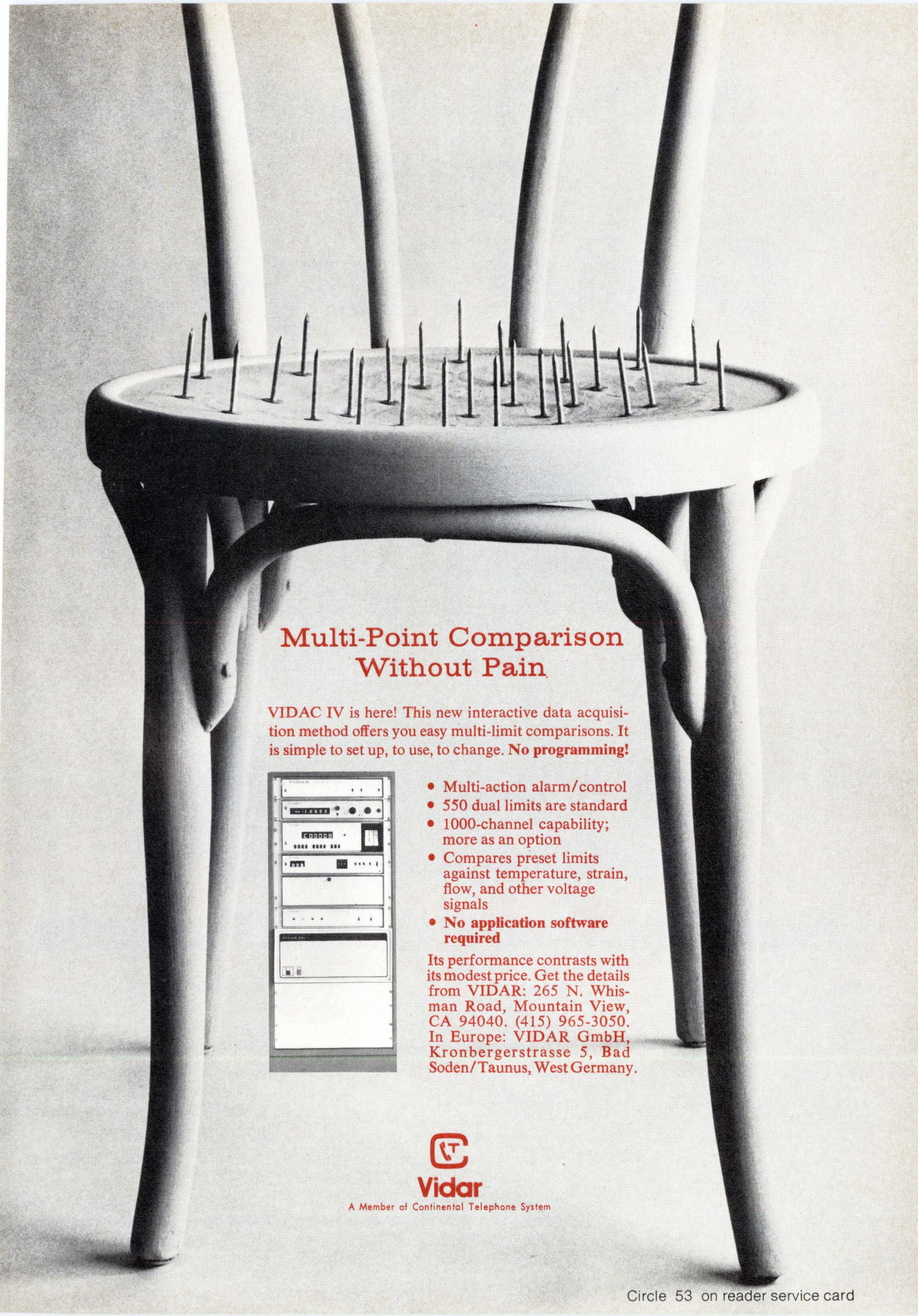
First computerized gas station opens

The nation's first computer-controlled gasoline station with on-line credit checking has opened in Lawndale, Calif., a suburb of Los Angeles. The self-service Atlantic Richfield (ARCO) station dispenses gasoline automatically under control from a minicomputer, accepting cash or the customer's credit card.

If the card is used, it is read and verified on-line with central computer files in Atlanta. If the card is stolen or has expired, the computer keeps the card. The system is expected to find wide use in view of the rising losses from fraudulent credit cards.

ARCO's station was developed in cooperation with Docutel Corp., Dallas. Docutel makes automated bank tellers for after-hours transactions.

Self-service and coin-operated stations have been around in the gasoline business for some time, but none included the computer control and on-line credit checking. □



Multi-Point Comparison Without Pain

VIDAC IV is here! This new interactive data acquisition method offers you easy multi-limit comparisons. It is simple to set up, to use, to change. **No programming!**

- Multi-action alarm/control
- 550 dual limits are standard
- 1000-channel capability; more as an option
- Compares preset limits against temperature, strain, flow, and other voltage signals
- **No application software required**

Its performance contrasts with its modest price. Get the details from VIDAR: 265 N. Whisman Road, Mountain View, CA 94040. (415) 965-3050. In Europe: VIDAR GmbH, Kronbergerstrasse 5, Bad Soden/Taunus, West Germany.

Vidar

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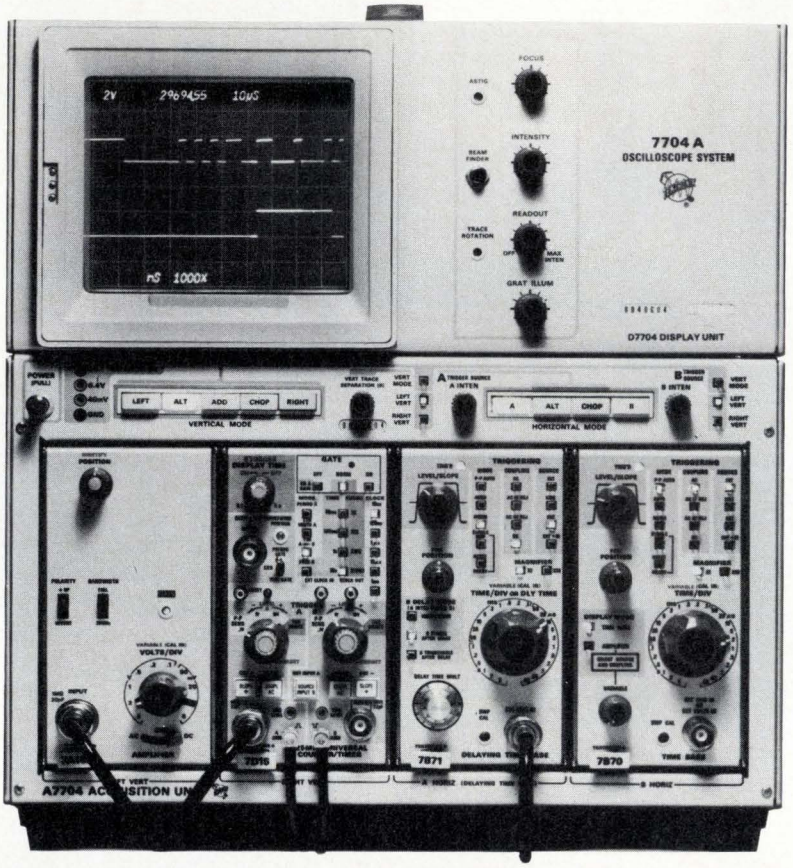
Circle 53 on reader service card

Oscilloscope plus Digital Plug-ins



Unique Solutions to Difficult Problems

Using the 7D15 Universal Counter/Timer

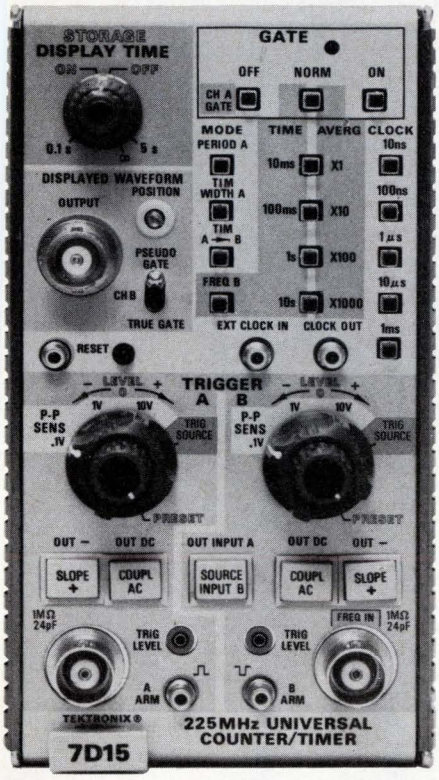
Problem:
Accurately measure the time between two nonadjacent pulses in a word train (displayed in upper trace).

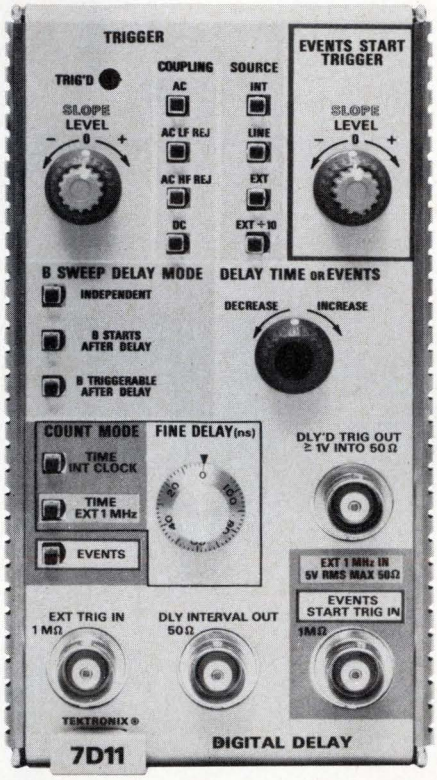
Solution:
Use the scope's delayed sweep gate to selectively control the counter's measurement interval (displayed in lower trace). A time interval of 29694.55 ns is measured and displayed on the scope's CRT READOUT.

A Time Interval Counter, a Frequency Counter, a DMM, and a Delay Unit make up the 7000-Series Digital Family. These plug-ins bring the accuracy and convenience of digital technology to waveform measurements. Both analog and digital information can be displayed simultaneously.

Applications unique with the new 7D15 Universal Counter/Timer include measuring: time intervals

7000 Series Digital Family





of selected portions of complex waveforms (such as telemetry and computers); time between nonadjacent pulses; time between desired events (such as radar)—while ignoring effects of noise; frequency of burst—the arming feature permits measurement inside a burst so that burst turn on can't introduce possible error; and frequency of events —while ignoring signal ringing.

Teaming the 7D15 with a scope gives you more solving power for today's complex measurements. This unique combination allows you to: (1) *Display* on the CRT the measured signal together with the measurement interval, or the counter Schmitt trigger signal; (2) *Precondition* the signal via the scope's vertical amplifier to provide input possibilities such as, 10 μV sensitivity, Differential input, and Current probe input; and (3) *Accurately Control* the start and stop points of measurement by selective arming.

The new 7D11 Digital Delay Unit with its 100 ns-to-1 s delay range in Time-Delay mode and its 10,000,000 count range in the Events-Delay mode, fulfills many measurement requirements for accurate delays.

Applications in the Time-Delay mode include measuring: accurate low jitter sweep delays; propagation delays of delay lines or delay devices; delay path equalization in networks, logic systems, cable systems, or distribution amplifiers; oscillator stability; pulse width jitter, pulse-to-pulse jitter; and more.

Applications in the Events-Delay mode include: disc memory skewing adjustments; computer main storage or local storage timing adjustments; lost bit identification and location on disc memory or magnetic tapes; modulation analysis on time division multiplexing (TDM) or pulse modulation (PWM) in communication and data systems; and more.

The 7D13 Digital Multimeter with its unique temperature probe and 7D14 525-MHz Digital Frequency Counter are two more problem solvers in TEK's digital family.

TEK's concept of integrating these digital measurement capabilities with the scope brings you many advantages over separate test units:

- measuring convenience and confidence
- easier and faster solutions to complex problems
- fewer dollars invested
- more bench working space
- signal conditioning

Add to these, the new dimension of scope-controlled measurements and you realize why we say "7000 Series . . . more than just an oscilloscope."

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These new devices come off the same high-volume, low-cost production lines that made our transfer-molded, Unibloc* plastic transistor outstanding the world over for economical, low-cost versatility. The result – the MLED500 series – now sets its own standard of leadership where price is the #1 parameter.

- High luminous intensity – 0.3 mcd typically at 20 mils
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- IC compatibility – low power consumption

You've tried LEDs produced by light guys, bright guys and innovators. *Now* try LEDs produced by a producer. Motorola Optoelectronics.

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Quote me a price on these LEDs in the quantities I've filled in:

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Title _____

Company _____

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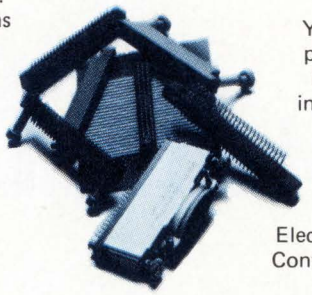
If you're that kind of electronic packaging design engineer, we want you to know about Winchester Electronics 42 Series Input/Output Connectors. What's so special about them? They're not just advanced and reliable. They're the surest, most convenient, most adaptable way to interconnect busy, multi-wired cables. Even in tight places.

With 42 Series Connectors, you can plug in to a back panel. To a printed circuit board. To an instrument panel. Or to another cable. And you'll plug in 50 or 74 high density input/output interconnects at one time. Anywhere, we repeat, in the package you want. It all happens neatly. Compactly. With minimum weight. In line with MIL-E-5400 airborne requirements.

Another point, now. In a sense, you're really the designer of your own 42 Series Connectors. Because just about any variation you want, to suit your package design, is possible.

Beginning with moldings of diallyl phthalate offering 50 or 74 .100 centers high density positions for pin and socket contacts. With 24 center row positions to use for polarizing pins, if you want them. With polarized guides.



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require, too. Dip solder contacts for printed circuit boar
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Circle 58 on reader service card

Washington newsletter

R&D for torpedoes and mass transit held related. . .

Official confirmation that **the Naval Underwater Systems Center, Newport, R.I., has taken on jobs for the Urban Mass Transit Administration** and other nonmilitary agencies has got Government electronics contractors suspicious. The assignments indicate to some that the Nixon Administration program for accelerating technology transfer by drawing on Federal laboratories is being used as **a ploy to keep some labs open by switching R&D appropriations between agencies.**

Sensitive to the charge that they may be taking work away from industry, Newport officials contend the center is but one of 15 military R&D organizations performing in areas where they are "uniquely qualified" **under a year-old technology-transfer directive of the President's Council on Science and Technology** [*Electronics*, Jan. 31, 1972, p. 42]. They add that the Center contracts work out when it can. One of Newport's jobs—to evaluate proposals for mass-transit-system safety guidelines, including computer and sensor requirements—will lead to a year-long industry contract in May. Navy officials explain that assignment as stemming from experience with underwater sensing and torpedo systems, reliability prognostication, and data-link techniques.

. . . since it's 'efficient use' of funds

Federal boosters of the juggling of Government R&D appropriations say it's no more than "an efficient use of available money." They trace implementation of the effort to the increasingly powerful Office of Management and Budget. Washington officials familiar with the program's management won't speak for attribution, though they vigorously deny any fiscal sleight-of-hand. **"It is just the beating-swords-into-ploughshares approach," argues one.**

DOD using F-15 to club Grumman?

McDonnell Douglas Corp. may get a competitive flyoff of its F-15 Air Force fighter with Grumman Aerospace Corp.'s F-14 built for the Navy, but the fleet is expected to stick with its Tomcat. This is the unanimous, if prejudiced, view of military and industry officials surveyed at the April convention of the Navy League in the capital, following deputy defense secretary William P. Clements' disclosure that he has ordered a "very serious" evaluation of the less costly F-15 as a possible Navy substitute [*Electronics*, March 1, p. 29]. Clements did note that the outcome of the competitive evaluation **will depend on Grumman's ability to cut F-14 unit costs by $1.5 million to $2 million.**

DOT, OTP steam toward fight over navigation policy

The Department of Transportation and the White House Office of Telecommunications Policy appear to be on a collision course over **who decides which of several maritime navigation communications systems will prevail:** Loran A, the follow-on Loran C, the Navy's Omega program, or Transit and proposed follow-on satellite systems. After a recent skirmish, DOT, with congressional prodding as well as backing from the Pentagon and the airline and maritime interests, is expected to rescind a cutback in Loran A service imposed on it at OTP's urging by the Office of Management and Budget. Meanwhile, OTP is asking DOT approval for a policy statement in favor of Omega, and **another battle is likely to be over DOT's wish for an upgraded Loran C,** also cut from its budget.

Washington commentary

An Administration without managers

Musing on the more than 20 senior jobs that are or soon will be vacant within the second and third tiers of Pentagon management, one official of a major Federal contractor recently asked an associate: "I wonder how long we could stay in business if we operated like that?"

The question has a great deal of pertinence these days in Washington as the Nixon Administration finds itself effectively stymied in its drive to recruit management and engineering talent to fill a variety of key posts within a number of executive departments. While the Department of Defense stands out because of its relatively large number of openings at the level of under secretary and assistant secretary, as well as deputy levels, there are other departments with similar problems. Commerce, Labor, and NASA are three that come quickly to mind.

White House controls

How did the industry-oriented Nixon Administration paint itself into this management corner? The view of one Johnson Administration holdover who recently lost his supergrade Government assignment—that is, a job not covered by the Civil Service Commission grading system and therefore subject to presidential appointment—is a view that many less biased bureaucrats have come to accept. That explanation is simply that "in their zeal to keep their fingers on everything, the White House staff screwed up." What the complaint refers to, of course, was the surprising post-election request by the White House for several thousand letters of resignation by supergrade professionals throughout the Government.

While cabinet members and other high-level appointees traditionally submit *pro forma* resignations at the end of each Administration, the number of politically sensitive jobs involved rarely exceeds a few hundred. Though some startled professionals who had held their jobs through several Administration changes were told at the time of the requests that theirs, too, were merely *pro forma*, many soon found themselves out of work. Others quit before they could be fired. Summarizes one Pentagon appointee among many who have yet to hear on their status, "The morale over here is lousy."

None of this backlash appears to have been anticipated by the White House where the drive for greater control over the Federal bureaucracy is reportedly being directed by presidential assistants Robert Haldeman and John Ehrlichman—dubbed the Katzenjammer Kids by some of their lesser fans. What they expected was that rising young management stars from friendly industries would happily kick their $50,000-plus jobs, bonuses, and stock options for a tour of national service at $35,000. This is clearly not the case.

No one knows with precision how many industry leaders turned down the image-plagued and troublesome DDR&E assignment. But it is known that an extended meeting and reception for defense industry chief executives by Secretary Elliot Richardson was designed to elicit from top corporate managers the names of possible candidates within their organizations for a variety of DOD jobs. Few names were forthcoming. Though Beckman Instruments' Malcolm R. Currie is set to take over as Director of Defense Research and Engineering from weary, longtime servant John S. Foster Jr., it is an open secret that the new deputy defense secretary, William P. Clements, would have liked to have seen Foster depart earlier if a successor could have been found.

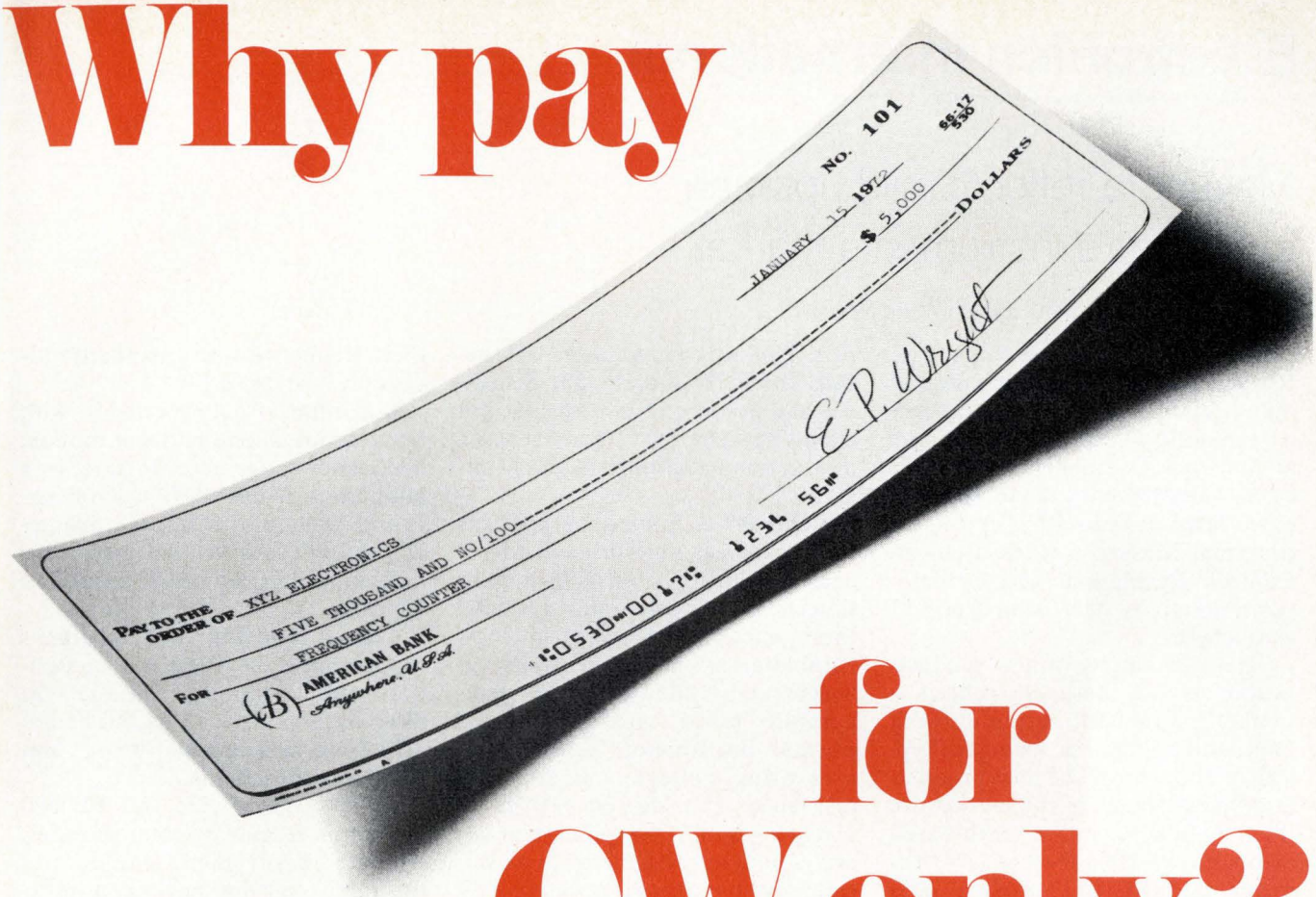
Who will serve?

What is becoming obvious in the capital is that many industry managers who do business with and support many of the policies of the Nixon Administration are unwilling to go all the way to become a part of it. A number of recent conversations with electronics industries officials holding jobs at several levels indicate that not all the reasons for their disenchantment with Federal service are monetary. Many who are accustomed to running their own shops—profit and loss centers, if you will—don't at all like the idea of tight White House controls. Too, there is some rising concern with the declining Nixon image as a result of the Watergate investigation. More important to many managers, however, is the disturbing prospect that their technical judgments—and even the appointment of their own subordinates—will be subject to political review by presidential aides who are more often than not ignorant of many of the elements involved in the decisions. As one recently departed Pentagon man put it, "Who needs that?"

The Defense Department, for one, doesn't need that. It seems to do nicely creating trouble for itself on its own. At a time when the Pentagon's credibility may be at its lowest ebb, with project costs continuing their upward spiral and the demanding readjustments to a postwar environment to be dealt with, it is a sad commentary that the second Nixon Administration has managed to make Government service so unappealing.

—Ray Connolly

Why pay



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Mesucora reflects mild upswing in Europe's instruments market

by Michael Johnson, McGraw-Hill World News, Paris

Instrument makers descended on Paris this week for the city's second major international electronics show in a month. Hardly had exhibitors at the Paris Components Show left town when representatives of about 1,200 firms began setting up for the triannual Mesucora (Measurement, Control, Regulation, and Automation) Congress, held from April 11 through 18.

The wide variety of new products introduced at Mesucora reflects a market that is both on the upswing and undergoing basic changes. Typical of the volume of new products that will be flooding the market are the exhibits of two French-based companies, Schlumberger's Instruments and Systems division (SIS) and Schneider Electronique, which presented 10 and 12 new products respectively.

Jean-Pierre Magnin, SIS president, is counting on custom-designed systems to bring in profits in 1973. "It will not be a fantastic year," Magnin concedes, "but the market should be up 8% to 11%."

Schneider Electronique president Martin Birnbaum says the European market is improving, but it is also being disturbed by fluctuating monetary rates among the countries.

Price trend. He also sees a fundamental shift in the multimeter and digital voltmeter market away from the low-cost instrumentation in favor of more reliable higher-performance products that can be guaranteed. "The market is still dominated by professional people," Birnbaum says. "They need suppliers with reliable instruments."

Magnin and Birnbaum are both losing interest in the low-cost instrument market because of the low profit margins involved. "This area of business requires new marketing methods," says Magnin.

Birnbaum is more direct. "The low-cost market is a dead end," he says. The future is not there." He recalls the early success that Schneider had in low-cost instruments, but claims he went into it "when it was a new option technically—with LSI circuitry."

ROM drive. Among the products that Schneider introduced at Mesucora was the Digitest 610, a multimeter that incorporates a digital thermometer using new technology. Birnbaum says he believes users will welcome the addition of the temperature probe capability to the normal multimeter functions of measuring voltage, current, and resistance. The Digitest 610 has a scale length of 11,000 points and operates on line voltage or with nickel-cadmium batteries or ordinary dry-cell batteries. Readings are displayed on Sperry gas-discharge tubes with digits 14 mm high.

Digital project chief Michel Barat says that until now, components' temperature could be measured precisely only by thermometers in the $600 range. The high cost was due to the complex system of operational amplifiers and compensating diodes needed to linearize each section of the temperature curve. Schneider's solution is to build in a read-only memory to drive the display. The ROM displays the correct temperature at a given transducer output.

Schneider is using standard ROMs from Texas Instruments, Fairchild, and Siliconix. A separate ROM is needed for each type of probe.

Synthesis. Another Schneider development shown at Mesucora was in the field of function generators. "We recognize market possibilities in the area of circuit stimulation," Birnbaum says. The new GF 105 and 106, which provide the versatility of function generators and the stability of frequency synthesizers, can produce sinusoidal, square, sawtooth, and triangular waves, and their frequencies are manually adjustable in steps of 10^{-5}.

Maximum frequency drift with temperature is one part per million. Frequency range is 0.001 hertz to 1 kilohertz in steps of 10 microhertz. Priced at around $700, the Schneider line will compete with frequency synthesizers in the neighborhood of $2,000.

Clip-on modules. Schlumberger's Magnin says he tried to "consolidate the company's image" at Mesucora by showing its full line of activity in instruments for time and frequency measurement.

Among them were the FB2600 automatic frequency counter series, whose measurement range and functions can be expanded inexpensively by "add-in" modules. Three modules are now available.

The simplest version in the series is equipped with a 50-megahertz "add-in" amplifier and can measure direct frequency and multiple time periods with 30-millivolt sensitivity and one-megohm input impedance.

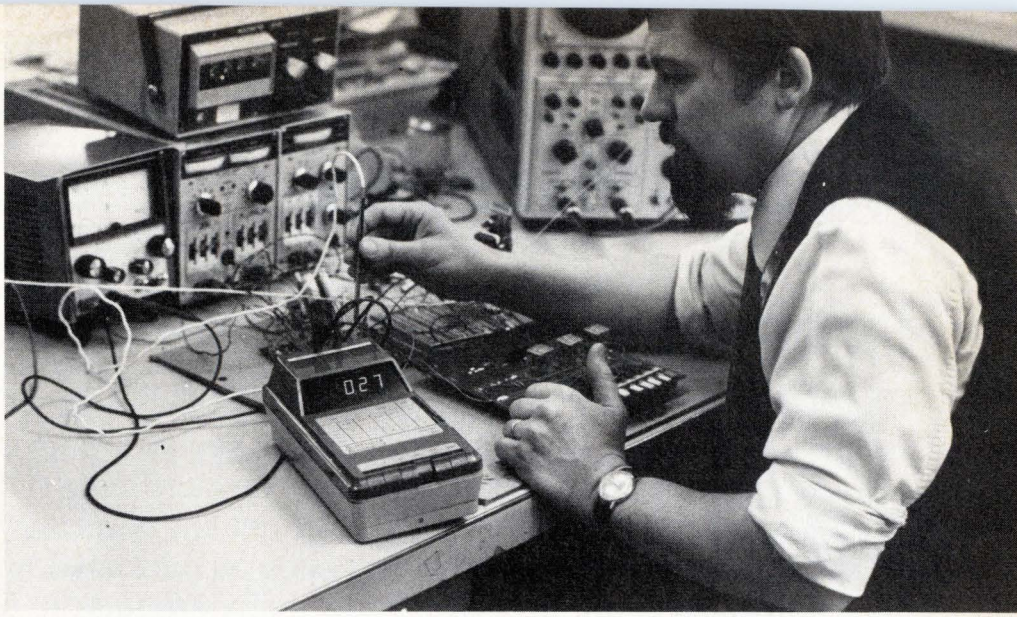
When a second 50-MHz module is clipped in, the counter also can measure time intervals, with 100-nanosecond resolution. The third module boosts the range to 520 MHz, with 50-ohms input impedance and 50-mV sensitivity (10-mV sensitivity is available as optional equipment).

The display is a seven-segment light-emitting diode in 10-millimeter characters, with brightness adjustment control. □

Great Britain

Glass switches with temperature change

A glass that will switch from a low-conducting state to a higher-conducting one when a threshold volt-



Something added. Multimeter introduced at Mesucora by Schneider Electronique includes a digital thermometer that probes and displays temperature of component and assemblies.

age is exceeded has been developed at England's Standard Telecommunication Laboratories Ltd., a major center for development of glass technology within the ITT group. This voltage varies linearly and inversely with temperature, so that as the temperature goes up the switching voltage goes down.

Cyril Drake, who's in charge of the glass work, believes that it may be used to make thermistor or thermocouple replacements that combine the temperature sensing and electric switching functions in one element. The present state of Drake's art is on show at the Physics Exhibition in London this week.

Structure. The glass is a vanadium phosphate compound. The switches are glass droplets with two wires protruding. Martin Regan, researcher working on the project, says that capillary action in the molten glass draws the two leads together until they are only micrometers apart.

Thin-film switches have also been made with glass, having typically a 1-micrometer thickness, on a metal substrate. Film techniques allow the spacing of the electrodes to be more closely controlled. Drake says that in some cases it may also be possible to put a film down directly on the item whose temperature has to be controlled.

All devices are the same in that if threshold voltage is plotted against temperature the curve is a straight line, which if extrapolated passes through the temperature axis at the point representing 68°C. However, a dozen devices are likely to have lines at a dozen different angles. Thus, the percentage change of voltage against temperature is the same for all devices—1.4% per °C—but the absolute change may be very different from device to device.

A typical device with 10 volts applied to it might switch from the low-current to the high-current state when its temperature rises above 30°C. Maximum current in the high state is a few milliamperes. If this current is reduced below a certain level, typically 100 microamperes, the device reverts to the low-conducting state. □

Japan

Sony to market stereo matrix IC

Sony Corp. is making a concerted effort to bring down the price of matrix-stereo-record playback systems made both by itself and by competitors. It has developed three separate types of integrated circuits and one type of thick-film resistance-capacitance network designed to provide full logic decoding for SQ stereo, favored by Sony's joint venture with CBS. Design of the circuits is such that a simple switch allows reconfiguring them to perform a similar function for regular matrix stereo, favored by many other record companies.

Change. In a departure from practice, Sony says that it will supply samples of the circuits by June and begin deliveries by October. In recent years, Sony has earmarked most of its semiconductor production for in-house use.

The kit of OEM components to be offered includes three plastic encapsulated ICs with a total of 56 pins and two resistance-capacitance networks, with nine resistors and capacitors each. They also say that while Sony may not get the price down that low, the rule of thumb for linear consumer ICs in the Japanese OEM market is 4 cents a pin.

Pins. Specifically, the basic decoder IC has 18 pins and includes four sets of six-pole, 90° phase shifters, and associated resistive matrixes, that are used with two outboard RC networks. The six-pole phase shifters maintain a phase shift of 90° ±15% over the full audio range of 20 hertz to 20 kilohertz.

The full logic IC has 24 pins, while the gain control IC with four separate gain control amplifiers has 14 pins. While two of the three IC types dissipate only very small amounts of power, all three are mounted in standard dual in-line molded plastic packages with metal strips that are brought out at one end of the package to form a heat-sink tab.

The use of ICs not only keeps the basic circuits small but also makes for small size and relatively moderate power drain for the entire decoder. It can be assembled in the spare space on a receiver or amplifier circuit board, saving the costs of an additional circuit board, power supply, and cabinet that are often needed for decoders made with discrete parts. Thus, a manufacturer should be able to offer a full decoder at between $20 and $40 more than a similar amplifier or receiver without a decoder. □

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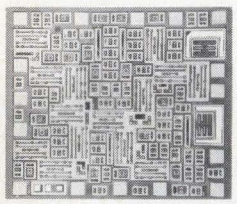
Here's why.



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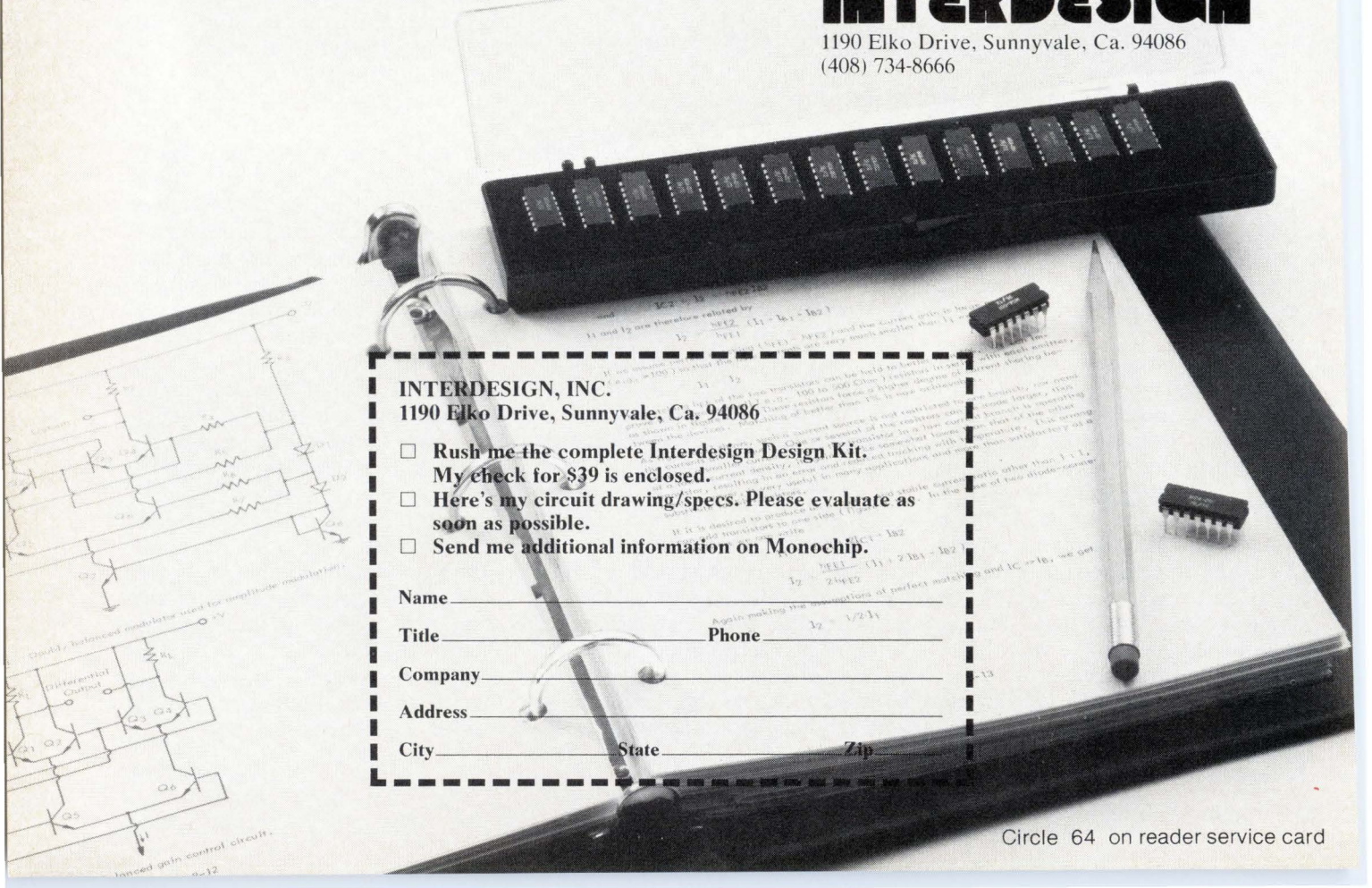

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International newsletter

Britain's post office takes step to PCM

The British Post Office has awarded contracts for development of two trial high-speed pulse-code-modulated telephone transmission systems **as the next stage in a program aimed at getting digital transmission into Britain's trunk telephone network by the late 1970s.** One trial system will be developed by the ITT subsidiary, Standard Telephones and Cables Ltd., and the other by General Electric Co. Ltd. and Plessey Co. Ltd. in cooperation. Both systems will use 120 megabits per second as the bit rate and be compatible with existing 0.175-inch-diameter, 12-megahertz-bandwidth analog coaxial-cable links. Capacity will be 1,680 two-way channels simultaneously.

The digital trunk network will be the third stage in the conversion of Britain's telephone system to PCM. Since 1967, about 1,800 PCM links between grouped local exchanges have been installed, using a 24-channel, 1,536-kilobits-per-second system, and some 4,000 more similar links are planned. For links between local exchanges and the group switching center to the outside world, 30-channel PCM, operating at 2,048 kilobits per second will be used. Post office plans call for trials, using equipment from five makers, to start next year. From group switching centers into the trunk network, the 120-megabit system will be used, with the slower signals multiplexed 56 times to produce the faster bit rate.

AEG-Telefunken finds Arab backers for PAL system

PAL, the AEG-Telefunken-developed color TV transmission standard, **is well on its way to dominating the Arab nations now that the Persian Gulf states of Saudi Arabia, Kuwait, Qatar, and the Bahrein Islands have officially opted for the German system.** A fifth country, Jordan, is expected to come out for PAL shortly and to start color broadcasts with this standard on a trial basis during the second half of 1973.

AEG-Telefunken officials in Frankfurt say that they are counting on Iran and Turkey to also adopt PAL. A decision from Turkey, they believe, will be forthcoming once the Ankara government crisis has ended. With the four Persian Gulf states now firmly in PAL territory, **the lineup of countries having decided for the system totals 27 around the world.** Of these, 15 are already using that standard for regular color broadcasts. Competing with PAL—which stands for phase alternating line—are the French-developed Secam—for sequential and memory—and, to a lesser extent, the U.S. NTSC standard, which is the basis for Japan's system.

British work with liquid crystals showing improved stability

Researchers at Hull University are developing a family of liquid crystals that look likely to combine useful electro-optic properties with much better chemical stability than is usual. Present materials, for instance the commonly used MBBA types, deteriorate quickly if moisture and other impurities are present. That means much care is necessary in display manufacture, and sometimes precautions also have to be taken against photochemical deterioration. In contrast, **samples of one typical new Hull material have been exposed to the atmosphere for weeks without apparent deterioration.** For example, the temperature above which the material loses its liquid-crystal properties and reverts to ordinary

liquid behavior has remained stable at 35°C, whereas MBBA materials fall several degrees within minutes of exposure.

Electro-optic tests at the Royal Radar Establishment show that this material has **a threshold field voltage in the twisted nematic mode of 1.1 volts compared to 2 V or more with established materials.** This figure means that applying a field of only 1.1 V will produce a black-on-white display. Similarly, the threshold in the cholesteric/nematic phase-change mode—that is, the threshold at which the display changes from cloudy to clear—is about one-third that of conventional materials with similar visual properties. A typical value is 5.4 V on a liquid-crystal layer 12.5 micrometers thick. **Hence, the materials may be very good in low-voltage displays.**

Europe's color TV sales to stay strong

West Europe's high-riding television industry will chalk up continued strong color-receiver sales during the next few years, according to market forecasts issued by Philips Gloeilampenfabrieken. Officials at the giant Dutch electronics company, whose predictions have been remarkably accurate in the past, **foresee West European color-set sales reaching 7.2 million units in 1975, about 28% more than the 5.7 million sets expected to be sold this year.** Last year's sales amounted to 4.3 million sets. At the same time that color is rising, the Philips forecasters say, the black-and-white receiver market will continue to decline, from 8.3 million sets in 1972 to 7.4 million this year.

Toyota invests in Fujitsu auto electronics arm

A large sum of money just invested in automobile electronics by Japan's largest automobile manufacturer and its leading components affiliate may mean that the automobile electronics business in Japan is getting ready to roll. The two—Toyota Motor Co. and Nippondenso Co.—have invested $1.7 million in what until the end of March was a wholly owned subsidiary of Fujitsu Ltd. **Now, Fujitsu Ten Ltd., which specializes in automobile radios, car stereos, and taxi two-way radio, is owned 55% by Fujitsu Ltd., 35% by Toyota, and 10% by Nippondenso.** Fujitsu Ten will now broaden its boundaries to include various facets of automotive electronics and their components, including systems for improving automobile safety and reducing exhaust pollution.

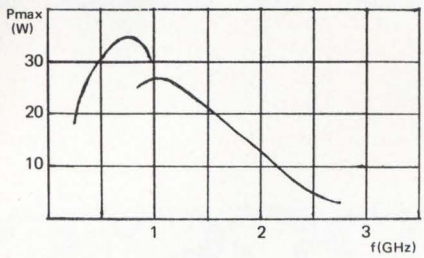
Japan's second largest automobile manufacturer, Nissan Motor Co., is in the same industrial group as Hitachi Ltd., and these two companies have done much joint development work on automobile electronics. Fear of being left behind—as well as the ever-more-difficult requirements in the U.S. market, which lead to similar requirements in Japan—may have helped catalyze the new agreement.

West German company plans ac power system for satellites

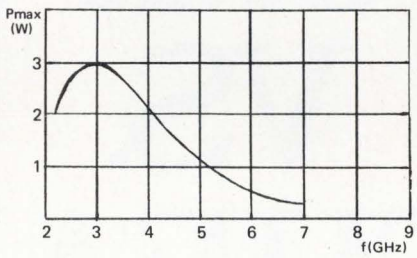
Designers at the German aerospace firm Dornier GmbH are developing a spacecraft ac power-supply system that is to replace the dc versions generally used in space applications. The work, carried out under contract of the European Space Research Organization, **aims at harnessing the advantages that ac systems have in energy distribution and at solving the problems relating to electromagnetic disturbances such systems usually cause.** The new ac system will be designed for vehicles in geostationary orbits and is to have a maximum output of 350 watts.

Power Signal Generators:

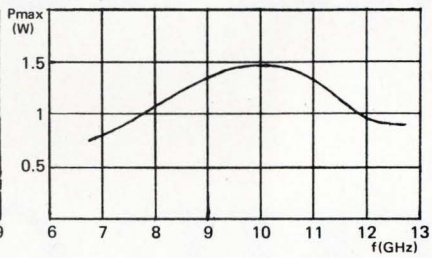
25 MHz – 12.7 GHz



Type SLRD
275 – 2750 MHz



Type SLRC
2300 – 7000 MHz



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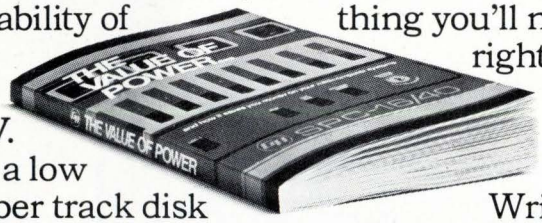

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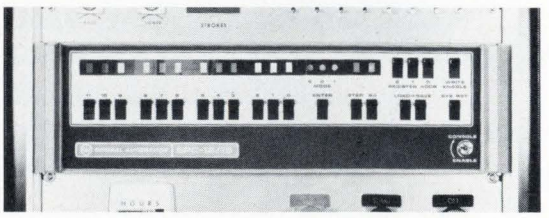

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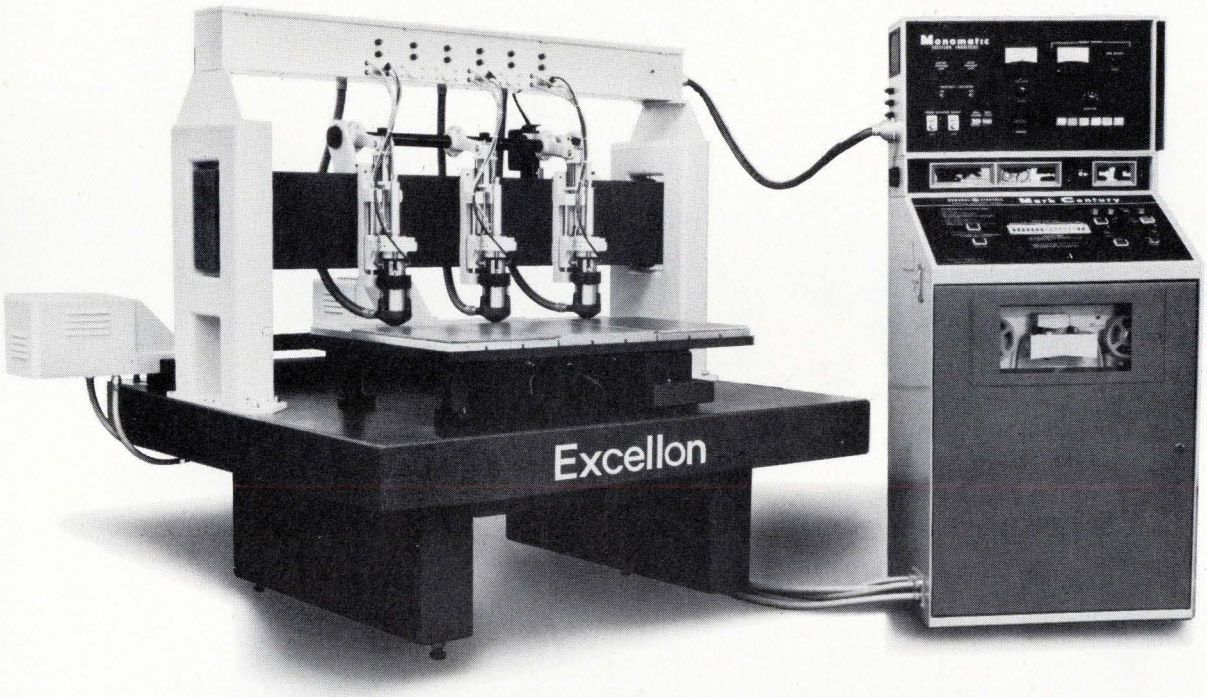

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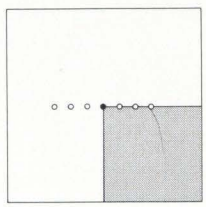
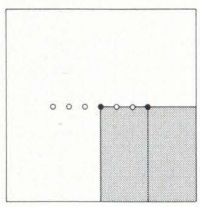
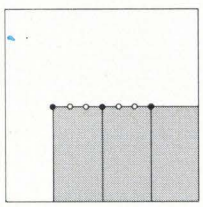


1 Spindle, 1 Stack 25.5″ x 25.5″



2 Spindles, 2 Stacks 12.75″ x 25.5″



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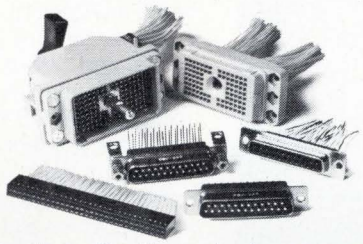

can handle the whole assembly. And that should save us money and headaches in the long run."

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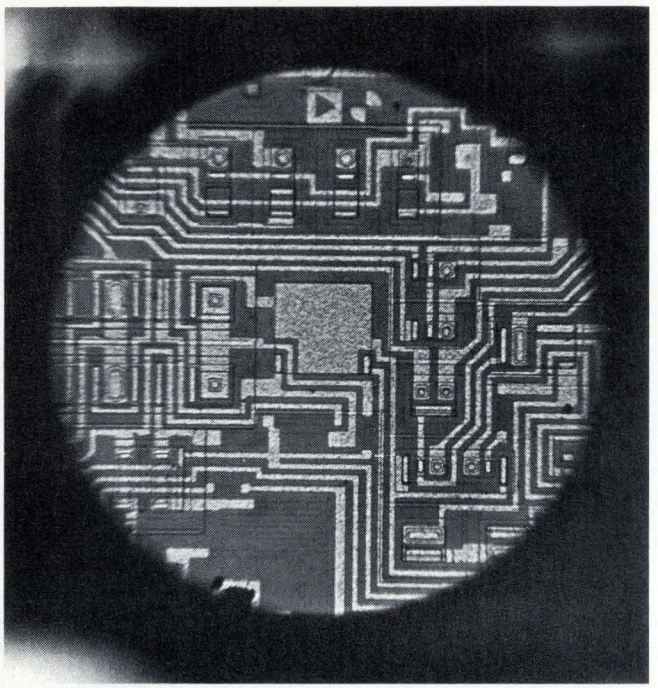

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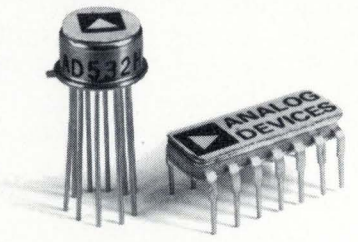

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4,096-bit RAMs are on the doorstep

This is the year for MOS memory makers at home and abroad to freeze designs for anticipated strong demand during 1974

by Howard Wolff, associate editor

The time for another showdown among high-density memories is approaching fast, and the issue this time is how to achieve the 4,096-bit random-access memory, the semiconductor memory product that is expected to be the death of cores. The reason is that with 4,096 bits on a chip, price per bit equals that of core—with the added performance that semiconductor memories provide.

But the MOS makers primed for the marketplace know they soon must commit themselves to a design in order to meet expected demands for the rest of this year and 1974.

Making those commitments will be the more agonizing because of the multiplicity of design options that are open. The semiconductor memory builder is free to:

- Stay with proven, though slow, p-channel metal-oxide semiconductors.
- Go to n-channel technology with its increased speed but added process complexity.
- Use a standard metal-gate approach or try for the more difficult, but space-saving, silicon-gate process.
- Opt for simplicity of cell layout and smaller chips by adopting the single-transistor cell with its switched capacitor, even though more sensitive sense amplifiers are required.
- Go along with the standard three-transistor cell construction, accepting the penalties of larger cells and bigger chips.

But whichever way the designs go, the manufacturers have learned from their experience with the 1,024-bit 1103 that any 4,096-bit RAM will have to be compatible with transistor-transistor logic in its I/Os and, for the sake of simple timing, will have to operate from a single clock. The 1103 succeeded almost in spite of itself—it was not TTL-compatible and had three clocks—because it was the first 1,024-bit semiconductor memory commercially available. But this time, there will be no comparable period of exclusivity.

Thus, the stage is set. As memory designers mind their p's and n's, juggle their cell layouts, and try to reduce chip dimensions, it appears that most will follow the n-channel route in an attempt to cut access time to the 300-nanosecond range.

Canada first. That's been the case with Microsystems International Ltd. of Ottawa, Canada, which has the only 4,096-bit part that has made it to the market so far [*Electronics*, Nov. 20, 1972, p. 131].

Peter D. English, memory-components marketing manager, says the company is presently sampling the parts, and an engineering program is under way to improve the memory's manufacturability and characteristics.

Access time for the three-transistor-cell part is 460 nanoseconds, but English is confident this will be reduced to "significantly" below 400 ns, perhaps to 350 ns. Cycle time is roughly 100 ns higher. English points out, however, that the changes being introduced are minor and would not affect designers already using the new RAM.

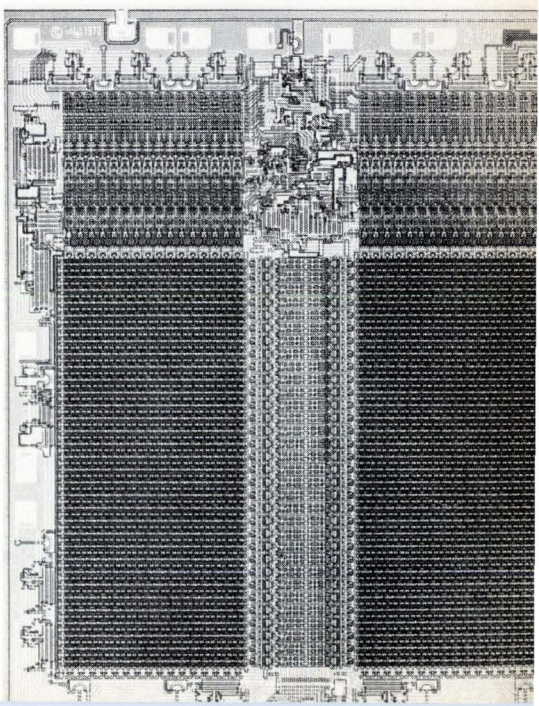
MIL's silicon-gate RAM is supplied in a 22-pin dual in-line ceramic package, that is like the standard 1103 package, but slightly longer. A lower-cost plastic package is in the works. English doesn't expect high-volume production at MIL before the end of 1973 or the first quarter of next year. One reason for this is the time it will take memory-system designers to update their designs with the new 4,096-bit chips.

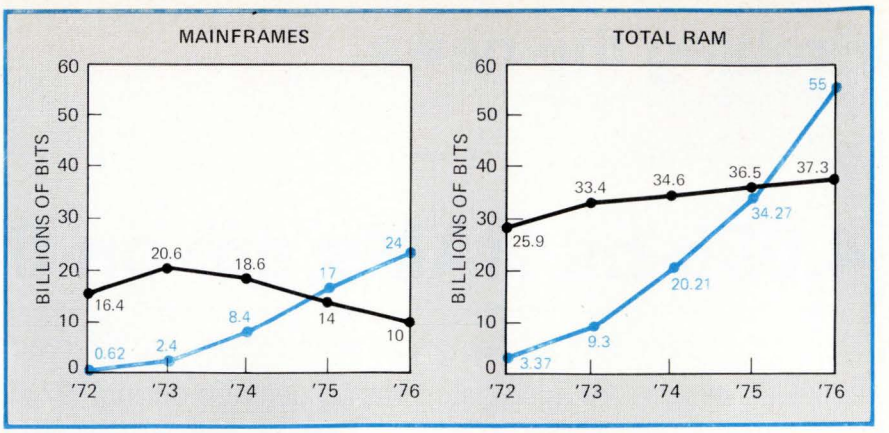
Furthermore, he predicts that cost per bit of the 4-kilobit RAM will be roughly equal to that of the 1,024-bit p-channel 1103 by mid-1974, at which time the savings in the number of printed-circuit boards and power supplies accruing with the larger chip will make them particularly attractive.

Although the Canadian company did the design work on the 4,096-bit device, it picked up a good deal of RAM knowhow as a licensee of the 1103 from Intel Corp., Santa Clara, Calif. And Intel itself expects to introduce two 4,096-bit RAMs this year.

The first will be a relatively slow

Intel entry. This is Intel's version of the 4,096-bit random-access memory.





Crossover points. These graphs, from Signetics data, show semiconductor use (blue) passing core in mainframes around 1974 and in total random-access memory the year after.

device, with access time around 600 ns, intended as a refresh storage in terminals, microcomputer memory, and similar applications in small systems that do not require a high speed. Later in the year, a high-speed version will be produced for large memories.

Both are n-channel with single clocks, TTL compatibility, and on-chip sense amplifiers for their three-transistor cells. This means that even though they are dynamic RAMs, they can be used in small systems with very few overhead circuits, much as static RAMs have been used in the past.

A.C. Markkula, sales manager for North America, says that Intel decided some time ago not to produce a 2,048-bit RAM. The reason is that in volume production, 2,048-bit parts would probably have a production life of only six to eight months, during which time they would be cheaper than 1,024-bit models, counting all memory system costs.

Besides Intel, at least seven other U.S. manufacturers are jumping into the 4,096-bit RAM market—National Semiconductor, Electronic Arrays, Standard Microsystems, American Micro-systems, Signetics, Mostek Corp., and Advanced Memory Systems.

Both or neither. National Semiconductor, also of Santa Clara, is hedging its bet. The company is developing both a three-transistor-cell 4,096-bit RAM and a one-transistor version—yet it may introduce neither. As explained by Thomas Redfern, MOS RAM product marketing manager, National may instead second-source another manufacturer's design after waiting to see which one is preferred for mainframe memories.

In any event, the two memories being developed are expected to have access times under 250 ns. They have high-voltage clocks for high speed, though this requires greater power.

Redfern maintains that RAMs will, in the future, have current, rather than voltage, outputs in order to speed up large systems. The current-output style requires an external current-to-TTL translator, but it does the work of circuits that would be needed anyway on the data output bus. Also needed is a buffer on the output.

As for potential prices on the parts, Redfern would say only that RAM prices these days are negotiated.

Next door. At another firm in the San Francisco Bay Area, Electronic Arrays, design of a 4,096-bit n-channel RAM is completed, masks are being cut, and prototype chips should be ready in 60 to 90 days. The product is scheduled to be introduced in the fourth quarter, says Robert Cushman, standard products manager.

There probably will be two versions, one with TTL-compatible inputs and outputs and one with current outputs. Both will have one high-level MOS clock. With TTL input and output, access time will be 250 to 300 ns, and cycle time will be about 500 ns. With current outputs, the RAM will run about 30 to 50 ns faster. Operating power will be about 400 milliwatts and standby about 10% of that, or about 40 milliwatts.

More refreshes. Electronic Arrays plans a 64-by-64-cell configuration, which is a departure from conventional refresh. That is, 64 accesses or refreshes will be needed every 2 milliseconds, rather than 32.

Standard Microsystems Corp., also in the Bay area, has shelved its original design but has developed a quad n-channel version of the 1103-1, which is in turn, the high-speed version of the Intel 1103.

The new RAM, intended as a high-density replacement of the 1103-1 to enable it to go into existing main-memory designs, uses the three-clock operating format of the 1103 and 1103-1. Access time is 180 ns, read cycle 375 ns, write cycle 440 ns, and worst-case power dissipation 600 mW.

On the verge. Standard Microsystems marketer Peter Schenck says the device is "very close to introduction." A contract has already been signed, but the company won't name the customer.

Ask about 4,096-bit RAMs at American Micro-systems, in Santa Clara, and you get answers that reflect a level of confidence unusual even for the chronically confident semiconductor industry. AMI's memory marketing manager, Frank Rittiman, says he expects his entry to become the industry standard because of its speed and power characteristics, its being second-sourced (by Motorola), its single-clock design, and convenient pinout—the so-called "lovable" configuration, with power supplies on the package corner and address inputs in sequential order.

The AMI device has an access time of 190 ns at emitter-coupled-logic output levels and 230 ns at TTL levels. Cycle time is 350 ns, and power dissipation is 350 mW average, with 5 mW needed for standby.

George Vashel, manager of MOS products at Signetics, Sunnyvale, Calif., says a 4,096-bit n-channel RAM is "well along in the design phase" and will be available later this year. It will be TTL-compatible and operate with a single clock. "We plan to be in the thick of 4-kilobit RAMs," Vashel says. However, he thinks that 2,048-bit RAMs will do

well until the larger ones are available in quantity. What's more, he labels predictions that the 4,096-bit models will rapidly take over the RAM market as "optimistic."

That view is reflected by the fact that Signetics is pushing hard for its model 2548 RAM, a 2,048-bit model. A p-channel dynamic part with three clocks, it has an access time of 345 ns.

At Mostek in Dallas, the talk is of an n-channel process that eliminates all cell contacts within the array. The results promise to be impressive: access time of 300 ns, active power of only 60 microwatts per bit, and TTL compatibility in both inputs and outputs.

Going abroad. While most semiconductor memory makers seem to be taking the n-channel route, Advanced Memory Systems of Sunnyvale is going p-channel, while one highly significant European competitor—Philips Gloeilampenfabrieken of the Netherlands—has opted for p-channel. To make the new AMS 6004, designers simply doubled the capacity of the 6003, a 2,048-bit RAM. They also retained the same reliable, high-threshold, metal-gate p-channel process used in the earliest MOS RAMs. Access time is expected to be 350 ns, cycle time 600 ns, and operating power consumption about 50 microwatts per bit.

Walter Steinmaier, head of MOS development at Philips, says samples will be ready this year, but production won't start until 1974.

Philips' one-transistor design incorporates a sense amplifier—probably the most critical element—that gives quite a respectable access time of 300 ns. And the Dutch firm's British subsidiary, Mullard Ltd., has just built the first development batch of its own 4,096-bit memory that also is p-channel. Target access time is 280 to 300 ns, and cycle time is 500 ns, a bit slow for new mainframes, so that its most likely initial market is in add-on memory. International Computers Ltd. is the major potential customer.

In West Germany, Siemens also is developing 4,096-bit devices. The company's sales and marketing manager for ICs, Erich Gelder, says that n-channel versions are now in the development stage, with samples due in 1974 and quantity production scheduled by the end of that year. Siemens says its RAM will have typical access time of 300 ns and cycle time of approximately 500 ns. Power consumption will be 200 MW.

In Japan, Nippon Electric Co. expects to complete development of a 4,096-bit RAM by May or June. An improved and enlarged version of Nippon's n-channel, three-transistor-cell 1,024-bit part, the memory should have a fast access time of 180 ns. Hitachi, which has a 1,024-bit p-channel RAM, hopes to start selling its 4,096-bit, 300-ns memory by the end of the year. And Fujitsu's n-channel models use three-transistor cells, though production versions might have one-transistor construction. □

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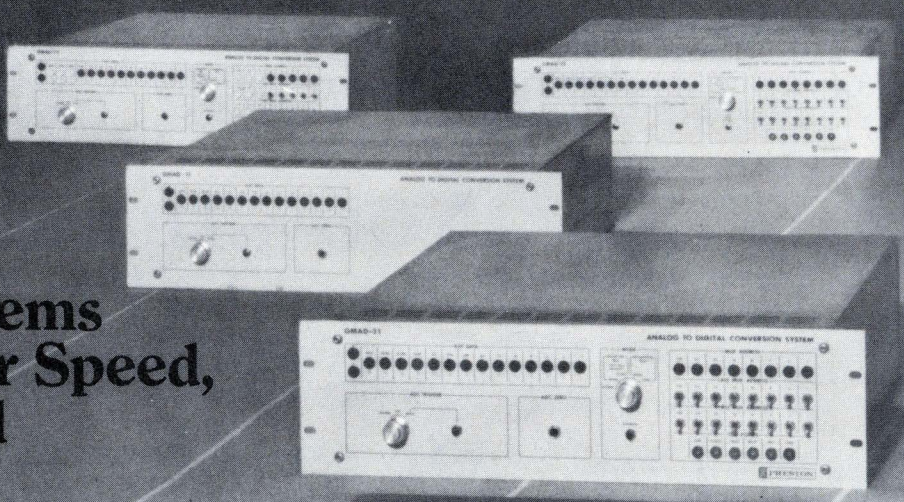

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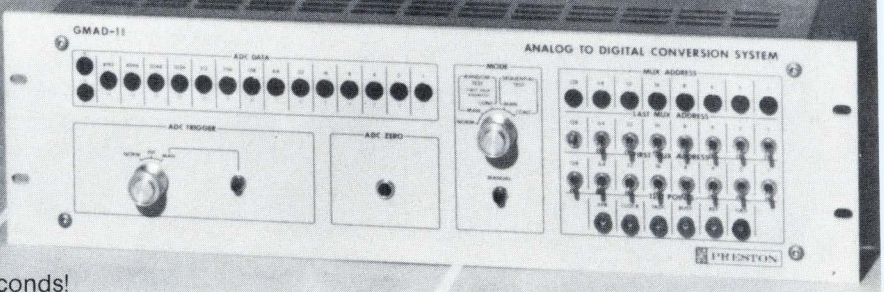

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Marketing

Business boom creates parts pinch

Deliveries of discrete components as well as TTL stretch out; suppliers quote 50 weeks, turn down orders

by George Sideris, San Francisco bureau manager

When the economists looked at their indicators late last year and forecast a 1973 upcurve for the electronics industries, they were rewarded with happy smiles. But something those economists failed to see—that the upcurve would become a boom—has brought with it materials and device shortages and changed many of those smiles to nervous frowns.

Suppliers and vendors are talking about delivery stretchouts that in some cases are a year long. In discrete components and transistor-transistor logic alike, would-be customers are facing a situation that some of them have never seen before. The result has been turned-down orders, a rush to add manufacturing capacity, and accelerated interest in medium-scale TTL.

Good is bad. For Teledyne Philbrick, a 20% increase in business has brought problems—like lead times of 16 weeks on delivery of critical items, says Howard I. Chechik, president of the Dedham, Mass., firm. Among the items affected are ICs, resistors, and thin-film resistors. For IC op amps the stretchout is 26 weeks. Product manager Walter Patstone tells of one order for 1,000 field-effect transistors that had to be spread among eight suppliers.

Clayton Ryder, director of marketing at Allen Bradley's Electronics division, remembers fondly the good old days last summer when his company turned around an urgent order for 1 million resistors in 48 hours. But times have changed: current delivery time on an OEM order is six weeks. On variable resistors and pots, the time is five to 12 weeks—and Allen-Bradley has three shifts working six days a week.

The company is taking care of long-term customers first, expanding capacity (it will start shipping this year from a new plant in Juarez, Mexico), and trying to balance distributor and manufacturer sales.

At the Amphenol division of Bunker Ramo in Chicago, Richard A. Colt, marketing vice president, is adding capacity as deliveries run 10% to 20% later than usual. On printed-circuit boards, the number is eight to 10 weeks instead of the usual four to six, and capacity is being doubled. Colt expects the situation to last through the middle of next year.

Albert Wartchow, marketing manager for electro-ceramic products at Centralab Electronics division of Globe-Union, says, "We've got a certain amount of capacity allocated to distributors so that small customers can continue to get capacitors through distributors, but we've had a moratorium on new orders or certain types of capacitors since Jan. 25—we simply haven't accepted orders instead of quoting a year or 60-week deliveries." Those capacitors are the "garden variety" type—bypass-coupling and temperature-compensating types of disk capacitors. Wartchow says that Centralab doesn't expect to accept new orders until June 1.

From Mexico. Centralab began production last May at a plant also in Juarez, Mexico, and has been shipping a small amount of product back to the U. S. from its Hong Kong facility. Plans at Centralab called for the closing of the original Milwaukee plant, but that is being kept open to help meet the worldwide shortage of ceramic products, he says. "Unfortunately, we're not giving OEMs the kind of service we'd like to, but neither is anyone else."

Despite the upsurge in semiconductor plant expansion that started last winter, TTL circuit suppliers probably won't return to normal 12-week delivery schedules until next winter. Order books have become so clogged that some deliveries have stretched out to six months. And, not averse to making hay while the sun shines, sellers have driven gate prices up 30% to 35%.

Some buyers have become so hungry for standard gates that, in addition to last winter's practice of

Silicon wafers in short supply

A major reason for the shortage of silicon semiconductor products of all kinds is the shortage of wafers. The biggest supplier, Monsanto Co., is quoting 12- to 16-week delivery to established customers. Potential customers will have to wait longer, a company source says, but adds that the company's recent move to standardization of the mechanical specifications of silicon wafers has officials hoping to reduce lead times for wafers to four weeks.

Monsanto is adding crystal pullers to boost capacity but is betting heavily that the move to standardized wafers will be a big factor in easing the bind. Instead of some 300 custom silicon wafer products, the company now has only 12, with standardized diameter, thickness and crystal-orientation specifications.

buying distributor stocks at list prices, they are buying expensive military circuits and Schottky TTL to prevent assembly-line shutdowns.

Getting worse. "All the bad words you've heard are true," says Dan Borozan, manager of advanced materials at Singer's Friden division. "We've paid $3 or $4 when we couldn't get 50-cent parts. The situation is continuously deteriorating. Commitments from suppliers are tenuous at best." He says deliveries run from 20 weeks to six months, with low-power TTL in ceramic packages the worst case. Friden hasn't been hit with price increases on ordered parts, since Friden negotiated blanket contracts last year. But those contracts are starting to run out, Borozan says.

Some IC companies are using the gate shortage to force contract renegotiations, according to an official at a large instrument company across the San Francisco bay from Friden's San Leandro plant. "We negotiated contracts for a year's supply but when we used up the orders in six to eight months, we were told we'd have to recommit. When we tried to negotiate, we were faced with longer lead times, missed deliveries, or no supplier."

Some comfort. Only military equipment manufacturers appear to have comfortable stocks. "Deliveries aren't bad," reports Steve Phillips, buyer for Rolm Corp., a military computer manufacturer. A few new types of Schottky TTL have long delivery times, but most other parts are shipped from stock or delivered within 12 to 16 weeks. Military parts prices have been fairly stable, Phillips adds, but he expects them to rise since second sources no longer "bomb" the prices set for new parts by prime sources.

At the other end of the pipeline, vendors insist they were losing money at the old gate prices. Small-scale ICs were used as loss leaders during the competitive recession days to win profitable medium-scale orders. With gates and flip-flops comprising 75% or more of mixed-order unit volumes, a nickel-per-part increase has generally been considered necessary to bring prices into line with rising production costs.

The prevailing opinion in the San Francisco Bay area is that the gate shortage started in Texas. Vendors here say that above five months ago there was a sudden influx of new customers pleading for gates.

However, Texas Instruments, the prime source of most TTL circuits, vigorously denies it cut back gate production last year. M. Douglas Rankin, digital marketing manager at TI's Houston facility, says the mix of small- and medium-scale ICs is the same now as before the recession—80:20.

Rankin says TI forecast the TTL surge early last year, started increasing production capacity, and warned its customers to place orders early. Those that heeded the warnings are getting deliveries, while those that delayed bookings have encountered stretchouts. "We are concentrating on not overcommitting, and we aren't overcommitted yet," Rankin says.

Double booking? On one point, there is agreement. Many bookings have probably been inflated by customers anxious to re-establish their inventories. "We could all be building capacity for the same customers," suspects Michael Hackworth, bipolar digital marketing manager at Signetics Corp. But Hackworth doubts that overcapacity will result because the real demand for circuits appears to be growing at a rate capable of sopping up capacity as it is built. Hackworth is hopeful of normal deliveries by year-end.

Robert Ulrickson, Fairchild's digital marketing manager, reads the situation similarly. "We are faced with an unprecedented demand rather than a shortage of supply—the TTL supply has grown greatly."

Fairchild is being pressed particularly hard by buyers of diode-transistor logic, turned away by companies who cut DTL production in favor of TTL. "We can't supply the world with DTL, we have to give priority to our traditional customers." He doesn't expect the situation to ease until additional plant capacity is ready and can be assigned to DTL.

Like Fairchild, most vendors are striving to protect their prime-source lines. National Semiconductor Corp. frankly admits it is "de-emphasizing" DTL in order to meet TTL commitments. Gene Carter, IC marketing manager, explains the industry expected TTL sales to total about $130 million this year but actual sales have soared to around a $205 million annual rate. Tom Thorkelson, National's TTL products manager, says the only circuits plentiful at National these days are military ICs, Schottky TTL and ECL. The waiting time at National runs over 20 weeks in some cases and Thorkelson thinks it could be four or five months before three new plants "take hold."

Growing plants. TI, which has opened two overseas assembly plants, is quoting an average of 16 weeks for sole-source circuits and up to six months for other devices. Fairchild is adding 100,000 square feet to its Korean plant, while Signetics is building another 50,000 square feet at its main plant. And everybody's going from 2-inch to 3-inch wafers to increase diffusion-furnace throughput.

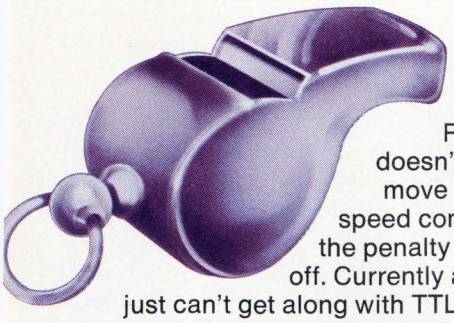
Whatever its origins, the shortage of small-scale ICs was aggravated by a sudden increase in orders for older, gate-heavy equipment designs when the economic boom hit last fall. In terms of functions per chip, gates take a disproportionate share of IC production capacity. In the same terms, they are also more expensive than complex circuits.

So sellers and buyers alike have been striving to shift the emphasis in equipment design to medium-scale integration. The effect hasn't been noticeable as yet at national, which has been producing MSI longer. Thorkelson says his mix is still about 60% gates, 15% flip-flops, 25% MSI.

Up with MSI. However, Ulrickson has noticed an upward trend in MSI, with new equipment designs using as much as 30% MSI. Hackworth expects the industry average to shift to 25% or 27% MSI by early 1974.

The trend is expected to alleviate the shortage as much, if not more, than new IC plants. And, as if to make MSI more attractive, prices of most MSI circuits are still edging downwards. "They've stabilized a bit," Ulrickson says, "but since there is more room for improvement in MSI than smaller IC prices, they can still continue to decline." □

No-hitch Schottky Comparators



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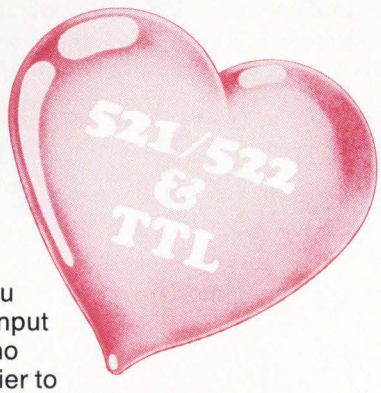
The 521 typically operates at 6ns, with 10ns guaranteed; 522, from 10-15ns. But you can't take advantage of these major increments in comparator speed if penalties keep cutting you down to size.

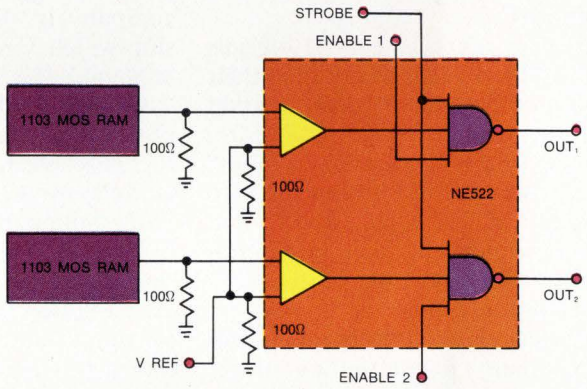
Use the 521/522 any place you'd snap your old 710/711/760 and you clear the board for maximized action. Pin-for-pin replacements for 75107/108: but Signetics' no-forfeit performance can't be matched, while requiring fewer auxiliary parts.



Absolutely TTL compatible in both strobes and output structure. Rock-bottom input characteristics for industrial applications. 20 μA max input bias current guaranteed—so low you won't load down your input transducers. And you no longer add a preamplifier to detect more minute variations of input voltage.

We built in function flexibility too. You not only reduce parts count, you save on stock variety needs as well. These versatile Schottky-fast dual comparators are smooth design-in's as zero crossing detectors, Schottky line receivers, and for A/D and D/A conversions. Plus the most popular alternate application to date—as MOS RAM sense amplifiers.

NE522 COMPARATOR USED AS MOS RAM SENSE AMPLIFIER



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Companies

TI story: consumer and computers

Semiconductor giant's game plan for next three years includes first bipolar, as well as n-MOS, logic and memory products

Texas Instruments is known as a semiconductor company that likes to keep its marketing plans quiet in an industry known for pre-announcements. But TI also is known as a company that, once it decides to reveal those plans, comes on like a herd of longhorns.

That, in effect, is what TI officials did last month as they outlined their view of the semiconductor market over the next three years. The review, entitled "Technology Update 1973," indicates big pushes for TI to develop and sell devices to OEMs in the consumer and computer end-markets. The breadth of the consumer-product push is new at TI; computer-related devices aren't, but the company is committing its resources to new technologies in that market for the first time.

Besides redoubled efforts to make its presence felt more broadly in consumer products—from calculators through solid-state watches to video tape recorders—TI is targeting on digital logic and memories with its first products that use the latest bipolar and n-channel MOS technology. And there are a number of complementary-MOS devices going into production this year—the first revelation of a C-MOS effort by TI.

Memory products in the works include a 1,024-bit TTL random-access memory scheduled for second-quarter introduction, a fast programable 1,024-bit TTL RAM, a 4,096-bit n-channel MOS RAM, a fast 1,024-bit n-channel dynamic RAM, a static 1,024-bit n-channel RAM, plus a host of new MOS shift registers.

TI's first entries in the fast-growing C-MOS market are six small-scale integrated logic chips in the 4000 series, developed for the military, that are now being offered for commercial use, plus C-MOS circuits going into production for the consumer market. The latter include an automobile-clock circuit, a chip for watches with mechanical hands, and a seven-segment clock chip. The company is also developing C-MOS stop-watch circuits and custom C-MOS auto-seat-belt interlock devices.

Growth predicted. The consumer push stems from TI estimates that the U.S. electronic consumer end-equipment market will grow from $5.74 billion by year's end to $6.8 billion by 1976 (see charts). The semiconductor share will grow from an estimated $276 million this year to about $450 million by 1976, TI forecasts. Computer end-equipment is figured to go from $4.94 billion this year to $6.4 billion in the same period, with the semiconductor portions for 1973 and 1976 pegged at $285 million and $355 million, respectively. In the industrial sector, end-equipment sold this year is expected to reach $8.89 billion, accounting for an estimated $274 million in semiconductor sales. By 1976, the semiconductor part will grow to $315 million in an equipment market of some $11 billion.

Another prime TI target is the semiconductor distributor market. Charles Clough, assistant vice president and marketing manager of the Semiconductor group, says the distributor business is typified by "small-quantity orders with fast turnaround, but it's an increasingly important and profitable market." He says distributors had 15.6% of semiconductor sales, or $193 million worth, in 1969; those figures will grow to 17.3% and $324 million, respectively, by the end of 1976.

The calculator-chip share of that 1973 consumer-equipment market total will reach a staggering $100 million, Clough estimates. He also predicts that U.S. color-TV production will grow 15% by 1975 to 7.5 million units, with sales of all sets totaling 9 million.

TI didn't muster its forces for an

U. S. SEMICONDUCTOR MARKET
(IN MILLIONS OF DOLLARS)

Segment	1969	1970	1971	1972	1973 EST.	1976 EST.
Consumer	113	97	125	210	276	450
Computer	326	254	201	243	285	355
Government	275	244	217	225	235	270
Industrial	188	197	207	238	274	315
Distribution	193	165	176	245	270	324
Domestic	1,095	957	926	1,161	1,340	1,715
Export	140	165	140	155	160	160
SC TOTAL	**1,235**	**1,122**	**1,066**	**1,316**	**1,500**	**1,880**

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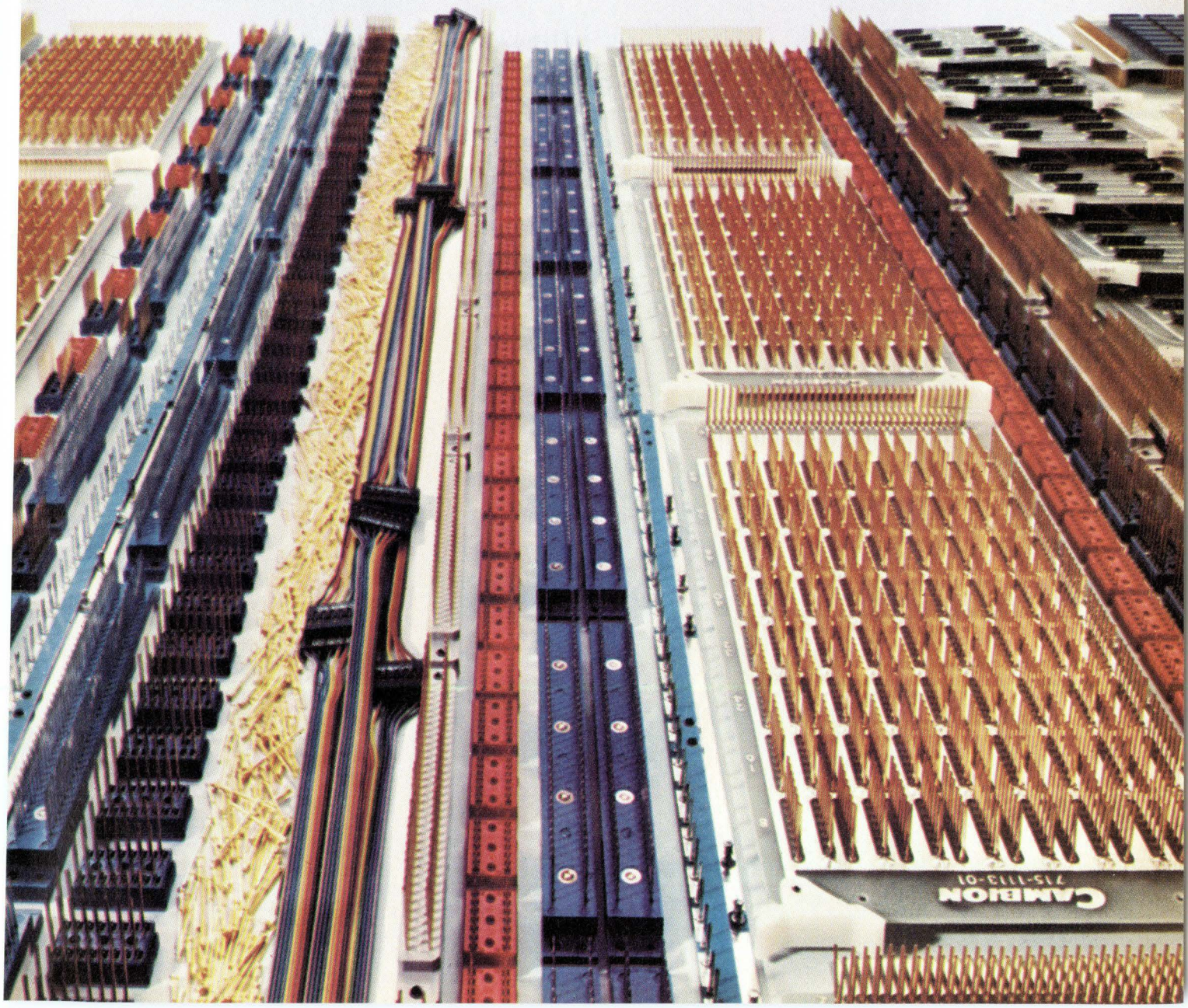

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Based on a very thorough material comparison, Cinch Division of TRW Electronic Components now molds these printed circuit edge connectors, shown below, in flame-retardant Celanex SE-0—replacing DAP and glass-filled phenolics. Why? Celanex cuts molded insulator costs by a whopping ⅔. And insulator properties in Celanex are equivalent or better.

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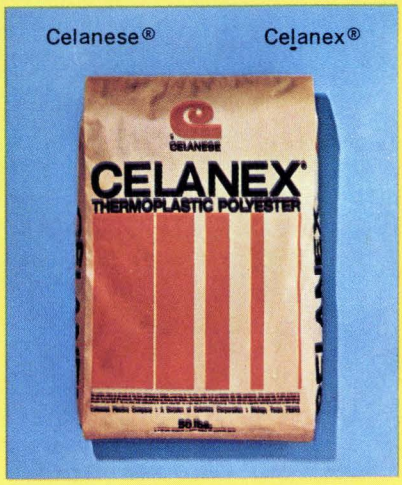

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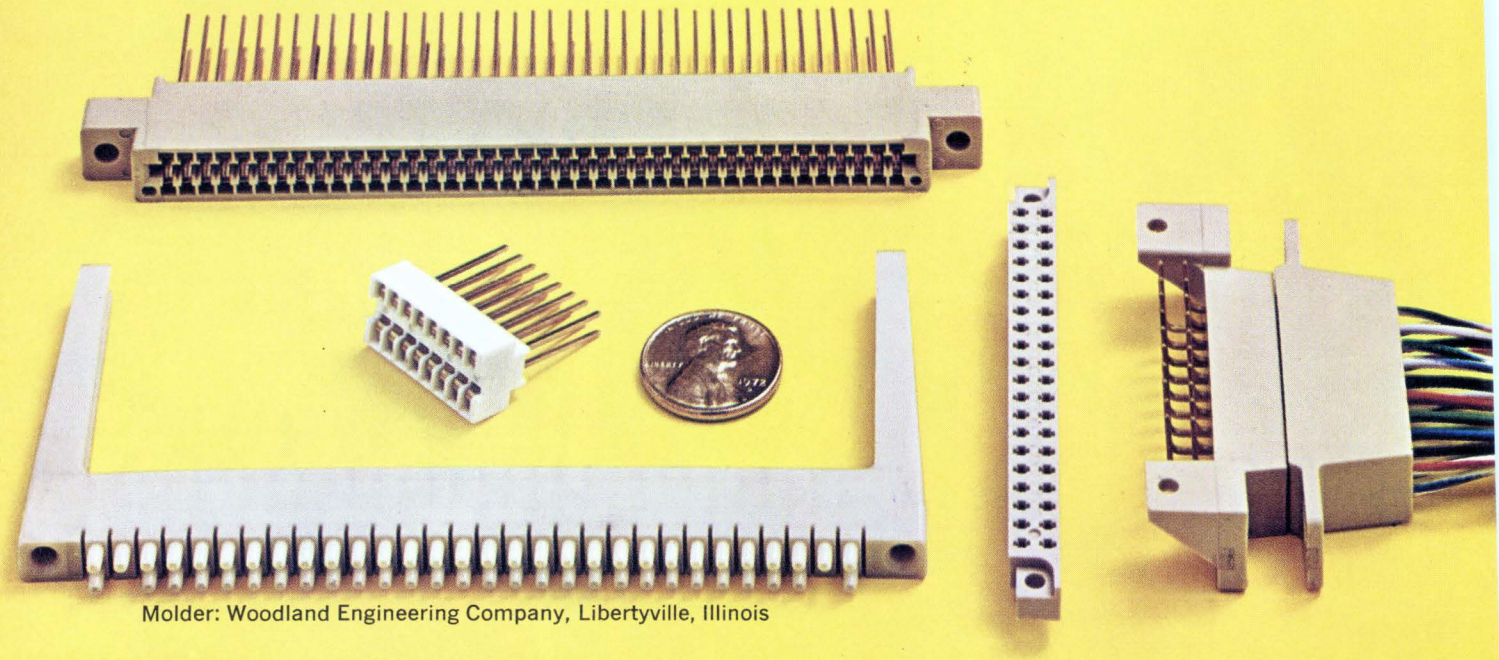


Molder: Woodland Engineering Company, Libertyville, Illinois

Circle 84 on reader service card

assault on the calculator business until recently, but now that the firm is in, the effort is prodigious, in both calculator chips and complete machines. TI planners believe handheld calculator sales will explode from 7 million units this year to 14 million by 1976 in the U.S. alone.

In the automotive market, TI looks for U.S. factory shipments of some 9.5 million to 9.7 million units by 1975, with $13 worth of semiconductors per car by 1976.

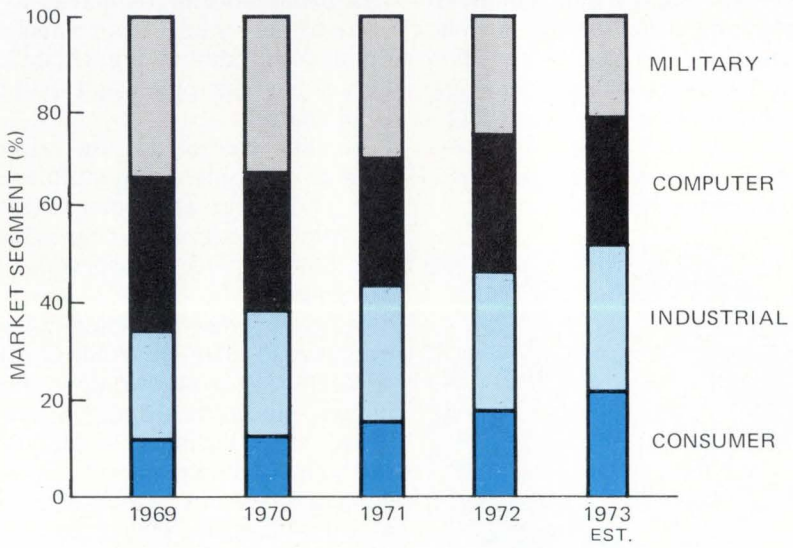
Moving heavily into memory. Like much of TI's strategy for addressing new-technology markets, its entry into the memory race was delayed until company planners were certain they knew the direction of the market and sure of the proper technology with which to address it. They now have committed to both areas: they are going after the mainframe and peripheral-memory market with proprietary TTL and n-channel memory products.

In TTL, TI's first entry for mainframes will be the 1,024-bit RAM, made, not with some form of oxide isolation like that of most other manufacturers, but with an older mask-compose technique. TI has long maintained that passive isolation was not needed at the 1,024-bit level. In any case, the performance is very high: using a Schottky TTL memory-cell design, this product will have a typical access time of only 38 nanoseconds, as fast as any 1,024-bit RAM on the market. And the company plans to use this same Schottky-TTL technology in the new ROM products, as well, with a 1,024-bit programable ROM having an access time of 30 ns, coming in 1974.

In MOS memory, TI is planning to augment its 1,024-bit p-channel-RAM capability with a host of n-channel products. This year, the company will enter the growing 4,096-bit n-channel market with a 300-ns memory design that incorporates many of the newest memory techniques—switched-capacitor, single-transistor cells, bipolar-compatible inputs and outputs, and single-clocking (two internal clocks on chip).

TI is also planning to address the fast-mainframe market with an n-channel RAM having an access time of less than 80 ns. The company is also planning to go after the terminal market with a slow (600 ns) but easy-to-use static 1,024-bit RAM of the variety that has rewarded Intel with such success. New MOS calculator chips are also in the works. Coming soon is a power-down version of TI's single chip for calculators and a two-chip calculator set offering 12 digits and memory capability. TI's 4000 C-MOS series will include a high-reliability 4000A line in a ceramic dual-in-line package that meets full MIL STD-883 requirements. □

U. S. SEMICONDUCTOR CONSUMPTION



Production

Wire-wrapping takes a new twist

Less expensive and faster, new machinery gives the technique a more solid posture for doing battle with multilayer pc boards

by Stephen E. Grossman, Packaging & Production Editor

The advent of an automatic wire-wrapping machine with a price tag within the means of many more potential pin-and-board users has manufacturing engineers taking a new look at the advantages and disadvantages of automatic versus semiautomatic wire wrapping, and of both techniques versus multilayer printed-circuit boards.

In the view of one consultant, Jack J. Staller, president of Techstal Associates in Norwood, Mass., automated wire-wrap machines have caught on tremendously. Because they were so very much more expensive than semiautomatics, "We thought they would die," he says, "but they have grown." The reason, he believes, is that automatics can be changed quickly to handle different types of ICs, "and with the rapid changes in ICs you need this."

What could turn this trend into a decisive victory is a new automatic machine from the Gardner-Denver Co.'s Electronics Products division. The model 14FV has a dramatically lower price and higher throughput level than earlier systems: it sells for $70,000—the previous automatic setup cost $168,000—and wraps 1,100 to 1,200 pins an hour, twice the rate of its predecessor. Moreover, the new machine is smaller, and the hydraulics are gone for easier maintenance.

What about the competing technologies—semiautomatic machinery and multilayer pc boards? Each has its advantages and drawbacks, and each has its proponents.

Less cost, less work. Semiautomatic is, for one thing, less expensive—$6,000 to $30,000 per machine. However, you get less throughput, typically 125 to 300 wraps per hour.

As for boards, once the copper is etched, the circuit is cast in concrete. Wire-wrap advocates point out that it's simple to remove or add a wrapped wire from the socket pin on a panel board, and the panels offer plug-in mounting for devices. Moreover, drawings are required to prepare a multilayer pc board; routing for an automatically wrapped board is directed by an easily changed algorithm.

On the other hand, multilayer boards have a low profile—no pins sticking up. And no matter how much data is presented to show the reliability of wire-wrap—and there is a good deal of it—some engineers just won't sleep nights unless they know that every connection has been soldered to its contact.

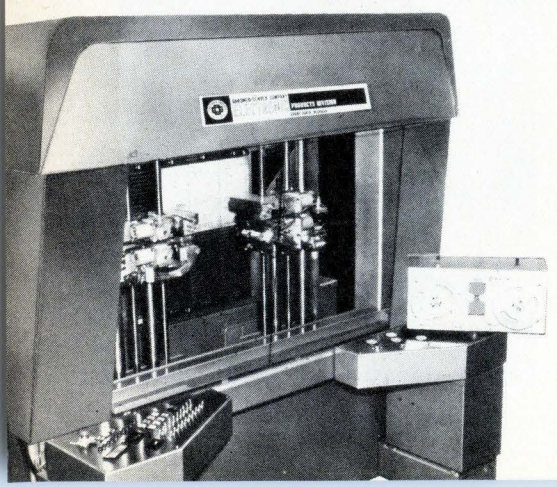
Still, wire-wrapping has piled up an impressive reliability record since it was developed at Bell Laboratories some 20 years ago. Richard Grubb, marketing vice president at Augat Inc. of Attleboro, Mass., a major supplier of socket wire-wrap panels, says, "Any doubts about its reliability are groundless," Granted, a marketing executive at a wire-wrap house is bound to be enthusiastic, but an examination of the way wraps are made shows why.

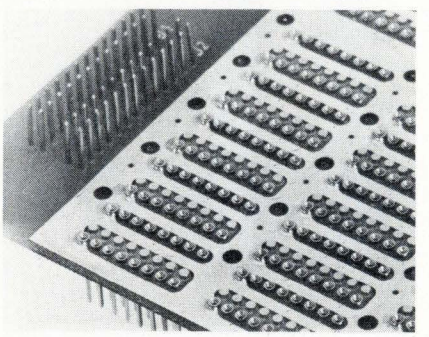
About seven turns are made around each pin, which is usually 25 mils square. The wrapping tool forces the wire to deform plastically about each of the pin's four corners, developing compressive forces of about 80,000 psi. In addition, these contact interfaces are gas-tight, thereby maintaining a stable, low contact resistance over the long term. And since a contact forms at each corner, there is a contact redundancy of about 7 times 4, or 28—hence, one bad apple won't spoil the whole barrel.

Quality control is also simpler than that required for multilayers, says Gardner-Denver's Walter Christian, sales manager, since there are few in-process inspection requirements.

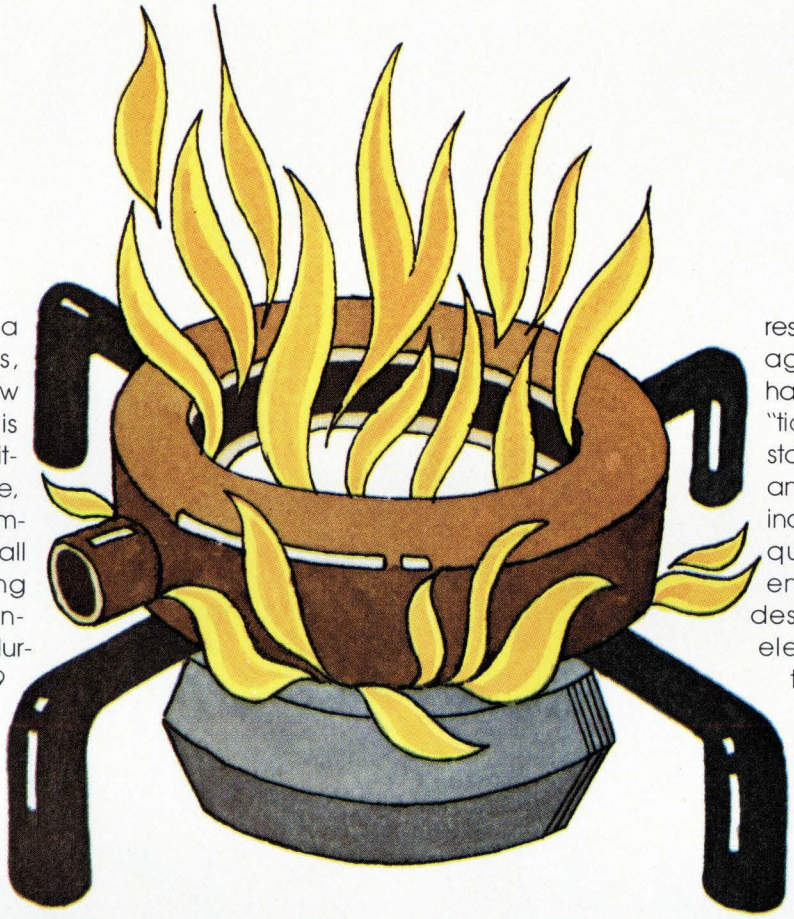
However, wire-wrapping doesn't exactly lead to an electronic Garden of Eden. Of the two wrapping techniques—pin in board or socket in board—the attachment of sockets to the board can create problems. Tolerances of the pin in the socket and socket placement may accumulate to the point where they will disrupt

Subject and object. Gardner-Denver's new 14FV, a less expensive, faster, and smaller wire-wrap machine, may make the pin-in-board shown below a more common sight.





Q1 What? An elastomer only 18 mils thick is UL SE-0?
Q2 It's ozone resistant too?
Q3 Can it take the higher 1973 voltages?
Q4 Where is it being used?



A1 You bet. Even in a thickness of 18 mils, General Electric's new silicone rubber SE5559 is rated SE-0 by Underwriters' Laboratories. You see, new stiffer industry flammability requirements call for non-wire insulating components to self-extinguish in 30 seconds during arc testing. SE5559 passes the test with self-extinguishing times of 3 to 8 seconds with a flame height of less than 1/4 inch.

A2 That's right. After 28 continuous days of exposure to 200 ppm ozone, even while under tension, there wasn't a trace of cracking in the SE5559 sample tested. And strong ozone exposure didn't affect the rubber's self-extinguishing properties.

A3 Yes. Because of smaller TV receivers and the higher voltages needed for sharp, clearer reception, designers have turned to anode caps made of SE5559. Silicone rubber anode caps have excellent resistance to high voltage breakdown and have helped eliminate "ticking." Also, they withstand high temperatures and meet all applicable industry flammability requirements. Which is enough to make most designers of electrical/electronic components think twice about organic rubber or plastics.

A4 Corona rings and anode caps for TV receivers are typical applications for SE5559. It has the right balance of properties: excellent physicals, high dielectric strength, resistance to ozone and thermal aging. It adds up to long service life. Which opens the door to a wide range of design possibilities in business machines, appliances and other electrical/electronic applications where flame resistance is required. Yet SE5559 is easy to fabricate, and it's priced like the average silicone rubber.

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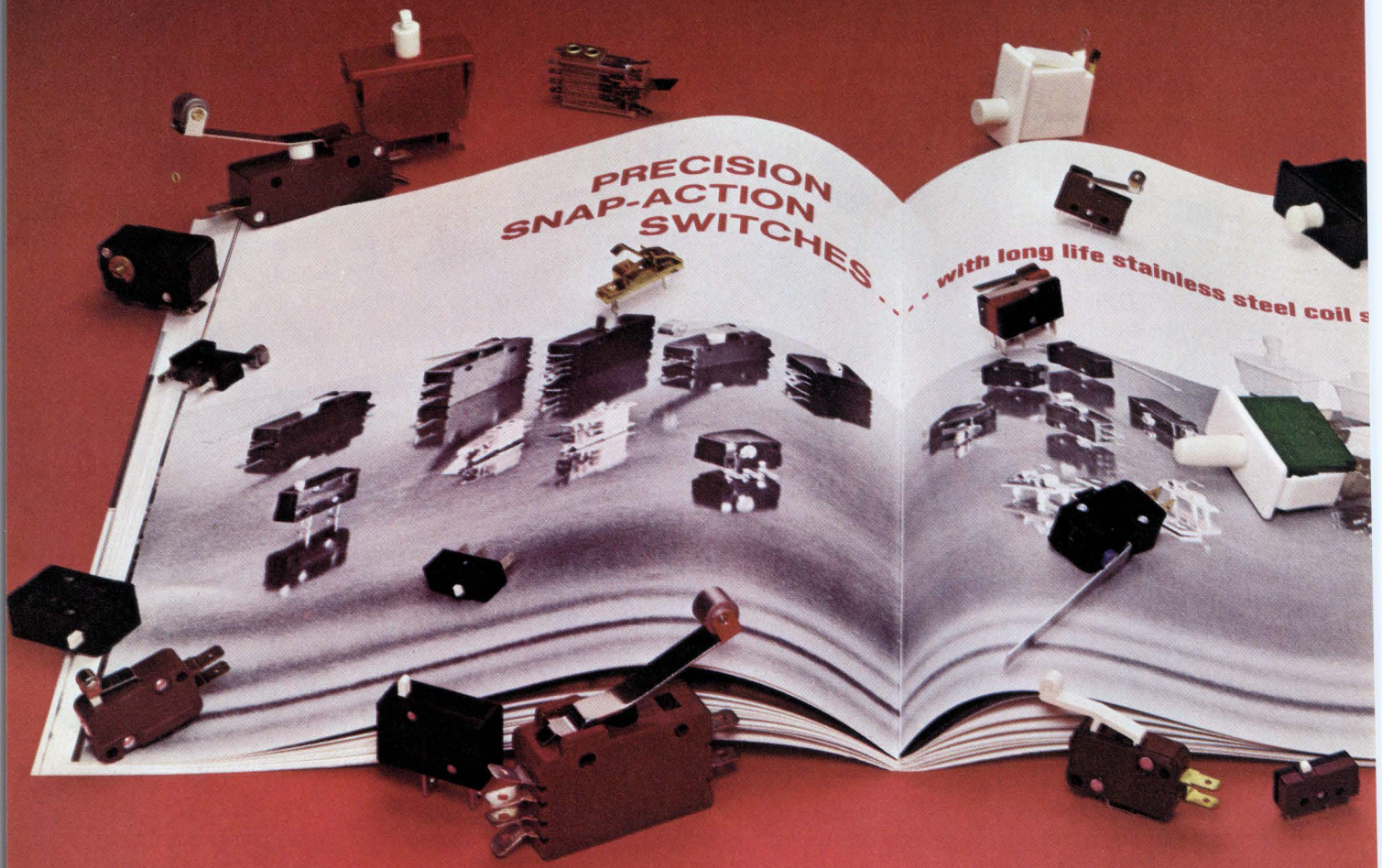

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the automatic wrap process. There have been complaints that if the tip of the socket pin is more than 10 mils off center this will occur.

To date, semiautomatic wire-wrapping has been the more popular technique. Raytheon Co.'s Wire Wrap division in Waltham, Mass., which offers wire-wrapping services and has 14 Gardner-Denver machines (it bought the last three machines in 1969 for $163,000 each), surveyed the U.S. and Canada in April and May 1972 and identified 234 companies that had automatic or semiautomatic equipment. It tracked down 525 semiautomatics, perhaps 90% of those in existence, and 285 Gardner-Denver machines.

Half day. "It appears that approximately half of a 24-hour-day, six-day-week capacity was being utilized" by all, manufacturing and marketing manager Russell W. Manchester says, "and productivity was shared about equally between semiautomatics and automatics. There was more unused G-D capacity than semiautomatic capacity, partially due to the recession which had not yet turned around." He estimates that in the second half of '72 capacity went back to near saturation levels and remained there—"a good 75% to 80% of capacity is being utilized," he thinks.

The company has also tried semiautomatic machines; it bought machines from several companies, but was dissatisfied. "We reached the conclusion that for our job-shop atmosphere these semiautomatics were not up to what we were trying to do," Manchester says, so the company decided to develop its own. Unfortunately it came on the market with these machines at about the same time as a dozen other companies that had made the same decision.

The new 14FV should eventually bring down the price of wrapping by about 1 cent per wire, Manchester thinks—perhaps even to 5 cents per wire from the current 7.5 cents. Raytheon has already ordered two. The new machine should also take back some business from the semiautomatic market, since it will cut down on overhead.

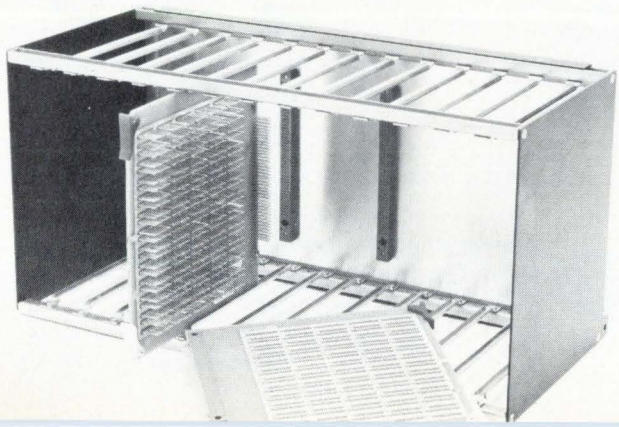
As for multilayer boards, Manchester says that if a product is well designed, then wire-wrap is cheaper. In the past, Raytheon customers have expected to use multilayers only to wind up going with wire-wrapping, he says, "and with the introduction of the new machine we know of some people who had planned on using multilayers who are now reconsidering."

Some users, such as Hans Schavemaker, manufacturing manager at Interdyne, says that though he has been quite pleased with the earlier Gardner-Denver machines, he is taking a wait-and-see attitude with the new ones. On the other hand, Excel in New Brunswick, N.J., will purchase four of the 14FV machines and is aggressively seeking contract opportunities.

At Standard Logic Inc. in Santa Ana, Calif., a maker of semiautomatic machines that sell for $5,000, executive vice president Bruce Billington sees the 14FV as a threat to the machine selling for $25,000 to $40,000. "They'll be killed from both sides," he says. "They had a place when G-D was at $250,000, but not now."

He concedes the new machine "does a beautiful job," but says it's not good for high-speed logic like ECL where lines must be short. Also, he adds, it won't do twisted pairs and trios and has a small wiring area. □

Putting it together. Here's a typical installation of small boards, shown with their rack, that can be wrapped automatically.



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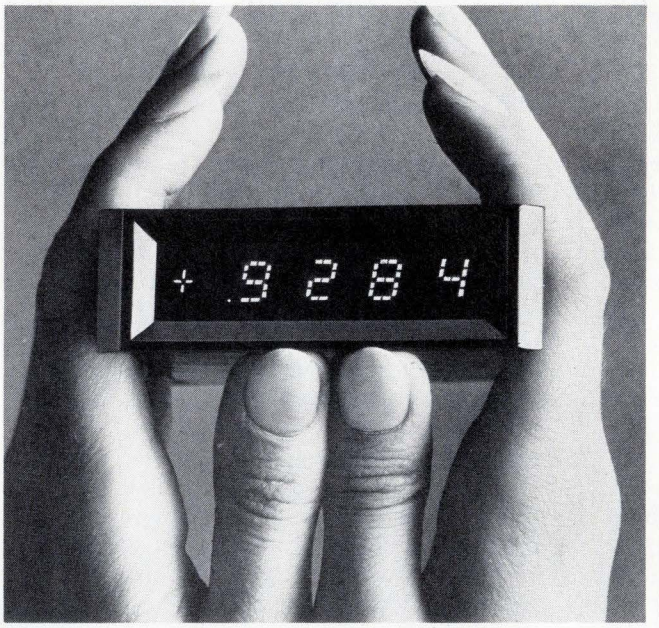

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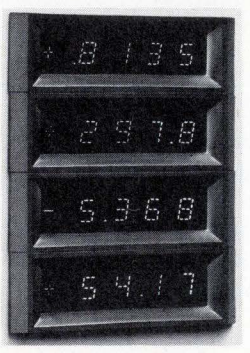

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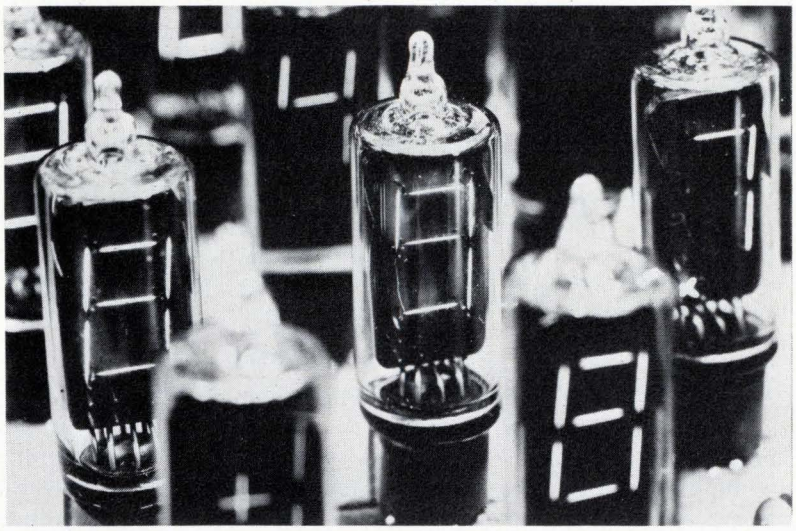


Special Report: The new displays complement the old

Don't let yourself be blinded to an application's over-all requirements by concern with a single display parameter: that's the message of this survey of the merits of available displays, from tubes to liquid-crystal types

by Michael J. Riezenman, *Instrumentation Editor*

☐ Never before have so many different types of display devices been available. To the venerable shaped-character gas-discharge glow tube, the rear projection display, and the simple array of incandescent bulbs, have been added the planar gas-discharge display, the directly viewed filament, the vacuum fluorescent tube, the light-emitting diode, and the liquid-crystal display. Since, by and large, the newer devices supplement rather than oust the older displays, the engineer today has an unprecedented opportunity for finding exactly the display he needs—or for fouling up royally.

The wisest way to set about the job is to put the main stress on the application and to relegate display technology firmly to second place. Some designers like to use the latest hot device, regardless of its suitability—and about the only thing that can be said in favor of that approach is that it sometimes appeals very powerfully to the final customer, too.

This brings up an important point. Unlike most engineering decisions, the choice of a display must take psychology into account. The display is something that is immediately visible, and the end user will almost certainly have an opinion about its looks. If the device is part of an instrument being considered by a knowledgeable engineer, he may well have an opinion about its reliability. And there is, of course, the user—especially in the consumer area—who is impressed (or decidedly unimpressed) by the latest stuff to come out of the labs. Add these psychological headaches to the more mundane considerations of cost, size, visibility, power consumption, temperature range, driving characteristics, lifetime, etc., and the choice of a display becomes a bigger problem than many designers at first expect.

Starting small

To most people who make and use displays, a "small" display is one that is suitable for use in a hand-held calculator. This typically means a character size in the range of 0.1 to 0.2 inch. Devices with only one digit per package would have a very tough time competing in this area, and in fact none are made. Incandescent filaments and shaped-character glow tubes are thus not even in contention. (Actually, a 3/16-in. directly viewed filament display is made by Pinlites, but at $18 a digit in large quantities, or $29 in singles, it is clearly a special-purpose item.)

The choice in this size category is pretty much between light-emitting diodes and planar gas-discharge devices. Both types are typically packaged with like segments of each numeric connected in parallel, making multiplexed operation essential. In most applications this is an advantage. It reduces the number of decoders

and drivers that are required, thus lowering the cost of the drive circuitry; and it reduces the number of interconnections that are required, thus enhancing reliability. A disadvantage of multiplexing—but one that seldom arises in small-digit applications—is that it makes getting a parallel BCD output harder and more costly.

LEDs seem almost made to order for the small display. There are four important reasons why.

First, the cost of a LED display is largely determined by the cost of the semiconductor material of which it is made. The smaller the digit, the less it costs. Furthermore, small LED displays lend themselves well to the use of molded plastic lenses that make possible a further reduction in materials cost by increasing the apparent size of the LED segments.

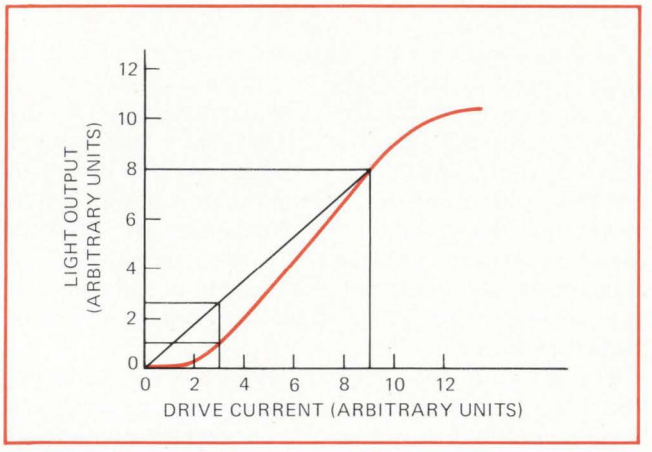
Second, LEDs thrive on multiplexing. In multiplexing a display, each digit is driven at N times its usual drive level for 1/N of the time. The result is about the same brightness as if the normal level had been applied steadily. LEDs made of gallium arsenide phosphide, however, get more efficient as their drive levels go up, so that the average drive level can be reduced substantially with no loss of brightness. In the example shown in Fig. 1, operating the LED at a 33.3% duty factor with a threefold increase in drive current boosts the light output by a factor of approximately 2.5:1. This property of gallium-arsenide-phosphide displays is so effective a way to reduce power consumption that pulsed operation is sometimes used in nonmultiplexed applications for the increase in efficiency alone.

The third factor that makes LEDs attractive for small displays is their ruggedness and ability to withstand extremes of temperature. Small instruments and calculators are likely to be dropped, banged around, left in hot automobiles in the sun, or cold ones overnight in the winter, and it's helpful if the display can stand up to this sort of treatment.

The fourth point in their favor is that LEDs are directly compatible with the 5-volt supplies typically encountered in digital equipment. Although the diode's forward voltage drop is only 1.6–1.7 V, the drive transistors and current-limiting resistor make the 5-V supply a good choice.

On the negative side, low-cost LEDs offer as much color variety as Henry Ford's earliest cars. You can have any color you want as long as it's deep red. Most people find the thin bright line of a directly viewed LED segment to be fatiguing to the eye, so that in an application calling for prolonged viewing, color can be a problem. Also there is a small percentage of people who have great difficulty in either seeing or focusing red light—a problem that worsens with the observer's increasing age.

Colors other than red are possible in LED displays—green and yellow are already being offered by at least one manufacturer—but these other units cost at least five times as much as equivalent red units and are therefore not used in low-cost applications.

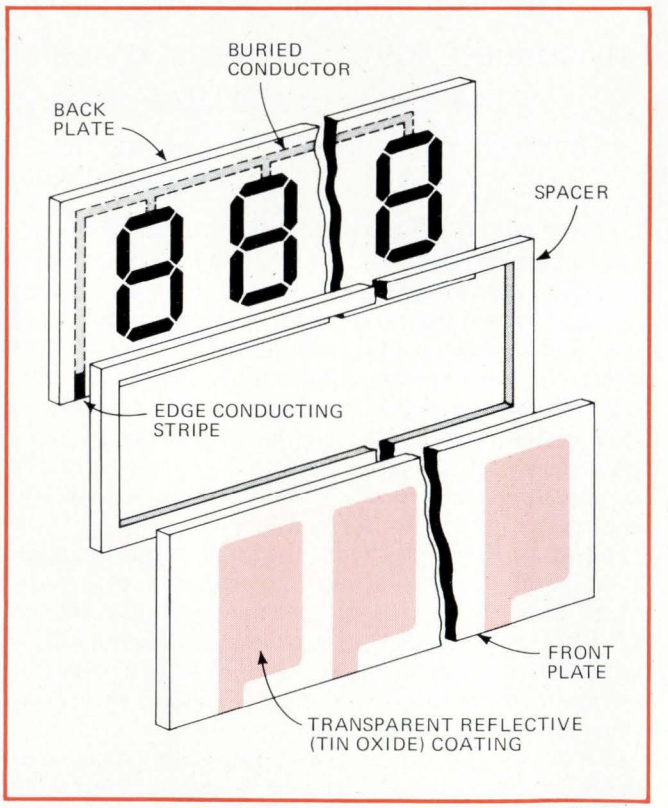


1. Efficiency booster. Light-emitting diodes are more efficient at high drive levels than low. Therefore, power consumption can be reduced by operating the LEDs with large pulses of short duration.

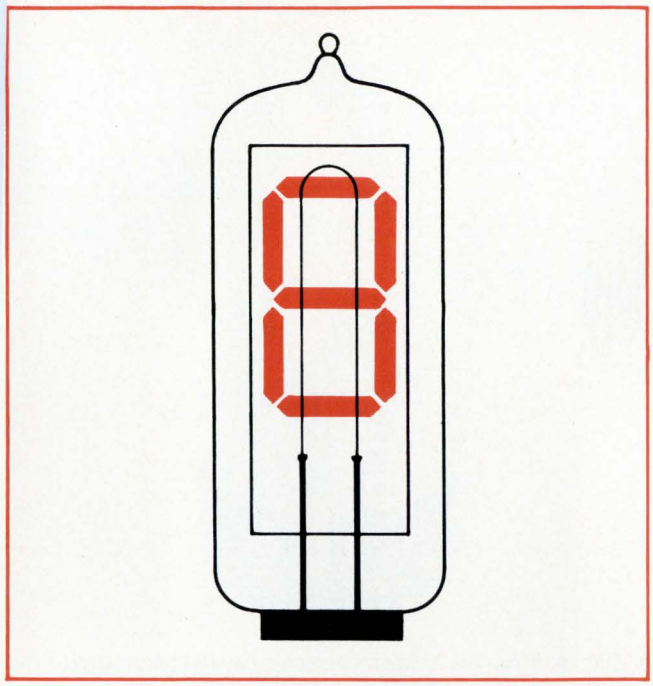
The only rival

Possibly the most important single difference between LED displays and planar gas-discharge panels is that there is only one domestic manufacturer of planar gas-discharge devices in the size range under consideration—Burroughs Corp.—and the display is the 0.2-in. Panaplex II, made by the Electronic Components division, Mt. Bethel, N.J. (Fig. 2). This lack of second sources, which characterizes much of the display business except for LEDs, is much mentioned by LED manufacturers as a point to ponder.

Whereas small LED displays come in packages of three, four, or five digits that can be stacked, end to end, in various combinations to produce almost any size dis-



2. Panaplex II. Burroughs' solution to the one-digit-per-bottle problem of its Nixie tubes is this multi-digit planar gas-discharge package. Corresponding cathodes of each seven-segment digit are interconnected by a buried conducting layer, making strobed operation essential. Each digit has its own anode—a transparent conducting layer of tin oxide deposited on the inside of the front plate.



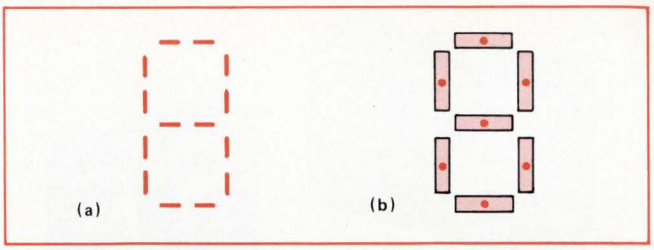
3. Easy on the eyes. The electrons that are emitted by the filament of the vacuum fluorescent tube are attracted to the phosphor-coated anodes, which then glow with a pleasant, soft bluish-green light.

play, the 0.2-in. Panaplex II is less flexible. The choice is nine or ten digits, period. Obviously, this display is aimed primarily at one market—hand-held calculators—although a frequency counter could presumably also use it to advantage.

What the Panaplex display has going for it is low cost and a pleasing appearance. An overwhelming majority of the display users interviewed for this report stated that both they and their customers preferred the appearance of planar gas-discharge displays to that of LEDs. Perhaps underlying this subjective preference for gas-discharge displays is the fact that they produce light over a fairly broad range of wavelengths in the red-orange region of the spectrum. Thus, they can be filtered to produce various shades of amber, orange, and red, and few if any people have trouble seeing them.

Comparing costs is made difficult by the fact that small digits are almost always used in high-volume applications, where prices are negotiated on an individual basis. Nevertheless, it can be stated with some confidence that, in lots of 100,000, the gas-discharge display sells for about $1.00 a digit, while the LED costs more like $1.35 to $1.60 a digit. Of course, what the user is really interested in is the total cost of the display, including limiting resistors, decoder/driver, power supplies, etc. It is even more difficult to evaluate the tradeoffs in this area, but it can at least be noted that gas-discharge devices, while they operate at very low currents (on the order of 300 microamperes), need supply voltages on the order of 200 v. Thus, at the least, the cost of a simple dc-dc converter must be included in the price comparison.

Gas-discharge devices work well over quite a broad range of temperatures, but two low-temperature effects are worth noting. First, the voltage required to ionize the gas and start it conducting increases somewhat, especially in the dark. Thus it's possible for a marginally designed power supply operating off a cold battery to lose its zip just when the display needs it most.



4. Closing the gap. Old-style LEDs used two chips in series and produced a gappy-looking character (a). New type uses a single small chip and a diffusing light pipe to save material (b).

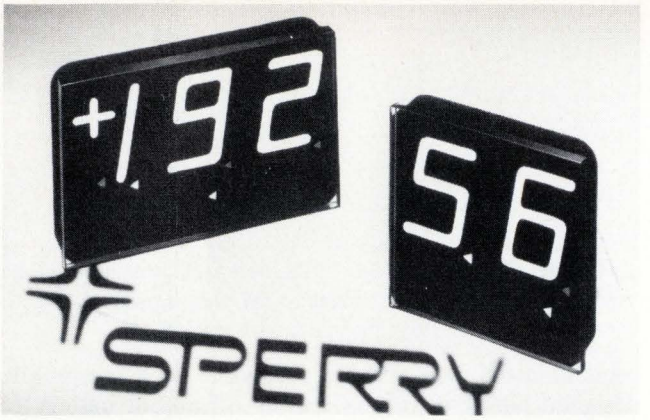
The second effect is related to lifetime. Gas-discharge devices are generally regarded as having lifetimes in excess of 100,000 hours. Behind this respectable number is a tiny amount of mercury vapor that's added to the panel's neon gas to inhibit sputtering of the cathode metal. (The mechanism behind this inhibition is not well understood, but John Pittman, manager of product marketing at Burroughs Corp., favors the explanation that the mercury vapor shortens the mean free path of the neon ions in the tube and hence reduces their ability to erode the cathode.) At low temperatures, the vapor pressure of the mercury is reduced, and so is its protective action. The effect becomes noticeable at about 0° C and is so pronounced at -20° C that the display then acts as if it had no mercury at all. Translated into lifetime terms, this can mean a reduction of 200:1, or from 100,000 hours to 500 hours. Of course, the panel and the circuitry it's mounted with are self-heating to some extent, so that ambient temperature and device temperature are not going to be the same. Nevertheless, an external heater may be required under some extremely cold conditions. This is no doubt out of the question in small-display applications, but it is a possible approach when larger displays are used.

One final problem that sometimes comes up with gas-discharge devices, regardless of size, is noise. Both the switching transients generated by the display's drivers and rf noise generated by the gas itself must be considered. If the circuitry near the display is strictly digital, as in a calculator, noise will probably not be a problem. But if the display is being used in a sensitive receiver or a low-level-signal generator, shielding will be essential. And the cost of shielding may well tip the budget balance in favor of some other display technology.

A fluorescent future

One display that has been omitted from this discussion so far is the vacuum fluorescent tube. The trouble with these devices in their small, multidigit form is that they are made only in Japan. And while the Japanese are turning out something like 2.5 million to 3 million digits per month, their calculator industry is demanding over 4 million digits. So very few such digits are available for use in the United States.

This situation will not last indefinitely, however. The Japanese are increasing capacity by building plants in Korea and Taiwan, and domestic manufacturers of single-digit vacuum fluorescent tubes are tooling up to



5. No gaps. Sperry's planar gas-discharge display is packaged so that all segments of all digits are accessible. Corners of seven-segment digits appear to fuse, eliminating gaps at corners.

make calculator displays. Industry insiders expect the present shortage to end in about September, and what will happen to prices at that time is anybody's guess.

So, recognizing that this is to discuss a technology not yet generally available in small sizes, let's examine the characteristics of the vacuum fluorescent display. Basically, the device consists of a vacuum container with seven anodes and a filament. The anodes, which are each coated with a phosphor, are arranged in the standard, planar seven-segment format. The filament, which is so fine it's almost invisible, is placed between the viewer and the anodes (Fig. 3).

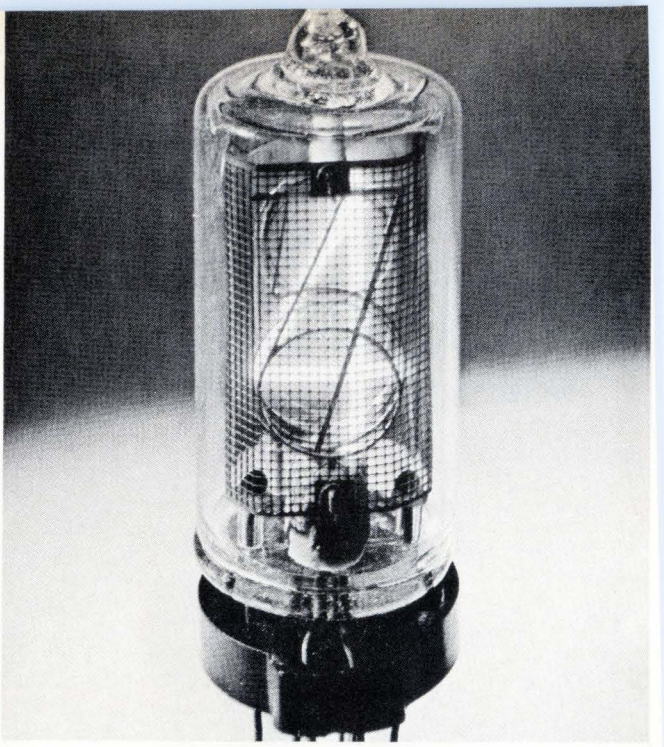
In operation, the filament is heated to just below incandescence so that it remains invisible, and a positive voltage between 12 and 25 V is applied to the anodes to make them glow. Although the filament of a half-inch tube might take 40 milliamperes at 1.5 V, this current need not be switched. What must be switched are the anode currents, and as these are on the order of hundreds of microamperes, MOS compatibility is obtained. To save power in portable instrumentation, the filament can be connected to a press-to-read switch.

Pricing of the vacuum fluorescent display is uncertain in light of the Japanese position. Before the "Nixon shock" and the recent dollar devaluation, small displays were selling for as little as 85¢ a digit in large quantities. The price has certainly gone up somewhat since then.

The large single-digit-per-bottle displays, which range in size from 0.25 in. to 0.6 in. in standard sizes, are more expensive. Prices run between $3 and $4 a digit in small quantities, dropping to about $1.65 a digit in quantities of 100,000.

When it comes to operating temperature range, the vacuum fluorescent device leaves little to be desired. A nominal range of −55° C to +100° C should cover just about all real applications situations.

Ruggedness and reliability are another matter. Some detractors point to the thin filaments as a weak spot. Supporters, on the other hand, argue that the extremely light mass of a fine filament allows it to take an enormous acceleration without strain. Furthermore, some manufacturers—Tung-Sol, for example, the Livingston, N.J., division of Wagner Electric Corp.—use two filaments per tube, so that the failure of one does not cause failure of the whole device.



6. Old reliable. The shaped-character gas-discharge glow tube, better known as the Nixie, has been around for over 15 years. Some units have logged over 100,000 hours of continuous operation.

The expected lifetime of a vacuum fluorescent display is about 20,000 hours. At this point brightness will be down to half of its initial level. If a more liberal definition of lifetime is used, as is done with other technologies where inability to read the device is taken as the definitive symptom of death, much larger numbers—in excess of 100,000 hours—can be generated.

A big plus for the vacuum fluorescent display is its color—a soft bluish green. Not only is this very easy on the eyes and very easy to see, but its spectrum is broad enough for it to be able to be filtered into just about any color except deep red.

Some potential users have rejected fluorescent displays because of optical hot spots on the segments. Such a consideration does not affect readability, but it may turn some people off.

One final point, courtesy of Dick Du Bois of Tung-Sol who introduced the vacuum fluorescent tube at the 1967 SID symposium: driving the vacuum fluorescent display in a static mode is easy, but multiplexing it may require some tricks in the drive circuitry and should be approached cautiously.

In the middle range

In the medium-size range, covering roughly ¼- to ½-in. characters, the picture is much broader and more complicated. Just about every display technology can compete economically someplace in this region, and applications include just about everything except the very small hand-held calculator or instrument.

With LEDs, a revolution has just taken place in the ¼-in. characters. Until very recently, the segments of GaAsP LED displays of this size and larger were made of two or more sub-segments. The aim was to decrease the amount of semiconductor material needed by adding small gaps as inoffensively as possible. In the popular configuration of Fig. 4a, this entails connecting two

diodes in series for every segment in the display. But labor costs are increased, reliability is decreased for the same reason, and appearance suffers.

The solution, which has been used with gallium-phosphide displays for several years now, is to replace each of the multi-diode segments by a single diffusing plastic bar illuminated from behind by a single tiny semiconductor chip (see "LED displays mount new attack," *Electronics,* March 15, p. 65). If the optical interface between the chip and the plastic bar is properly made, a great increase in light-gathering efficiency can result. The benefits that then accrue are impressive: a reduction of material usage of up to 85%, a halving of the number of dice to be put down, a halving of the number of bonds to be made, and a significant reduction in the amount of heat to be dissipated in the package. All of these factors combine to lower costs, and the last three also directly increase reliability. Further, the soft glow of the wide plastic segments is much more pleasing to the eye than the older brilliant thin line.

Above the ¼-in. character level, LEDs grow rapidly less attractive. Costs soar because of the increase in material, and appearance suffers because of the attempts to save material. Power consumption also goes up from 200 milliwatts per digit for the new ¼-in. softlight LEDs to about 500 mW/digit for the 0.6-in. units and to over a watt for large dot matrix displays.

Not even the most die-hard LED supporter claims that these devices can compete on an economic basis for character sizes above about ¼ in. today. What they do claim is that the devices provide the ultimate in ruggedness and reliability, as well as minimum size and compatibility with a 5-v supply.

A display that does compete economically in this size

How liquid-crystal displays work

There are two kinds of liquid-crystal display. Each consists of two parallel glass plates, with conductive coatings on their inner surfaces and a drop of liquid-crystal material sandwiched between them.

In the dynamic-scattering display, a normally clear material becomes turbid when a current flows through it. In the field-effect type, the material either does or does not rotate the plane of polarization of the polarized light passing through it, depending upon whether or not a voltage is applied across it.

Dynamic-scattering displays are by far the more popular (Fig. A). They have two requirements: the liquid crystal must exhibit negative dielectric anistropy—that is, its dielectric dipole moment must have a larger component perpendicular to the molecular axis of the rod-shaped liquid crystal than parallel to it—and it must conduct enough current to produce a readable display. This requires doping of the material since the pure chemical typically has a resistivity on the order of 10^{12} ohm-cm and resistivities of 10^{8} to 10^{11} ohm-cm are needed.

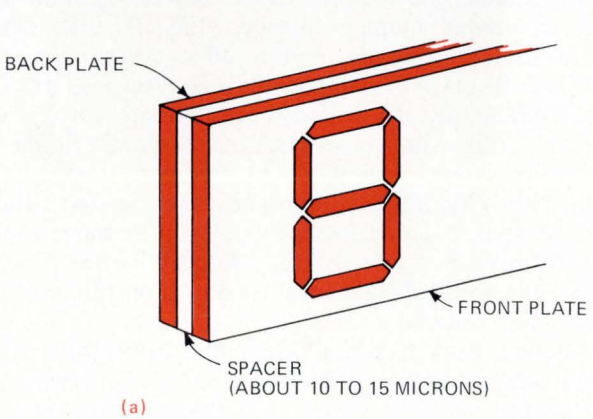
As usual in engineering, choosing the doping level involves a tradeoff, for, while increased doping improves contrast ratio and reduces response time, it reduces the material's operating temperature range, and the lowered resistivity increases power consumption.

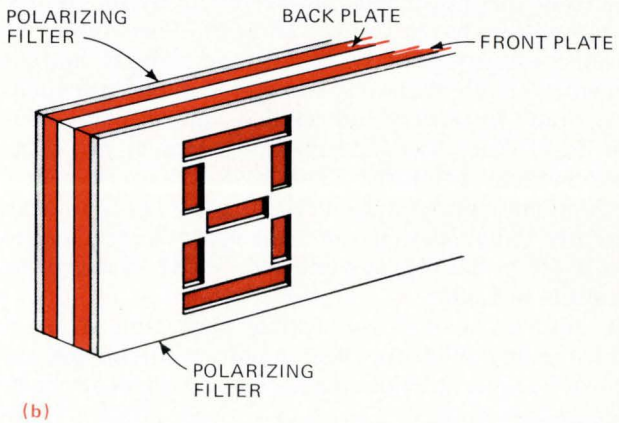
Operation may be in either the reflective or transmissive modes. In both cases, the front plate of the display is coated with a conductive transparent material, usually indium oxide, in a seven-segment or other pattern. The back plate may have either a transparent or reflective conductive coating depending upon whether the display is transmissive or reflective.

In the field-effect display (Fig. B), the basic package is placed between a pair of polarizers. In addition, prior to assembly, the inner surfaces of the front and back plates are treated by being rubbed in two directions orthogonal to each other. This causes the molecules of the liquid crystal to line up along one face of the display cell at right angles with the alignment adopted by the molecules along the opposite face, and to experience a gradual twist with distance from one plate to the other.

The dimensions of the twist are much greater than the wavelengths of visible light, so that polarized light entering the display follows the twist of the material and emerges parallel to the rubbing direction of the second face. The key to the operation of the field-effect display is that the material untwists under the influence of an applied electrical field, and thus can no longer cause rotation of the plane of polarization of light passing through it.

In the case of a transmissive display, the polarizers would be oriented parallel to each other, leaving the display dark when no field is applied, and turning bright when a voltage is present. For a reflective display, crossed polarizers would be used, and a diffuse reflector would be placed behind the rear polarizer. This display is normally bright but turns dark with an electric field.





7. The brightest. Where high ambient-light levels are expected, the directly viewed filament display can't be beaten. This RCA Numitron can be made visible under 10,000 foot candles of illumination.

arena is the planar gas-discharge type. In the ¼- to ½-in. range under consideration, there are two types to consider, each being a single-source proprietary product.

Larger gas-discharge units

Burroughs' Panaplex II, already mentioned, also comes in the larger sizes of 0.25 in. and 0.4 in. High-volume prices for this product are not published, but one example may give an idea of the kind of economic muscle this technology can wield: a 16-digit, ¼-in. Panaplex II Panel sells today in quantities of 100,000 for 90¢ a digit. The key parameter in this equation is the 16 digits; since the manufacturing costs of a Panaplex panel are not seriously affected by the number of digits, the digit price goes down as the number of digits goes up. This is unlike LED displays, where the cost is determined primarily by materials.

A major disadvantage of Panaplex II, for anyone but a calculator or counter manufacturer, is the fact that its smallest package contains eight digits—a waste if you're only trying to build a 3½-digit voltmeter. Also, Panaplex II must be strobed, as all of the like segments of the various digits are connected internally.

Both of these problems are overcome by the Sperry planar gas-discharge display (Fig. 5). This display is packaged in groups of 1½, 2, 2½, and 3 digits, and all segments of all digits are brought out on individual pins. Made by Sperry Information and Displays division, Scottsdale, Ariz., the display comes in two standard character heights—0.33 in. and 0.55 in. (Recently the company announced a new ¼-in. display that looks more like Panaplex than the main Sperry line; it comes nine digits to the package and sells for $1.75 a digit in quantities of 1,000.)

In addition to its more flexible packaging arrangement, the Sperry display has one other unique and attractive feature: although made of seven segments each, its characters appear to be all of a piece—no gaps show up at the junctions of the segments. Many designers consider this of great importance, others do not. The real question is: what does the customer think?

Appearance and packaging flexibility aside, the Sperry and Panaplex displays are very similar. For both displays, power consumption is on the order of 35 mW/digit for the smaller size and 80 mW/digit for the larger. Both require high-voltage power supplies, and both use mercury vapor to get lifetimes in excess of 100,000 hours. As was noted earlier, the protective action of the mercury is severely degraded at low temperatures.

Another point to be borne in mind about mercury vapor is that it's very toxic. Should either of these displays break while operating, a small amount of mercury vapor would be released. Though that would be no problem under normal conditions, in a closed environment, like a submarine, it could be very dangerous.

One final minor drawback of gas-discharge devices is in the area of brightness control. Brightness can be altered over a range of about 5:1 by adjusting the current through the device. Any greater adjustment must be made by operating the display in a pulsed or strobed mode and varying the duty cycle. For laboratory instruments, this consideration is of little significance. For an automobile dashboard, it may be crucial.

No discussion of gas-discharge devices would be complete without some mention of Burroughs' venerable Nixie tube (Fig. 6). Unlike the gas-discharge panels, the Nixie uses a separate cathode for each character. The cathodes are stacked, one behind the other, in a glass envelope. The advantage of this arrangement is that each character is well shaped. The disadvantage is a restricted viewing angle caused by the non-zero depth of the stack of cathodes.

Because they are packaged one digit per bottle, Nixies occupy more space and cost more money than multidigit devices. On the plus side, however, some instrument makers find that the Nixie can save costs in assembly because it can plug directly into the instrument's main mother board, when other displays would require a separate board and wiring. So although Nixies and their look-alikes do seem to be on the way out, they aren't dead yet. And the wise designer will not fail to consider them in any new design he's planning.

In favor of filaments

In applications where very high ambient light levels are expected, one readout device ranks supreme—the directly viewed filament display (Fig. 7). Like LEDs, these displays typically operate off a 5-V supply, and like LED displays of comparable size, they use quite a bit of power—say, 0.5 to 1 watt per character for the 0.6-in. size. Unlike LEDs, however, directly viewed filaments never wash out, even in direct sunlight. It may take some fancy filtering, including the use of circular polarizers, to do it, but a filament display can be made easily legible in an airplane cockpit flying above the clouds, where the ambient light level by day is on the order of 10,000 foot candles.

Another way in which filaments differ from both LEDs and gas-discharge devices is in their spectral content. Since the light source is a glowing filament, the output spectrum is broad and continuous. Virtually any

color can be obtained by simply filtering out the unwanted components. These two areas—high brightness and great color flexibility—are the two most outstanding features of the directly viewed filament.

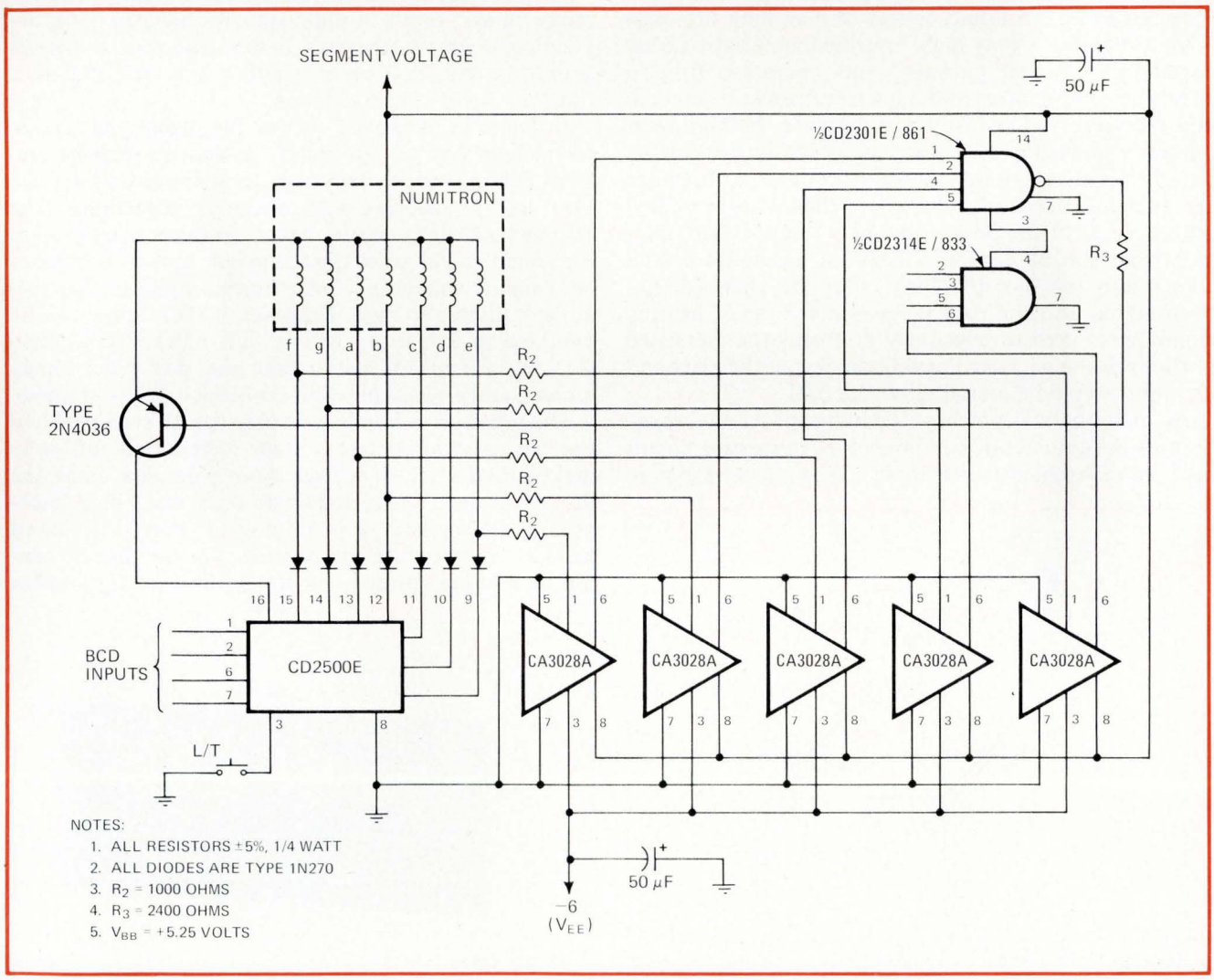
Cost has been a negative factor for quite a while, although RCA Corp.'s Electronic Components division, Harrison, N.J., recently announced price cuts on its Numitron line of displays that lower the cost to $1.95 each without the decimal point and $2.10 each with the decimal point—both figures for quantities of 10,000 or more.

The RCA Numitron is packaged in a standard receiving-tube envelope and suffers the drawbacks of size and fragility to be expected from such a device. Drop a Numitron onto a concrete floor and it will probably break. But Pinlites, the Fairfield, N.J., division of Rejac Technology Development Corp., uses a much smaller, flatter, more expensive package that has the additional advantage of extreme ruggedness. The package consists of a metal header with a glass window sealed onto one face. Hurling this device against a brick wall has no bad effects unless, as ill luck would have it, a small projection comes squarely into contact with the glass window.

The price of this ruggedness can be considerable, however. A 5/16-in. digit sells for over $6 in quantities up to 10,000. And a miniature 3/16-in. display can cost $18 each in similar quantities. Pinlites' new Dip-Lite package knocks the cost down to $3.45 a digit, and provides pin-for-pin compatibility with MAN 1 and other popular LED displays. Incandescent costs, then, would seem to be higher than the competition but showing a downward trend unexpected in a technology as old as a glowing filament.

The association of seven-segment filament displays with ordinary household lamps has another unfortunate connotation. Light bulbs burn out, goes the reasoning; so incandescent displays are unreliable. What's omitted from this equation is the fact that ordinary light bulbs operate at temperatures on the order of 2,000° to 2,500°K, while filament displays operate in the range of 1,200 to 1,400°K. This difference translates into an average life expectancy of over 100,000 hours for a filament display. Furthermore, despite the apparent fragility of fine filaments, these devices are routinely used in aircraft cockpits and on board ships where vibration requirements are fairly stiff.

There's one more plus—and a possible minus—for directly viewed filament displays. The plus is the operating temperature range: anything from −50°C to



8. Fail-safe. This circuit monitors the current through those segments of a Numitron display whose failure could cause ambiguity. If the segment opens, the circuit blanks the entire digit. Segments whose failure would cause an obvious distortion are not monitored.

+125°C causes no problems, and it's probably possible to go a lot further if there's any point to it.

The minus is the possibility of a filament burning out and causing an incorrect reading. One way to deal with this possibility is to periodically check the display by means of a "display test" button. More positive action would be the incorporation of a fail-safe circuit into the display design. Such a circuit (Fig. 8) completely blanks the digit being displayed if any of its segments should fail and cause ambiguities.

Hope of the future

Whenever the subject of display devices comes up, sooner or later the conversation turns to liquid crystals. These devices, many people agree, are the displays of the future. Their cost is potentially extremely low, they use very little power (in the reflective mode), and they are directly compatible with MOS circuits. The problems with these devices have included limited lifetime, limited temperature range, unattractive appearance, and sluggish response on turn-off. The question facing the designer today is how soon these problems will be solved.

According to Zoltan J. Kiss, president of Optel Corp. in Princeton, N. J., lifetime need not be short. All that is required to give a liquid-crystal display long life, says Kiss, is: the use of only highly purified materials, a truly hermetically sealed package, and operation from a purely ac drive source. Making a true hermetic seal on a liquid-crystal package isn't easy because the high temperatures needed to make the seal will easily destroy the liquid-crystal material. Optel's solution is to metalize the edges of the glass cover plate that is to be sealed onto the rest of the package—a high-temperature operation that can be carried out before the liquid crystal comes into the picture. Then, after the chemical has been added and the package assembled, an rf heating technique is used to selectively heat only the metalized portions of the package, leaving the rest of the glass and the liquid-crystal material relatively cool.

Ac-only operation means designing special ICs whose outputs have no net dc component. If an existing circuit must be redesigned to accomplish this, it can be expensive, but if it's a new design, then the extra cost is negligible, Kiss says. Kiss is confident that his displays will have a lifetime of five to 10 years; he has close to three years of nonaccelerated life-test data so far.

Expansion of the limited temperature range, however awaits the development of better materials. Until they are developed, extreme temperatures will make liquid crystals unsuitable for certain applications. The picture at present isn't as bad as some people think, however. Digilin Inc. of Glendale, Calif., for example, is currently making and selling a digital panel meter with a liquid-crystal readout. The operating temperature range of the device is 0° to 70°C. That upper end figure is probably good enough for most conceivable applications, but the low end leaves something to be desired.

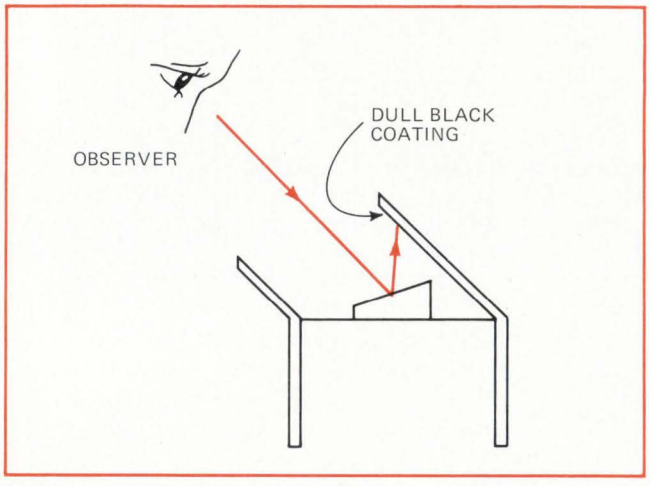
One way of improving the low-end performance is to go to the newer field-effect liquid crystals instead of the older dynamic-scattering type (see "How liquid-crystal displays work," p. 95). At present, field-effect displays work reasonably well down to about -10°C. It's tough to give an exact figure because these displays simply get slower and slower as the temperature drops.

The look of liquid crystals

As far as appearance is concerned, there are four different "looks" that a liquid-crystal display can have, depending upon whether it's a field-effect or dynamic-scattering unit, and upon whether it is operated in a transmissive or reflective mode.

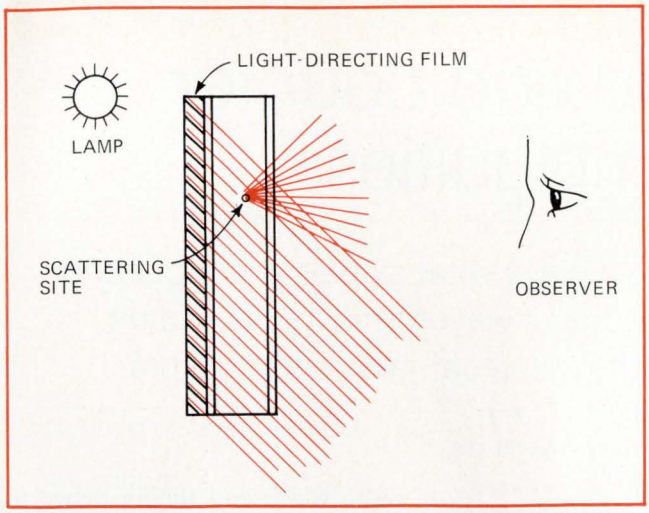
In the reflective mode—where the display has no internal light source, but simply selectively reflects ambient lighting—the dynamic-scattering liquid-crystal display has a problem with specular reflections. The display looks like a mirror except at those places where a segment of a character is to appear; and there it takes on a milky whiteness. Under normal lighting, this is a difficult display to read. However, if the display can be mounted in a housing with a dull black inside finish (Fig. 9), the mirror will reflect the dull black background, and a pleasant white-on-black look is obtained.

The reflective field-effect display has no such problem because its back reflector is made deliberately diffuse to make sure the light it reflects is not polarized. Thus, the display presents dark characters on a dull white background. Its appearance is quite good when it is viewed head on, but because the polarizers in the display cannot be mounted directly on the liquid crystal, parallax

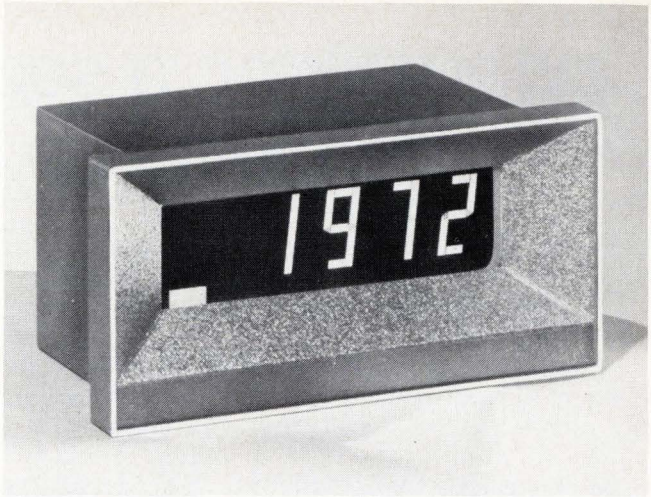


9. Housing. Reflective liquid-crystal displays of the dynamic-scattering type can be difficult to read because of specular reflections. But proper mounting can make them quite good-looking.

10. Power saver. This Tekelec digital panel meter uses a field-effect liquid-crystal display. Although it requires backlighting, it only needs a 0.5-watt bulb to obtain an excellent contrast ratio.



11. Light waster. Much of the light emitted by a dynamic-scattering liquid-crystal display is wasted when it's used in a transmissive mode; therefore, a fairly bright light source is needed behind it.



12. Low cost. The transmissive dynamic-scattering liquid-crystal display in this Digilin digital panel meter costs only a dollar per digit. And the economies of truly high-volume production still lie ahead.

problems creep in when the viewer is significantly off axis.

In the transmissive mode—that is, when the display is backlit by a lamp of some sort—both types of liquid-crystal readout produce glowing characters on a dark background. The field-effect device excels in this mode because it acts as a simple shutter and can get good character definition with only a small bulb behind it (Fig. 10).

The transmissive dynamic-scattering display is a bit more complicated. In its unenergized state, this display is transparent, developing scattering sites in regions where it is excited. To effectively "hide" the illumination source from the eye of a viewer, the source is placed off to one side and behind the display (Fig. 11) and a light-directing film—a sort of miniature, solid, Venetian blind—is used to make the lamp invisible except from an extreme viewing angle. When a segment of this display is energized, it scatters light in all directions and thus becomes visible from the front. Because only a small fraction of the lamp's output is scattered toward the observer, this type of display needs a much more powerful lamp than the field-effect type.

Liquid crystals are slow devices and will never compete with LEDs in high-speed data communications. When used as displays, however, all they have to compete with is the human eye. And with turn-on times typically on the order of 5 milliseconds, this half of the problem isn't a problem. The turn-off time is the trouble, because instead of being driven to a particular state, as happens when it turns on, the liquid crystal is now simply relaxing into its normal state. This can easily take about 100 ms—a discernible length of time.

Eventually this problem will be solved by the development of better liquid-crystal materials. In the meantime, the solution is simply to drive the display off just as it was driven on. What's needed here is a high-frequency erasing field of several kilohertz. With this approach, the turn-off time becomes about the same as the turn-on time—about 5 ms.

With these solutions in hand, all that's left are considerations of size, cost, power consumption, brightness, supply voltage, and so on—in other words, the things that make liquid crystals very attractive.

Since a liquid-crystal display is essentially two flat glass plates with a little chemical compound between them, the cost is low and not very dependent upon size. Kiss of Optel says that, in the 10,000 to 100,000 quantity range today, a liquid-crystal display should cost anywhere from $1 to $1.50 a digit. He doesn't mention size because he says it doesn't matter, at least for characters up to several inches high. E. B. Hibbs Jr., president of Digilin, confirms this price information. His company is currently paying $1 a digit for the display used in its digital panel meter and made by American Micro-systems, Santa Clara, Calif. (Fig. 12).

In power consumption the liquid-crystal display stands alone. Where other technologies talk of tens or hundreds of milliwatts, a liquid-crystal display uses only microwatts of power. A complete electronic wristwatch with C-MOS circuitry and a reflective liquid-crystal display uses less than 20 μ.

In brightness, the liquid-crystal display is the only real challenger to the incandescent display. The reason, of course, is that the liquid crystal is an optical judo player—it uses the enemy's strength against him. As the ambient lighting increases, so does the readability of the liquid-crystal display.

A corollary of this is that a reflective liquid crystal is about as easy to read in the dark as a newspaper. Some form of illumination must be provided and, depending upon the application, this may knock the power consumption completely out of the running. Of course, it's always possible to provide a lamp that's only turned on when it's needed.

Last, but not least, the liquid-crystal display is the only type today that is completely compatible with MOS circuitry and needs no other power supplies to drive it. Dynamic-scattering liquid-crystal displays today run very nicely off 13 V—a voltage that a C-MOS circuit can easily drive—and drive levels as low as 6 to 7 V are possible. For field-effect devices, the range is more like 1.5 V to 6 V. Thus, this display technology is directly compatible with both bipolar and MOS circuits. □

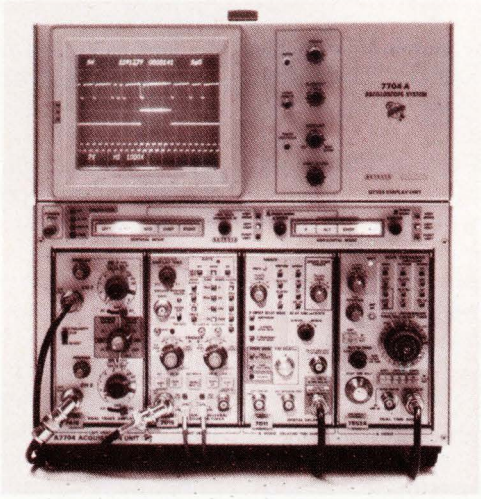
Teaming a scope and counter clears up ambiguities

This combination of instruments, which displays what signals are triggering the counter, can check frequencies, parts of waveforms, pulse widths, timing between pulses, and bursts; the setup can also count errors

by Neil A. Robin, *Tektronix Inc., Beaverton, Ore.*

☐ Most engineers have probably connected a counter to a circuit at one time or another and found more than one stable answer. There's something wrong, but the question is—where?

The problem probably isn't in the counter, but in certain characteristics of the signal that cause the counter's trigger circuits to fire at the wrong time. It would help to be able to see what the signal looks like, and more importantly, to understand how the counter's trigger circuits recognize it.



One of the best ways to solve this problem for most counter measurements is to use a dual-trace oscilloscope to display certain signals from the counter, along with the input signal. There isn't much of a problem with an ideal source, such as a signal generator, but most measurements are far from ideal. In addition, counter specifications usually cover sensitivity, bandwidth, and impedance, but the engineer doesn't always know his counter's overdrive characteristics or what happens under certain noise conditions.

For example, an input signal may have an amplitude of 11 volts peak-to-peak with a signal-to-noise ratio of 40 decibels. If the counter has a sensitivity of 100 millivolts peak-to-peak, the counter will be sensitive enough to respond to the noise, as the noise level equals 110 mV peak-to-peak. The net result can be a serious malfunction of the counter.

Whether dealing with random or synchronous noise or using the instrument in frequency- or time-measurement mode, the net result of the reading can vary considerably. One example is ringing on the baseline, which may be greatly exaggerated in the counter's trigger circuits, thanks to the counter's sensitivity. Such errors can be overcome by adding a dual-trace oscilloscope to the counter.

For measuring frequency, the Schmitt trigger of the counter would be valuable as a waveform. In time-measurement modes, the counter gate would be effective. This dynamic combination can selectively measure part of a waveform, use the delayed-sweep gate to measure pulse width and timing between two pulses, measure bursts, and count errors. The user enjoys an added measure of confidence when he can see on a scope the true representation of the signals in these situations.

Figure 1, an example of a frequency measurement with the Schmitt-trigger output displayed, shows how misleading an answer can be. It's one thing to know there is something wrong, but with the scope display, the user can see what's going on and make adjustments to correct the misleading counter reading.

Selective measurements are also easier to set up by combining the dual-trace oscilloscope with the counter. When the user wants to check a particular segment of the waveform with the counter, the scope is almost a must because it can verify the part of the waveform actually being measured. The upper trace in Fig. 2 is from a time-division-multiplex (TDM) pulse-width-modulation (PWM) system. If the width of the third pulse is to be measured, the digital counter is "armed" by the delayed-sweep gate, shown as an intensified zone. A glance at the lower trace, representing the counter-gating response, verifies that the measurement is, in fact, being made during the third pulse interval.

Not all counters have these signals available at the rear panel. For those that do, delays between input signal and counter signal should be matched when presented to the oscilloscope.

Using the scope's delayed-sweep gate

The delayed-sweep gate of a dual-time-base oscilloscope is a useful signal that can be applied to counters. In most such oscilloscopes, the first time base is called the main, or delaying, sweep. This is the normal sweep used for the majority of applications. The other time base is derived from the delayed sweep, which obtains its trigger from a comparator circuit on the main sweep.

When the comparison voltage and the sawtooth voltage of the main sweep reach equal magnitudes, a comparator circuit either triggers the delayed sweep to begin at that time or allows it to accept a trigger pulse that

starts it from that period of time. Thus, by changing the comparison through the front-panel control, it is possible to "walk" the start of the delayed sweep across the entire width of the interval of the delaying sweep.

The delayed-sweep gate is the logic signal that corresponds in time to the interval of the delayed sweep. It is used to unblank the CRT trace internally whenever the delayed sweep is used, but it is often available externally, as well. On some scopes, its magnitude is +5 volts unterminated, about +0.5 V into a 50-ohm load. The low state is about 0 V.

Now the measurement in Fig. 2 becomes clearer. The figure shows a TDM/PWM telemetry signal. Each pulse represents an individual channel of information, and its width represents the analog magnitude of the modulating voltage for that channel.

To measure the width of the third pulse by a digital time-interval counter, the main sweep for the scope must first be synchronized with the framing pulse of the telemetry signal so that it's possible to display the various channels of the signals at fixed points on the CRT.

By running the delay-time control of a delayed-sweep time base over to a point just ahead of the third pulse of the sequence, it's possible to start the counter just before that pulse; that is, if the counter has the correct input circuits to perform this type of measurement. This requires a counter that can be armed by using the delayed-sweep gate to accept an input signal.

This arming method adds visual control to the measurement, while retaining the full accuracy of the counter. For long intervals, analog methods of measuring time cannot compare to this digital method.

In addition, the intensification of the trace, caused by the delayed sweep gate in Fig. 2, makes it easier to locate the gate's position. Because the start point of the delayed sweep is arbitrarily selected by the delay-time control, it's just as easy to select any other pulse. In any case, the feedback to ensure that the measurement was made in the correct place is the gating response of the counter, shown as the lower trace on the CRT.

The example of measurement by a delayed-sweep gate covers a signal only four channels long. For a signal containing hundreds of channels, lining up all the pulses on one trace of the CRT would create a meaningless blur. Instead, digital delay by events-counting can be a worthwhile means to measure some characteristic of a long sequence of pulses. The idea is to count out the prescribed number of pulses to be measured to the starting point.

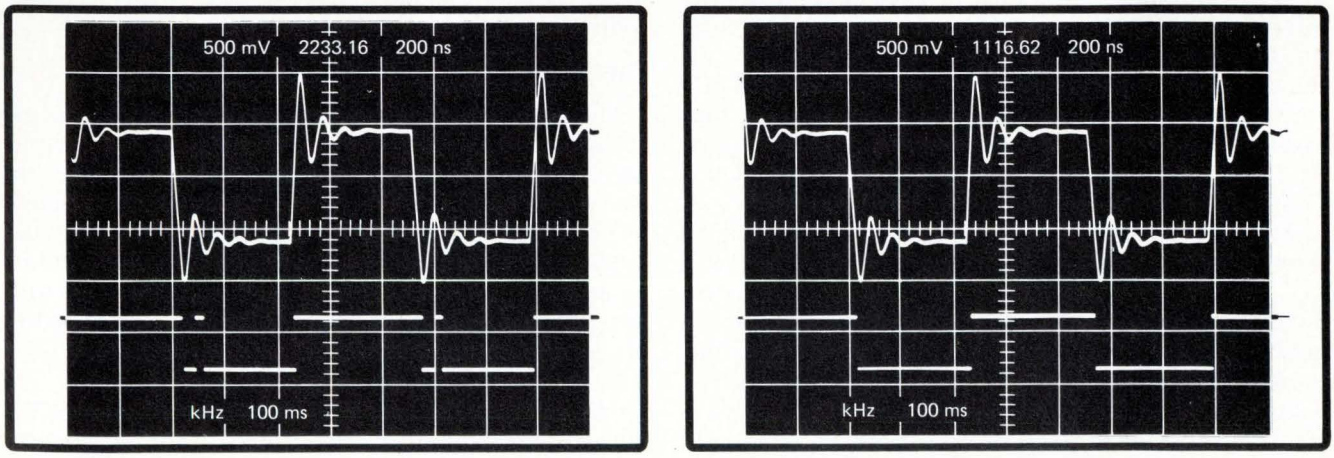
For example, Fig. 3 shows a long sequence of pulses for which the time elapses between two specific but nonconsecutive pulses. This is shown at the top of Fig. 3. The middle trace (counter gate) has revealed that the counter has indeed measured the elapsed time between the two nonconsecutive pulses. The procedure is similar to that of Fig. 2, but here a plug-in digital-delay unit is used to delay the main sweep starting point.

The technique demonstrated in Figs. 2 and 3 suggests another advantage in using the delayed-sweep gate to control counter measurements. Because the width of this gate and its corresponding sweep length are continuously adjustable, both the start and stop points of the digital time-interval counter can be armed, thus providing a selective window for making a measurement at any point desired, which can be identified on the scope.

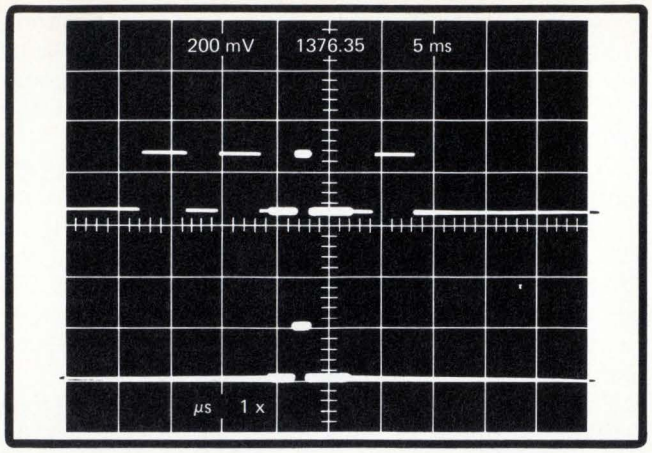
To take advantage of this technique, it's necessary to have a counter that is designed to accept a positive signal for arming the start point and a negative signal for the stop. This means when the delayed-sweep gate triggers a logic 1, the counter is armed for a new measurement, and when the gate flips to logic 0, the counter accepts a stop pulse. Thus, the variable width of the delayed-sweep gate gives added control.

This feature is especially important when the logic of conventional universal-counter timers is not adequate to perform an elapsed-time measurement. For example, in Fig. 3, one pulse in the measurement is ignored. This is because the width of the delayed-sweep gate is wide enough to prevent arming of the stop circuits until after this ignored pulse has passed. The width of the delayed-sweep gate is adjustable so that it can determine start and stop points, as in Fig. 3. Here again, the scope shows exactly what the counter is measuring—that is, that the counter is ignoring one pulse.

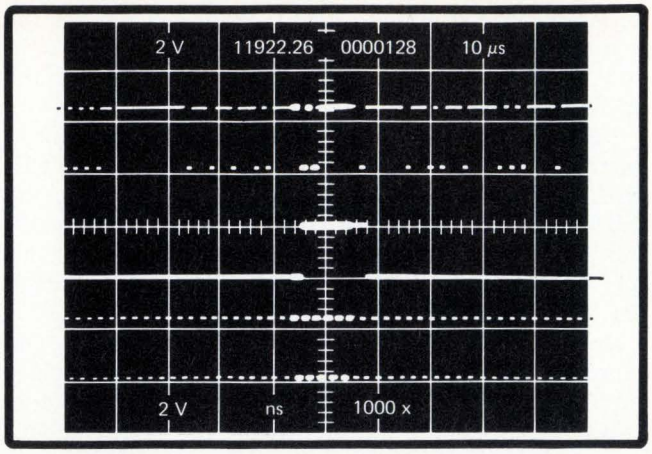
Besides the capability to arm a counter for time-interval measurements, the technique can determine the frequency and period of waveforms. An example is burst measurements. Many electronic systems contain keyed



1. Counter ringing. A lower trace, left, represents response of counter Schmitt trigger to the upper trace, and the frequency count—2,233.16 kHz—is steady, but incorrect, because of double counting caused by the counter's sensitivity. After the trigger level disappears, and the reading at the right—1,116.62 kHz—is correct.



2. Armed for counting. To measure width of third pulse, digital counter is armed by delayed-sweep gate (intensified zone). Lower trace represents counter's gating response, which verifies measurement is made during third pulse interval.



3. Good timing. For determining interval between two non-consecutive pulses, measurement is made from negative edge of first pulse (intensified) to positive edge of second pulse following. Answer, an average of 1,000 samples, is 11,922.26 ns.

tones or keyed rf signals, and it is often necessary to know the frequency of the signal during the burst interval. Frequency measurement by conventional digital counting is not always effective for this type of signal because the duration of the burst is usually too short.

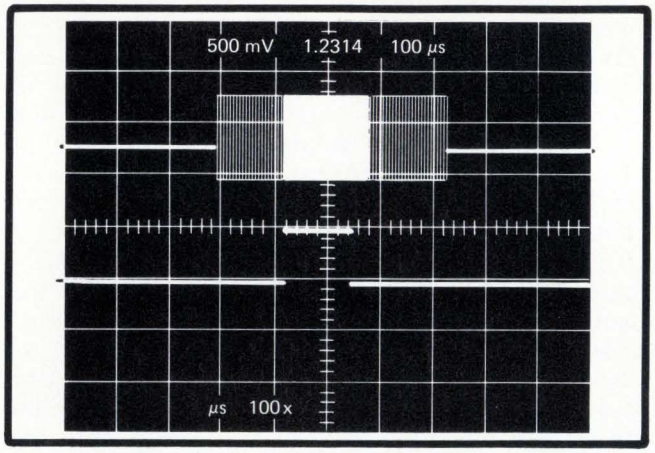
Computing counters of various degrees of sophistication that can measure the period of the signal and compute the frequency have been on the market for several years. Not all can be armed, however. For those with arming capability, a dual-trace oscilloscope makes this type of measurement and computation comparatively simple. In the typical situation shown in Fig. 4, the counter is armed well into the burst interval. This helps to prevent any distortion of the signal at the turn-on point from causing a false answer. Of course, the period can be averaged, so long as the measurement is terminated before the end of the burst interval.

Another handy task the delayed-sweep gate can perform is error-counting. If the counter is gated to accept an input signal for the width of the delayed gate, it is possible to count events that occur during this interval. This is a good feature when not only the number of error pulses is important, but also their timing.

Various comparison measurements can also be made by measuring the width of the delayed-sweep gate with the digital counter and displaying the counter-gate signal on the screen. This technique doesn't have nearly the accuracy potential of the arming methods, but it is convenient, and the results are probably better than those obtained by simply reading divisions off the graticule, which may introduce errors caused by horizontal time-base nonlinearity.

A slightly different approach is to measure a digital time interval from the sawtooth waveform of the sweep. The start and stop points can be picked off independently and smoothly, since the ramp waveform has a gradual slope. However, noise can be a significant factor in determining the start and stop points accurately.

On most oscilloscopes, whenever the main sweep is displayed and the delayed sweep is running, an intensified zone on the screen corresponds to the period during which the delayed sweep coincides with the main or delaying sweep. Some users have contended that the Z-axis modulation could show timing relationships when a digital counter is used. However, this method is not advisable because of the signal delays involved. The vertical-amplifier signal usually travels through a delay line, while that of the Z axis does not. Also the Z-axis bandwidth is usually far short of the vertical channel's bandwidth.



4. In a burst. Upper trace represents a typical burst waveform. The counter is armed to measure the period of the burst signal— answer, an average of 100 periods, is 1.2314 microseconds.

The scope as preamplifier

Many overlook the vertical amplifier section of an oscilloscope. On a scope equipped with a vertical amplifier, it's often easy to connect a counter to the "vert sig out" jack and take advantage of the much more sensitive unit that results. Typical output levels run about 0.5 v per division unloaded. With a high-gain vertical amplifier, net sensitivities of the counter will amount to 2 microvolts if the counter has a built-in sensitivity of 100 mv peak-to-peak.

In a plug-in oscilloscope, such as the Tektronix 7000 series, a counter-timer that is available can, when plugged directly into the mainframe, route the preamplified vertical signal internally to the counter. Usually referred to as the trigger-source signal, this signal triggers the horizontal time bases in the internal mode. □

Using transistor arrays for temperature compensation

by Mahendra J. Shah
University of Wisconsin, Madison, Wis.

Monolithic transistor arrays make handy temperature-compensating devices. For instance, a highly temperature-stable zener reference can be realized by employing one of the transistors as a zener diode, a second transistor as a conventional diode, a third transistor as a chip heater, and a fourth transistor as a chip-temperature sensor.

A typical transistor array is shown in (a), RCA's model CA3046. Only two of the five transistors are needed to implement a temperature-compensated zener diode, which is also shown in (a). It is obtained by reverse-biasing the base-emitter junction of one transistor (Q_3 is used here) and then temperature-compensating this device with the forward-biased base-emitter junction of a second transistor (Q_2 here).

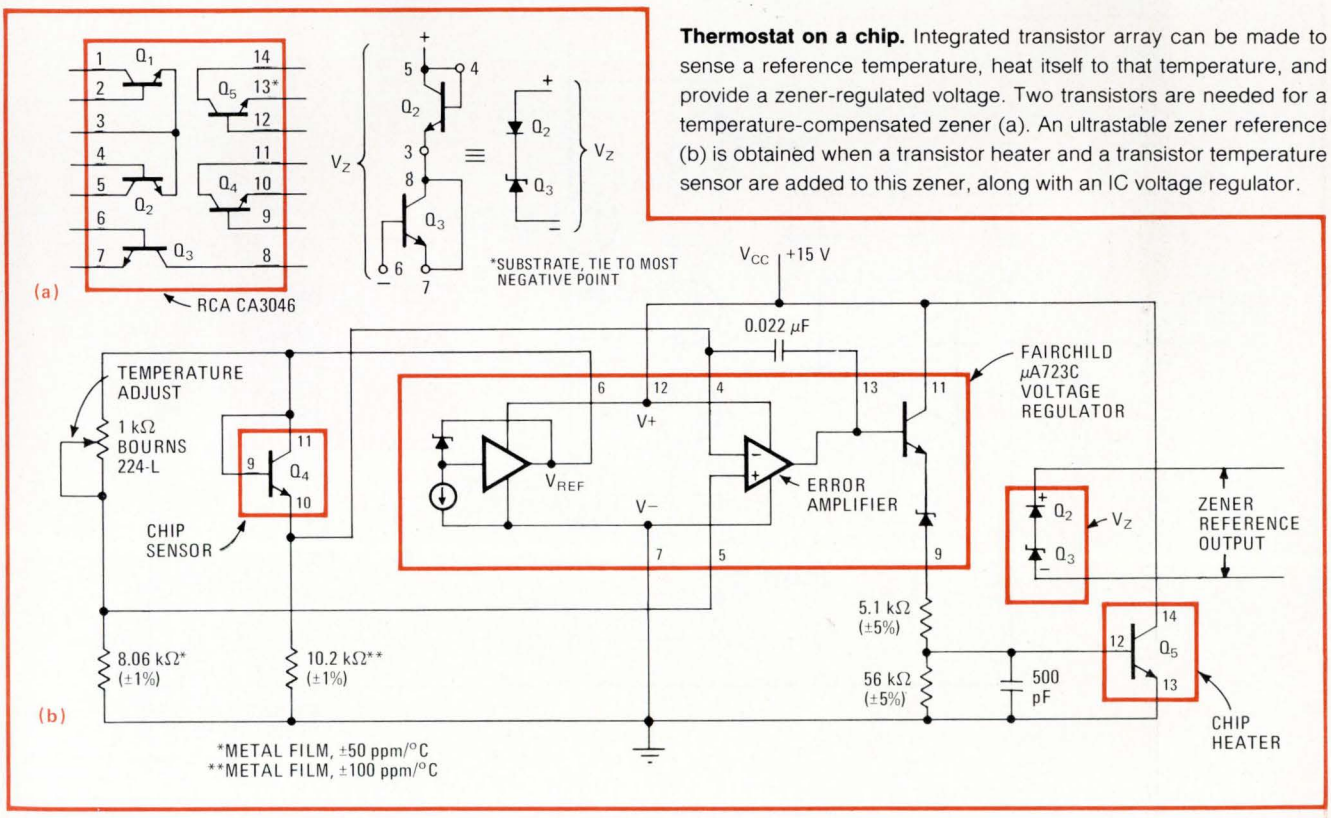
Since all the transistors make good thermal contact with each other, good temperature compensation is provided. For a zener reference current of 200 microamperes, the two-transistor zener develops 7.83 volts and has a temperature coefficient of +196 ppm/°C.

Even better temperature stability can be obtained by making one of the transistors a chip heater, by connecting its collector to the supply voltage. Whatever heat is dissipated in this transistor heats the entire chip. A fourth transistor, with a forward-biased base-emitter junction, can then act as a chip-temperature sensor. It will have a sensitivity of about –2 millivolts/°C. When the heater/sensor arrangement is used with the temperature-compensated zener of (a), the array exhibits a temperature coefficient of merely –3.1 ppm/°C from 33°C to 50°C.

By adding temperature-reference and temperature-control functions to the array (compensated zener, chip heater, and chip sensor), a highly stable zener reference is formed. In (b), an integrated voltage regulator provides these temperature-reference and temperature-control functions with its internal voltage reference and error amplifier.

The potentiometer sets the circuit's temperature-reference voltage, which is compared with the voltage developed by the chip-temperature sensor (transistor Q_4). Any difference voltage between the two passes through the error amplifier before being applied to the chip heater (transistor Q_5). The heater then brings the chip sensor to the temperature that is set up as the temperature reference, keeping the temperature of the entire transistor array constant.

The zener reference circuit, which uses only one power supply, offers a temperature coefficient of +4.25 ppm/°C from 33°C to 50°C for zener current of 200 μA. (Transistor Q_1 of the array is not used.) □



Thermostat on a chip. Integrated transistor array can be made to sense a reference temperature, heat itself to that temperature, and provide a zener-regulated voltage. Two transistors are needed for a temperature-compensated zener (a). An ultrastable zener reference (b) is obtained when a transistor heater and a transistor temperature sensor are added to this zener, along with an IC voltage regulator.

Dc motor control circuit cancels armature resistance

by Leland N. Van Allen
Ideas Inc., Beltsville, Md.

An ideal permanent-magnet dc motor (or one with a separately excited field) rotates at a speed that is determined solely by applied voltage and is independent of motor load. This is the speed at which the back-emf generated in the rotating armature just equals the applied voltage. Since an ideal motor has no armature resistance, the current drawn can rise to any value necessary to support the load.

But practical motors do have an armature resistance, which degrades their speed regulation with increasing load. This problem can be solved by placing a negative resistance that is exactly equal to the armature resistance in series with the armature.

With the motor-control circuit in the diagram, motor rpm is linearly related to input control voltage, no matter the size of motor load. A high-power operational amplifier is used to drive the motor, and positive current feedback is used to create the necessary negative resistance.

A current-proportional signal is obtained by inserting a small sampling resistor, R_S, at the return side of the motor. This signal, which is applied to the noninverting input of the op amp, causes the voltage that drives the motor to be just enough higher than what should be needed by an ideal motor to satisfy the armature and sampling resistances. The over-all effect is the same as driving an equivalent ideal direct-current motor from a firm voltage source.

The circuit's supply voltages should be about 3 volts higher than the maximum voltage to be applied to the motor, but less than ±22 V, unless a different op amp is used. After a reasonable value is chosen for input resistor R_{IN}, say 10 kilohms, feedback resistor R_F can be determined from:

$$R_F = R_{IN}(\text{rpm})/kE_{IN}$$

where k is the motor "tachometer" constant, expressed in units of rpm per volt. The value of this constant can be found experimentally by driving the motor at a known speed and measuring its open-circuit voltage.

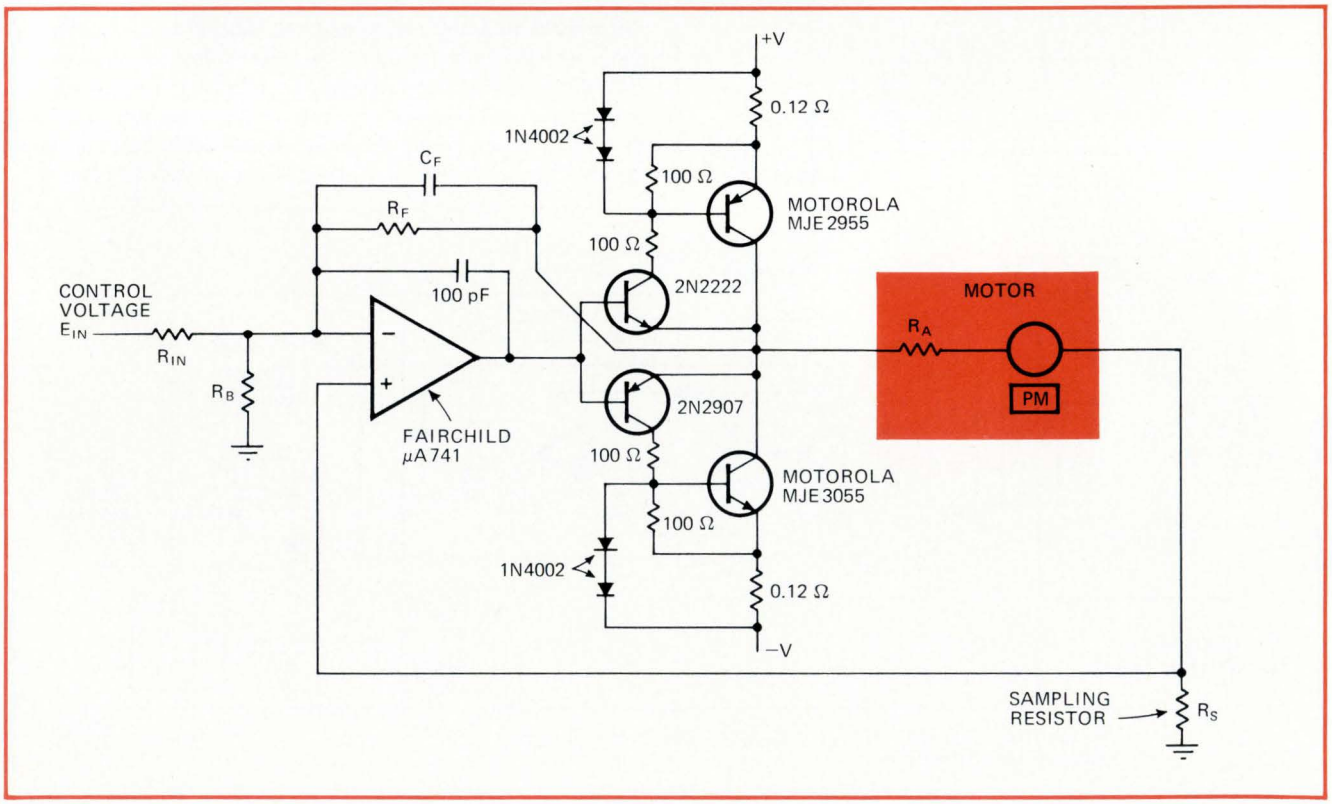
Next, a reasonable value must be selected for the current-sampling resistor, R_S. To minimize power waste, resistor R_S should be considerably smaller than the armature resistance, R_A—for example, $R_A/10$ is a good choice. The value of resistor R_B can then be computed:

$$R_B = R_{IN}R_FR_S/(R_AR_{IN} - R_SR_F)$$

Resistor R_B determines the size of the negative resistance that appears at the output of the op amp. Its value does not affect the motor's rpm-per-volt response.

Capacitor C_F, which is determined experimentally to find the best choice of values, should be as large as possible, but not so large that the motor responds sluggishly. An R_FC_F time constant of 50 milliseconds should serve for most applications. □

Making motor response linear. Permanent-magnet dc motor rotates at rate that is linearly proportional to input control voltage, no matter what the load is. This positive-feedback circuit generates a negative resistance that is equal to the motor's armature resistance, allowing the motor's rpm-per-volt response to be independent of the load. A sampling resistor is used to get current feedback.



Three-mode network is filter or oscillator

by Michel Baril
University of Quebec, Montreal, Quebec, Canada

A triple-function circuit can be built with standard inexpensive components to operate as a bandpass filter, a notch filter, or a sine-wave oscillator. The operating mode is switch-selectable; the operating frequency range is 1 hertz to 20 kilohertz. Both of the filters can be separately adjusted for Q and center frequency.

The circuit (a) functions as a bandpass filter when switch S_1 is in the FLTR position, switch S_2 is open, and switch S_3 is closed. A notch filter is obtained by keeping S_1in the FLTR position, closing S_2, and opening S_3. There are three possible oscillator outputs, one at each amplifier output; they are 180° out of phase with each other. For the oscillator mode, switch S_1 is in the OSC position, switch S_2 is open, and switch S_3 is closed.

The basic functional block of circuit (a) is the phase shifter shown in (b). The transfer function for this network is:

$$e_o/e_i = (1 - RCs)/(1 + RCs)$$

where s is the Laplace transform variable. Although there is no attenuation, the output lags the input by an angle that varies from 0 to π as frequency increases from zero to infinity. Cascading two of these blocks yields a phase-shifter whose angle is adjustable from 0 to 2π. Its transfer function is:

$$e_o/e_i = [(1 - RCs)/(1 + RCs)]^2$$

When a voltage divider made up of resistors R_1 and R_2 is placed across the two blocks, as shown in (c), the transfer function is modified to:

$$e_o/e_i = R_1/(R_1 + R_2) + [R_2/(R_1 + R_2)]\,[(1 - RCs)/(1 + RCs)]^2$$

If $R_1 = R_2$, output voltage e_o is a minimum (or equal to zero) when the phase lag is π.

When circuit (c) is used as the feedback element of an operational amplifier, the transfer function becomes that of a bandpass filter:

$$e_o/e_i = (R_1 + R_2)/[R_1 + R_2(1 - RCs)/(1 + RCs)]^2$$

The resulting circuit is the one shown in (a). Amplifiers A_2 and A_3 are the basic phase-shifters in the feedback loop of amplifier A_1. If amplifier A_3 is used as a buffer, the circuit becomes a notch filter.

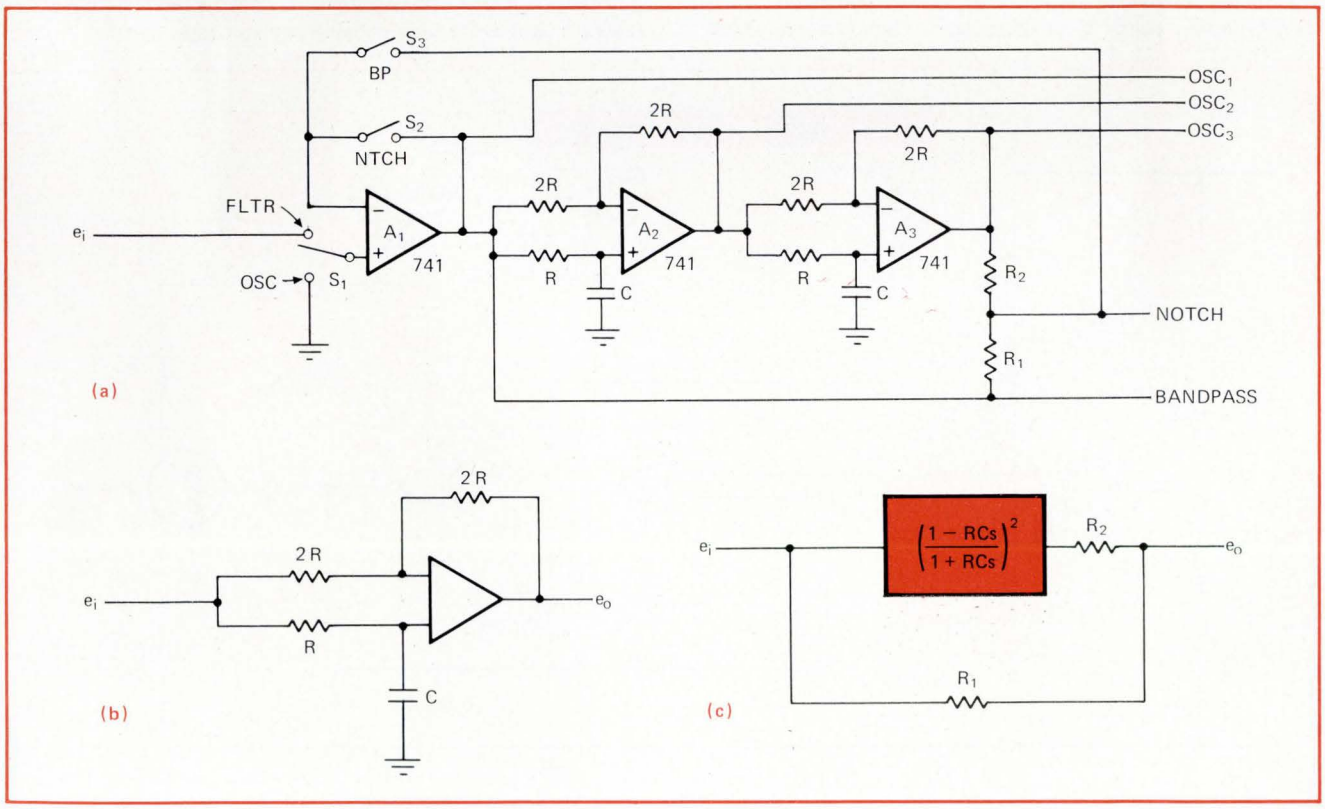
The Q factor of either the bandpass or the notch filter can be adjusted by changing the ratio of R_1:R_2 (theoretically, $Q = \infty$ when $R_1 = R_2$). Filter center frequency (f_o) can be varied by changing the values of resistor R and capacitor C:

$$f_o = 1/(2\pi RC)$$

For the circuit to work as an oscillator, the non-inverting input of amplifier A_1 must be grounded and resistor R_1 set equal to resistor R_2. Again, the operating frequency is set by varying the values of resistor R and capacitor C.

Circuit performance depends principally on the amplifiers, rather than the passive components. It is not

Choice of functions. Circuit (a) has three switch-selectable operating modes—it can be a bandpass filter, a notch filter, or a sine-wave oscillator. The three oscillator outputs differ in phase by 180°. Two of the phase shifters shown in (b) are cascaded and, along with the voltage divider formed by resistors R_1 and R_2, placed in the feedback loop (c) of a third operational amplifier.



necessary for resistor R or capacitor C to be precision components; resistors having tolerances of ±5% will do. And the resistor labeled 2R in the diagram can actually be much larger than 2 × R without impairing the performance of the circuit. However, to get very high filter Q or to use the circuit as an oscillator, voltage-divider resistors R_1 and R_2 must be precision parts, with tolerances as tight as ±1% or ±0.1%. □

One lamp can monitor battery voltage

by N.D. Thai
Huntec Ltd., Toronto, Ont., Canada

A single lamp can monitor an unregulated voltage, for instance from a battery, indicating whether that voltage is high, low, or normal. For a normal voltage, the lamp stays off; for a high voltage, the lamp stays on; and for a low voltage, the lamp flashes on and off. The low and high voltage limits are independently settable, and the flashing frequency is also adjustable.

Two complementary-MOS NOR gates perform the logic for the circuit. The voltage applied to the input of gate G_1 is AV, where A is a constant determined by the setting of potentiometer R_1. Similarly, the voltage applied to the input of gate G_2 is BV, where B is a constant determined by the setting of potentiometer R_2. Constant B is made larger than constant A.

A logic 1 is applied to both gate inputs when voltage V goes high. Voltage BV then exceeds the gate threshold voltage (V_T), or:

V is greater than $V_T/B = V_H$

where V_H represents the high voltage limit. The output of gate G_2 is low, and the lamp stays on. A logic 0 is applied at both gate inputs if voltage V goes low. Voltage AV is now smaller than the gate threshold voltage, or:

V is less than $V_T/A = V_L$

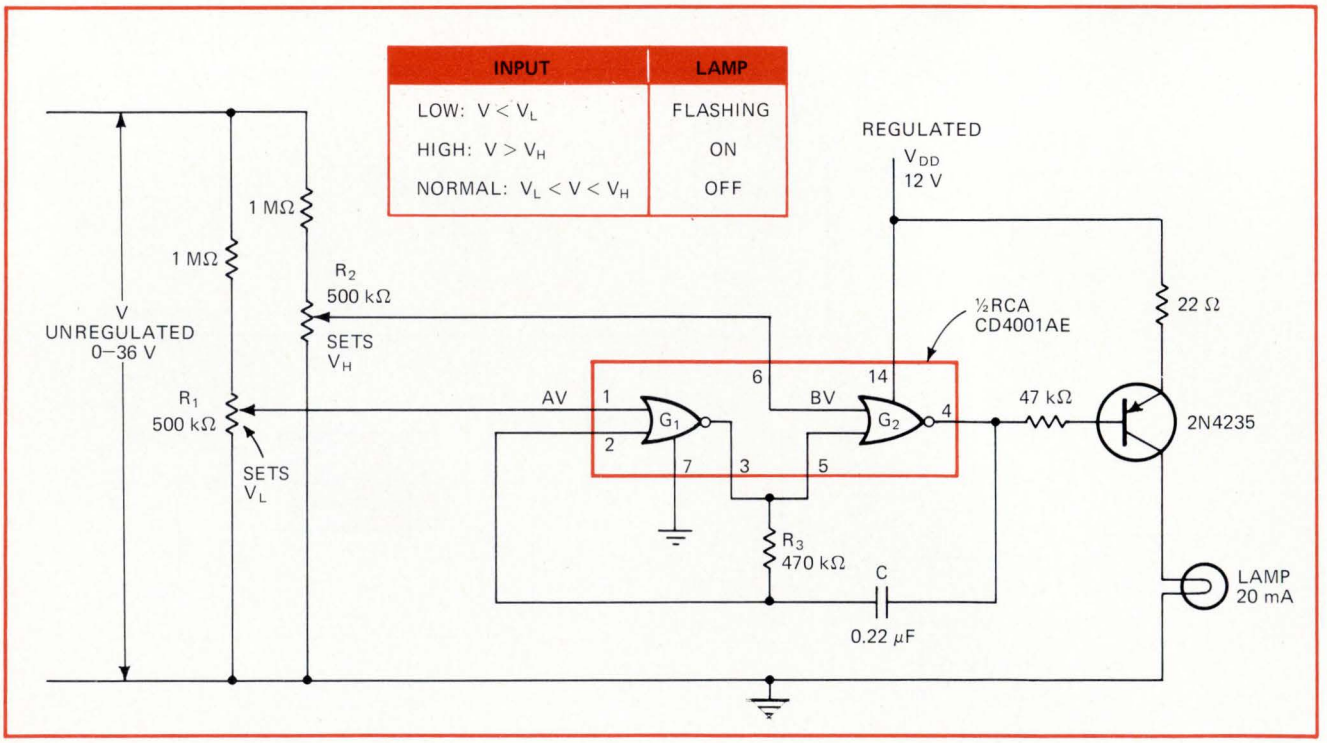
where V_L is the low voltage limit. The two NOR gates, resistor R_3, and capacitor C form a conventional astable multivibrator that drives the lamp with a square wave. The flashing frequency (assuming $V_T = V_{DD}/2$) is approximately equal to:

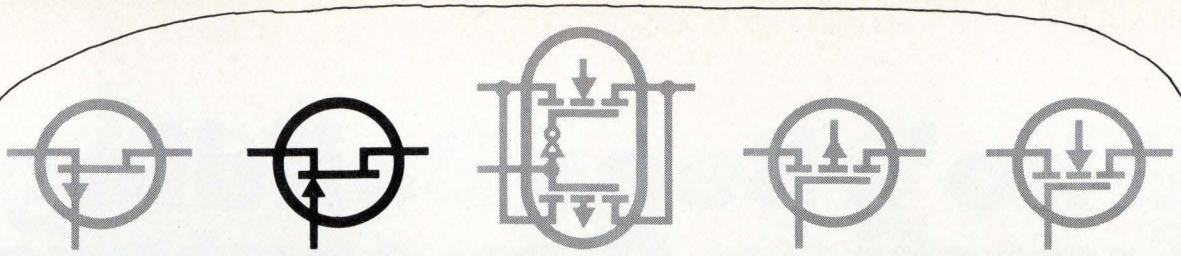
$f = 1/(1.4)R_3C$

When voltage V lies between the low and high limits (that is, if voltage AV is greater than threshold V_T and voltage BV is less than threshold V_T), a logic 1 is applied to the input of gate G_1, while a logic 0 is applied to the input of gate G_2. The lamp remains off because the output of gate G_1 is low and the output of gate G_2 is high. □

Designer's casebook is a regular feature in Electronics. We invite readers to submit original and unpublished circuit ideas and solutions to design problems. Explain briefly but thoroughly the circuit's operating principle and purpose. We'll pay $50 for each item published.

Lighting the way. Single lamp indicates when unregulated (battery) input voltage is low, high, or normal by flashing, remaining on, or remaining off. The low voltage limit, V_L, is set by potentiometer R_1, the high voltage limit, V_H, is set by potentiometer R_2, and the flashing frequency is determined by resistor R_3 and capacitor C. Complementary-MOS NOR gates are used as the logic elements in this voltage monitor.





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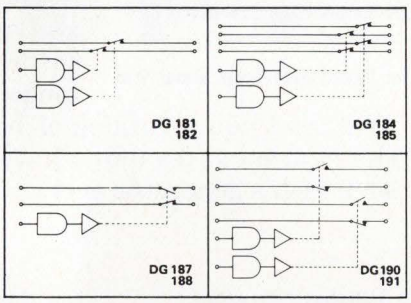
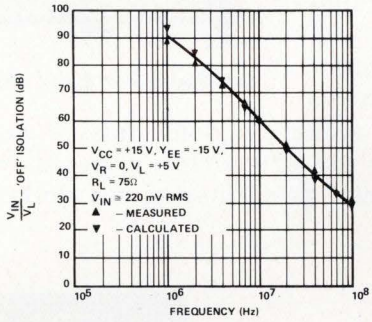


DG181-DG191 Functional Diagrams



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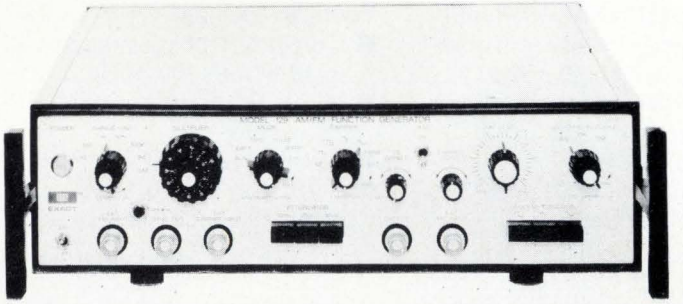

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Part 2
MINIS IN ACTION

Hard-wired numerical controllers yield to efficient minicomputers

Standard processors, easily integrated with individual NC mechanisms, enable data-processing programs to control all machine tools in the shop; modularity of hardware and software provide expandability for the future

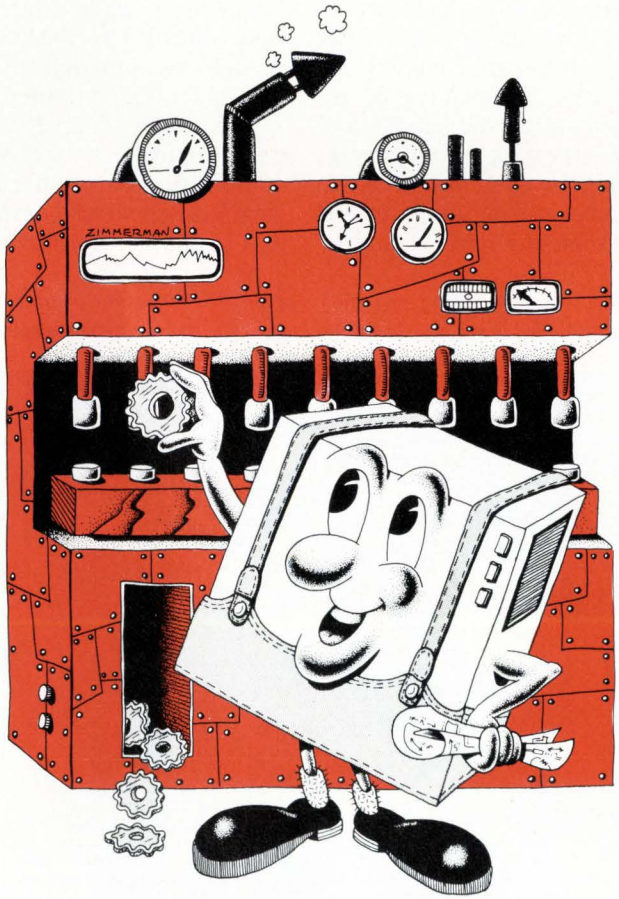
by Marion Kosem, *Allen-Bradley Co., Highland Heights, Ohio*

☐ Builders of numerically controlled machine-tool systems are turning to general-purpose minicomputers, which can control all NC applications in their plants merely by changes in software. However, until the dropping prices of minicomputers made them so attractive, it was more economical to use hard-wired controllers for each task.

But minicomputers have dropped in price by a factor of three in only five years, and today's computerized numerical controllers (CNCs) far outperform the NC systems of a decade ago at much lower cost. The lower cost of minicomputers is largely attributable to decreasing costs of integrated circuits and other solid-state devices. And fortunately, as these devices were decreasing in price, their capabilities were increasing dramatically, which has helped make minicomputers much more reliable and easier to use.

The major benefit of computer control in NC-system design is that it permits new features to be implemented easily just by changing the software, instead of building new hardware. Software can be altered, removed, or replaced at any time. Therefore, a general-purpose system can be turned into a special-purpose system by means of a standard program, which can customize, or "soft-wire" virtually any off-the-shelf minicomputer—without modification—to any NC system.

And the CNC system can be expanded as the plant grows because most modern minicomputers offer both modular software and hardware, and most machines have adequate power and flexibility to control most CNC systems. Minicomputers with 12-bit words have been successful, but 16-bit machines are somewhat more efficient.



A standardized approach to interfacing minicomputers to NC functions results in a truly universal controller. Standardization also offers many benefits to the machine-tool builders, as well as eventual NC users. For example, the machine-tool builder can use one control to satisfy virtually all NC applications, from a three-axis milling machine to a five-axis machining center with a tool changer and shuttles. When a purchaser requests particular features, customizing the control for the most part is only a matter of customizing software.

This drastically shortens the long lead time from the NC builder, allows last-minute additions or changes to be accommodated, and reduces the machine-tool builder's spare-parts inventory. New technology can be added to the system after installation, reducing obsolescence and extending the system's useful life.

Having only one control in the plant reduces the training requirements because only one system needs to be learned, and only one kind of hardware needs to be maintained. Controls with different options are not distinguished because their various features—positioning, contouring, offsets, and so on—are all in software. Once it is written and checked out the software needs no maintenance. Documentation costs are reduced, and efficiency of personnel in programing and maintenance is improved.

Another factor contributing to the total cost of a shipped product from the machine-tool builder's plant is the actual cost of integration. The sequencing logic that formerly needed to be synthesized with magnetic or solid-state relays is

no longer a major cost factor. On the contrary, the machine builder's sequencing-logic costs are reduced to zero because the control connects directly to the machine. Furthermore, because the number of components is reduced, total system reliability is improved.

One attractive feature of any computer is the set of diagnostic programs that comes with it. With these programs, even a relatively low-skilled technician can isolate any problem down to a subsystem or a card level. By following a systematic procedure, he can easily correct most failures (usually by card-substitution) and thus minimize equipment downtime. These computer diagnostics, by themselves, provide a fault-isolation capability that no hard-wired NC can have.

Conventional NC

The basic functions required of any contouring NC system, shown in Fig. 1, also prescribe a functional organization for the traditional hard-wired numerical controller. Designing such a system without a computer and determining the internal functions it performs require a detailed consideration of the interfaces between the machine, the control, the operator, and the program input. All of these parameters, and more, make up the specifications—in other words, a detailed description of inputs and outputs.

Data input to the system originates typically on punched-paper tape; the specifications must include the data-coding format for this tape input. This data includes information for the feed generator, which controls the rate at which the machine-tool axes are to move, and the contour-generator, which determines the paths that they are to follow, with linear or circular interpolation, or both. Various feed modes may be required; for example, in a lathe control, the cutting tool may be directed parallel to the lathe axis, perpendicular to it, or at any intermediate angle by combining the two motions—and all in terms of inches per minute or inches per revolution. Absolute or incremental input data may be provided. Sometimes these options are designed to be provided by simply adding new modules, but that flexibility usually demands a premium price. However, in every case, each additional feature of the control requires additional hardware.

The basic design parameters also specify the range of feed rates, servo-following error limits, and word lengths—the number of digits required to provide a given range of motion with a given precision. In a closed-loop NC system, usually having both position and velocity loops, the following error is the difference between the accumulated command and feedback signals. The NC system supplies the command signals for the servo drives in the machine tool, which also contains position and velocity transducers that reply with feedback signals to the controller.

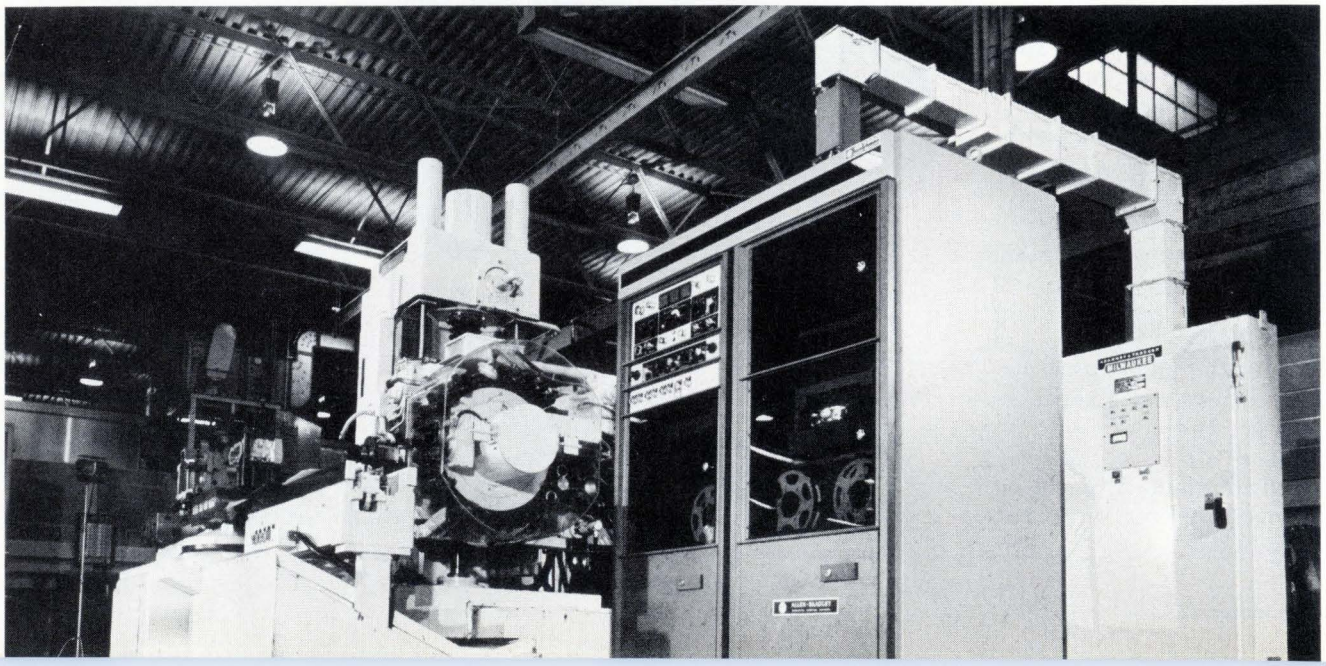
The common-control area is a traffic-control center for the entire system. It provides the basic interface between the operator's control panel and the rest of the system functions and provides all the timing and coordination.

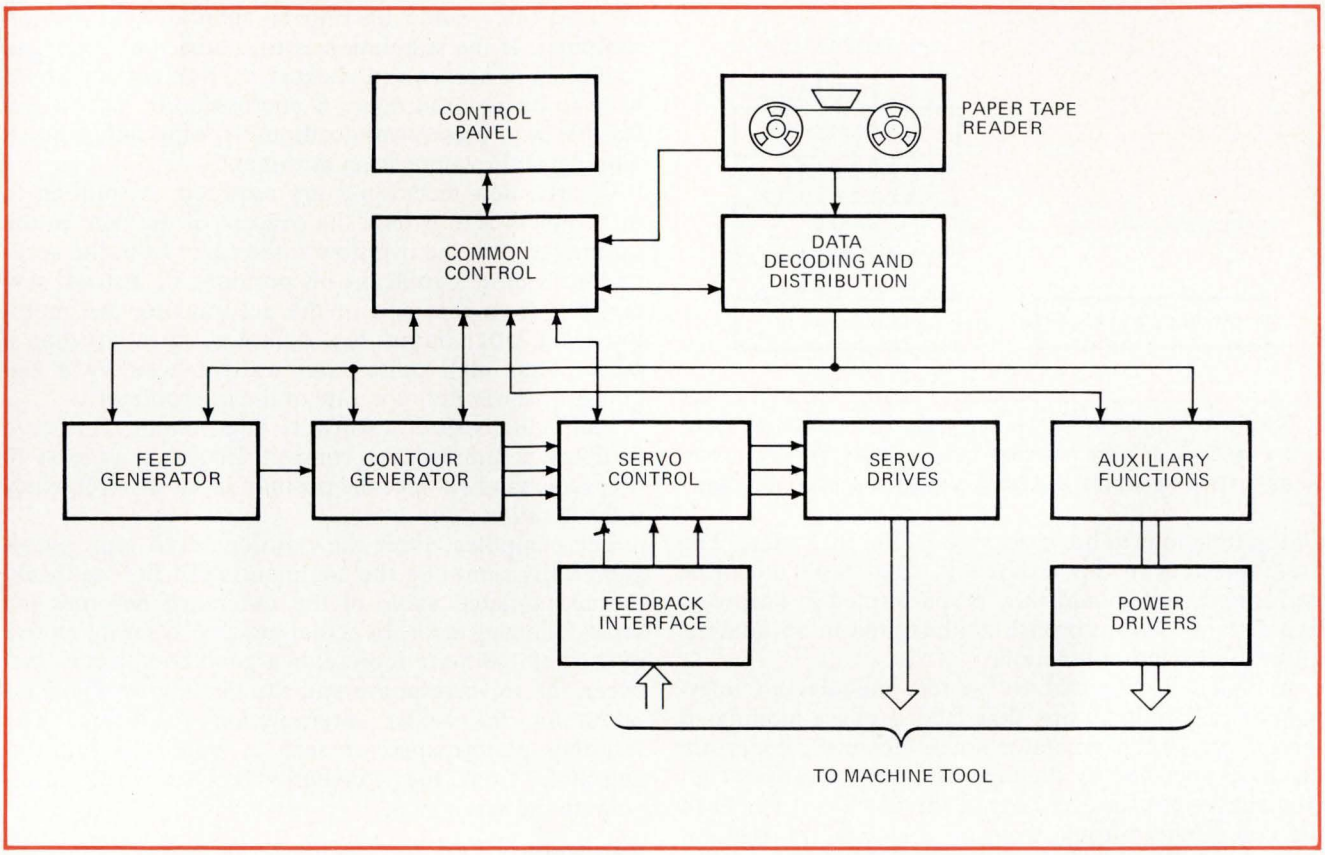
Custom design

Many of these parameters are standardized; but standards leave one remaining problem—to integrate the control to a particular machine. Each machine has its own custom requirements, such as control of tool changers, pallets, spindles, and coolant. Usually, the machine-tool builder and the NC builder must compromise; the former pays for a special design, or more frequently designs a relay panel himself. Lately, solid-state controls have been substituted for relay panels, although this approach still involves expensive design, recurring costs, and limited field flexibility.

Every closed-loop NC includes the same basic functions required of hard-wired controllers. In addition, many systems also offer optional features such as tool-length offset, which compensates for the length of a tool that is different from that assumed by the tape; cutter

Efficient controller. Kearney & Trecker automatic milling machine is capable of multiple movements of both the object being milled and the tool doing the milling—and changes its tools automatically. Computer control is in the two cabinets at the right.





1. Basic functions. Any numerical control system, computerized or not, requires that its design account for all interfaces between the program, the operator, the control, and the machine—the sum total of which makes up the system specifications.

compensation, which allows for differing cutter diameters; fixture offsets, which aid the setup of the machine tool; and thread-cutting and constant surface-speed capabilities on a lathe control. Manual data input and displays help to check out the programs, and an additional tape reader may be required in some systems.

All these functions and many more are synthesized by the logic designer into an NC system. The hard-wired control combines registers, counters, flip-flops, gates, and other logic blocks, all permanently wired together. An NC system designed this way can do nothing more than it was originally designed to do without difficult and expensive hardware modifications.

There is nothing wrong with this hard-wired NC design as long as all its ramifications are recognized. NC will continue to be built this way. However, using the new well-proven and well-established minicomputer in NC not only will provide immediate improvements, but more importantly, it will provide a basis for adapting to future trends.

Interface is standardized

The first major advantage of a soft-wired controller is that, in place of special-purpose hardware that implements control algorithms, the computer performs those functions in software and permits use of standard interface hardware. For instance, a lathe has different control requirements from a five-axis machining center. The number of servo loops and the kinds of features are probably different. But all the servo interfaces can look the same—at least in hardware—and all the switches can look alike. Thus a general-purpose computer interfaces with other general-purpose devices on the machine tool. The latter may be switches, indicators, feedback transducers, digital-to-analog converters, servo amplifiers, and so on. All of these are common to almost any type of machine-tool applications, and they constitute the building blocks of a dedicated computer NC system.

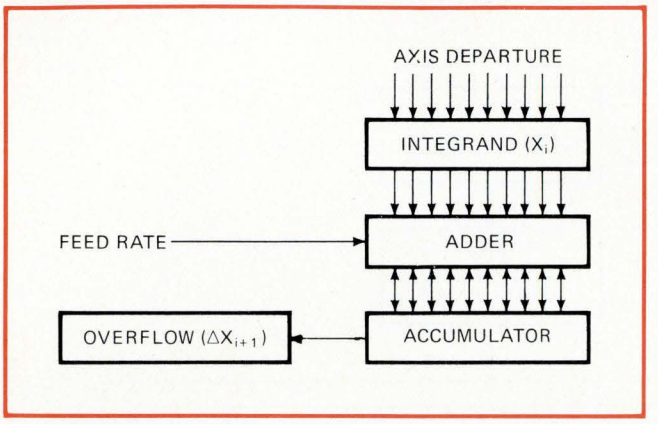
Though the building blocks are still hard-wired to the computer, they do not provide any of the control logic, nor does special hardware perform any functions such as data decoding and distribution, feed-rate calculations, or interpolation. Instead, these functions are reduced to their basic logical or mathematical equivalents, translated into a computer through the required logical and mathematical manipulations, and coordinate the machine-tool elements in a predefined way.

Design approach

The soft-wired controller has four basic design objectives:

- Do as much as reasonably possible in software.
- Minimize the necessary hardware and design it for a generalized use.
- Consider how improvements in related technologies will affect the design.
- Leave room for growth.

Following these guidelines, the first task is to analyze



2. Simplest. A digital differential integrator produces single output pulses as increments are repeatedly added. An extended form produces multiple-bit outputs, and controls faster-changing processes.

all the functions to be performed by the NC system. The basic question in this analysis is, what tasks are to be performed, and should they be performed in hardware or software? This approach is illustrated in an analysis of the interpolation function.

A typical hard-wired NC system includes an interpolator and pulse trains that feed a phase-modulated servo loop. The interpolator breaks down the departure distances specified by the tape input into a series of incremental steps for each axis of the machine tool. Then the coordinate outputs from all the axes are algebraically summed with their respective feedback signals to produce the generated contour.

Each pulse commands a specific increment of movement—typically 0.0001 inch—along one machine axis. Thus, to generate a movement along one axis at 60 inches per minute, requires a pulse rate of 10,000 pulses per second. A typical maximum feed rate is 300 in./min, equivalent to a pulse rate of 50,000 pulses/s. These rates have been achieved in today's designs by using digital rate multipliers or digital differential integrators (DDIs).

With a basic DDI, an increment is repeatedly added to an accumulator, which overflows from time to time; the overflow is the desired output pulse. This pulse drives a counter, but the servo feedback signal drives the counter the other way, and the contents of the counter at any time determine the motion of the servo, which drives one of the machine-tool axes. Only the one pulse is available from a DDI—the carry-out of the most-significant bit position of the accumulator—and its frequency is variable only by increasing the magnitude of the repeatedly added increment. Therefore, the DDI is limited to controls with a relatively slow output rate. This process is illustrated in Fig. 2, and it represents a commonly used technique in NC today.

This process is easily duplicated in software by using registers within the computer and generating an output pulse whenever the accumulator register overflows. But to perform this operation for a typical application would be a formidable task. For example, to handle feed-rate and path-interpolation functions for two axes of contouring, three DDIs—one for each axis and one for the feed rate—would have to be simulated by a minicomputer. If the simulation is to match the speed and resolution of hard-wired systems, each integrator would have to be serviced every 6 microseconds. This is not feasible with present minicomputers, especially since it requires multiple precision arithmetic.

Clearly, new techniques are required. A solution to the problem is to extend the concept of the DDI. In the traditional DDI, the overflow is the carry from the accumulator's most significant bit position; if, instead, several bits from that end of the accumulator are monitored, the DDI's output is a digital word rather than a pulse. Thus high pulse rates are replaced by a significantly lower iteration rate of the interpolator.

This is the basis of a software interpolator. The servo feedback is sampled at a constant frequency at least 10 times the bandwidth of the position loop; this frequency is the iteration rate.

The computer closes the position servo loop by algebraically summing the command with the feedback; the accumulated value of the difference becomes the servo-following error. In actual practice, a sampling frequency of 100 hertz represents a good compromise between the servo response and the loading on the computer for the linear interpolation algorithm. The resulting performance of such a system is indistinguishable from the conventional hard-wired interpolator and servo loop.

Hardware

The Allen-Bradley 7300 is a practical computerized numerical-control system, made up from a set of modular functions (Fig. 3). Some of these functions reside within the mainframe obtained from the computer manufacturer, while other modules are designed and built by Allen-Bradley.

The A-B 7300 uses an HP-2100A computer—a microprogramed central processing unit with a 980-ns cycle time, hardware multiply and divide, pre-wired input-output section, up to 32,768 words of memory, and a power supply. The computer is programed in assembly language. The basic system, with a standard tape reader, control panels, cathode-ray-tube display, six servo axes, and linear and circular interpolation requires less than 8,000 words of memory. Many typical applications with most of the mentioned options require more memory. The system has been price-competitive, mostly when used in the more sophisticated NC systems. Hard-wired controllers for smaller and less demanding machines are less expensive than CNC.

Other machines that are quite satisfactory for CNC systems are the Digital Equipment Corp. PDP-11, General Automation Inc. SPC-16, Data General Corp. Nova, Interdata 70/74, and Texas Instruments 980A. Any off-the-shelf minicomputer can do the job without modification. However, those with 16-bit word lengths tend to be somewhat more efficient than the 12-bit machines.

Included in the equipment from the computer maker are such computer peripheral devices as tape readers and CRT displays. Optional equipment includes a tele-

typewriter and a tape punch, which may be useful for general maintenance and to generate software. The rest of the modular hardware, which is connected to the computer through the input-output multiplexer, is subdivided into discrete inputs, discrete outputs, axis feedback, and servo outputs.

Since the control performs not only the traditional data distribution, interpolation, and closed-loop servo functions, but also such machine-sequencing operations as controlling the tool changer or shuttles, the system design is standardized around a discrete signal interface, in which all signals are either on or off. All the discrete input/output signals are buffered and are available in either 115 v ac or 24 v dc levels. Each signal function is assigned by software, as is the automatic 10-millisecond scanning of their status. This provides an optimum design flexibility and permits general application.

In the software-closed servo loop, the standard position-feedback element is an incremental photoelectric encoder. Linear or rotary feedback devices are available as options. The serial output from any of these feedback transducers is accumulated in a bidirectional counter during each 10-ms sampling interval. From the sum of this feedback and the command, the computer generates the following error, which, via the digital-to-analog converter, becomes an equivalent bipolar analog voltage. This voltage is sent to the axis servo drive, which, in turn, may be either electric or hydraulic.

This hardware is about as general-purpose as it can be—but more importantly, it is organized in a way that facilitates further expansion when that becomes necessary, at no sacrifice in flexibility. Nevertheless, the system becomes an active, useful, working system only with software.

Software

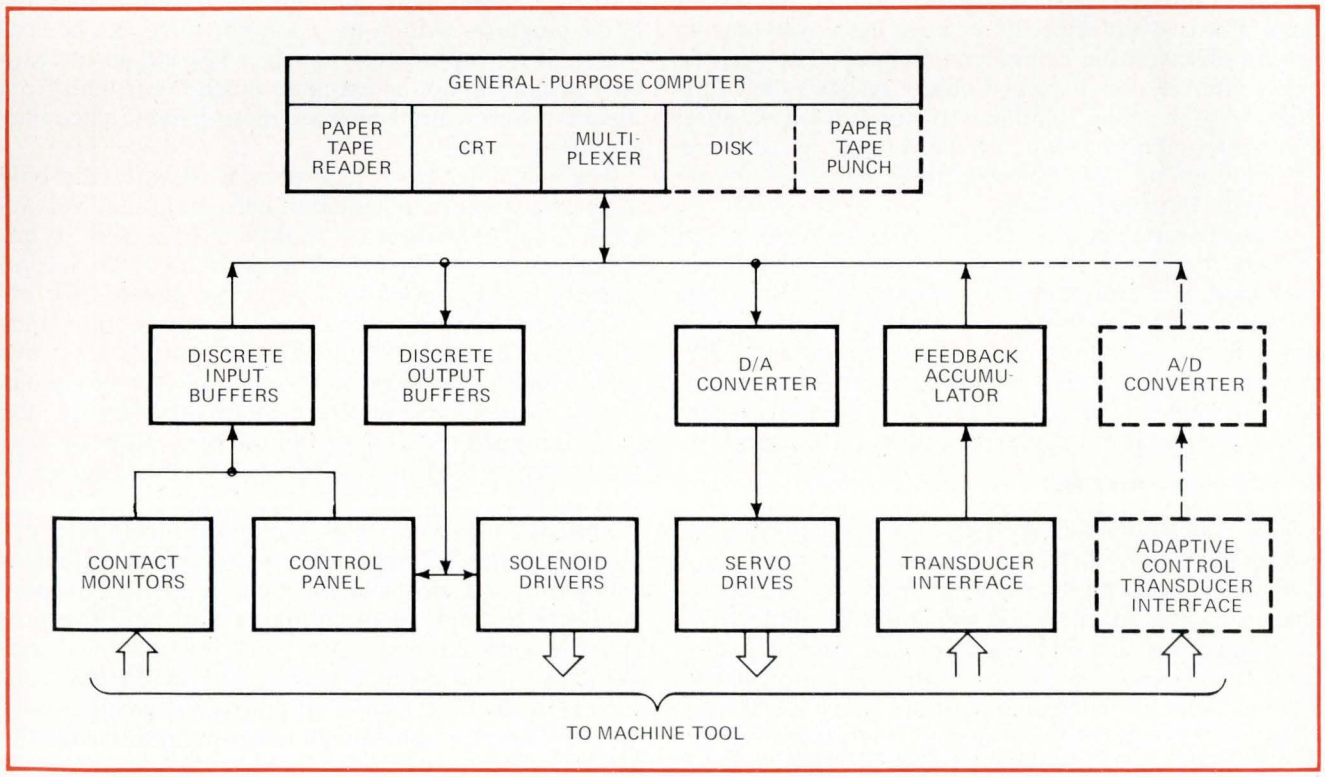
Since the software programs are stored in the computer memory, they can be easily altered at any time. Physically, they exist as rolls of tape, punched with binary programs suitable for a particular computer and a specific machine-tool configuration. Thus, different modes of operation, different capabilities, and new features or options are possible without changing hardware or wiring.

The main software module is the executive program, which, like the main controller in a hard-wired system, controls the operation of the entire system and ties together the various software routines.

Under executive control, the software routines, each of which performs a specific function, are called from memory in an orderly fashion with proper priority. For example, the input-output drivers control the operation of the tape reader and the CRT display. When the data-distribution routine determines that more data should be read into buffer storage, the executive program is notified; it, in turn, commands the tape reader to read more data.

Feed-rate, interpolation and servo functions are examples of software programs. Feed-rate calculations are easy for the computer. With the standard system, feed rate is programed directly in inches per minute. Used

3. Computerized. Practical system comprises several modular functions, some within the computer itself, come in related equipment connected to the computer. Latter includes discrete inputs, discrete outputs, axis feedback, and servo outputs.



with the data input, in terms of absolute coordinates instead of incremental movements, this capability goes a long way toward the possibility of manual programing of relatively simple parts. Both linear and circular interpolation are available now, and higher-order interpolation can be implemented by changing only the software.

Computer effects on NC

All these capabilities of a computerized NC merely duplicate the traditional capabilities of hard-wired NC. But additional capabilities are also available. For example, most NC systems offer buffer storage for one or more blocks of data ahead of the active data. The A-B 7300 NC tape reader reads four blocks of data with one command, while the memory stores up to eight blocks of data. This relatively simple extension improves tape reader reliability because fewer start and stop commands reduce wear on electromechanical components.

An extension of buffer storage is the facility to store the entire part program. Once it is read into the control, the part program can be executed directly and completely, obviating the need for tape reading and possible errors during execution.

A further extension of program-storage can allow space to edit stored programs. The desired changes to a tape program, stored in core memory, are correlated with the data. The original program can then be run in a normal way, while the changes are automatically inserted.

Another example is offset storage to compensate for tool length and cutter diameter. Traditionally, this compensation has been implemented by thumbwheel switches, and it has been limited by the cost of the switches and the physical space required to mount them. But cost and space limits have been overcome by storing offsets in the computer's memory. They can be easily inserted and displayed on the system's CRT. Furthermore, the actual computations for tool-length-offset and cutter-compensation are performed in software. The only system cost of these features is the memory required to store the programs.

A third feature is axis calibration in software, which corrects for known inaccuracies in the machine feedback loop, and thus eliminates repeatable errors in machine slides and feedback elements. The error profile is stored in the computer memory, and the correction factors are applied on-line during directed machine motion. An analog equivalent is available in cam compensation, but it requires expensive additional hardware.

What's ahead for CNC

The list of potential features of a computerized NC system is limited only by the imagination. Before long, a new capability—adaptive control—may become available in computerized NC. It will improve productivity by monitoring the machining process and adjusting feeds and speeds on-line for optimum performance. Various adaptive-control algorithms have been proposed; a soft-wired controller could be programed for one of them, and the machining sensors could be interfaced directly with the computer through analog-to-digital converters. Not only would this approach require little additional hardware, but it would also facilitate the development of the algorithm, since the latter could be rapidly changed.

A part program for an NC system could be generated by a digitizer scanning a model. The requirements for digitizing are similar to those of numerically controlled machining. Instead of transmitting desired movements from a tape to a cutting tool, the digitizer senses movements from a tracing head, transmitting them to the computer through analog-to-digital converters. The computer monitors the deflections and axis-position transducers, and it generates a part program that can reproduce the scanned part.

Finally, a computerized NC system can include mass-data-storage peripherals to store an entire library of part programs. Or the system can incorporate a data base. It can automatically monitor up/down time, piece count, malfunction alert, and other system-performance parameters, and integrate the data into a larger management-information system.

The trend toward more computerized numerical control is expected to continue and increase in the future. Minicomputers are becoming cheaper, more powerful, and smaller in size. Their environmental specifications are constantly being improved, thus making minicomputers even more suitable in extremes of temperature, humidity, vibration, and other demanding environments. The replacement of core memories by semiconductors should help widen the temperature specifications of the computer even further.

The microprograming capability of some minicomputers offers exciting possibilities in increased performance, lower cost, and higher system reliability. Some programs written for a soft-wired NC can be converted to microprograms, which, when stored in read-only memories, can be executed much faster than from main memories, and which are more reliable since they cannot be erased.

The new microprocessors, when used with read-only memories, have the potential of becoming small NC systems. A microprocessor, or "computer on a chip," is implemented entirely in a single integrated circuit. Several of these could be used in a larger NC system. For example, one such processor could perform the interpolation and the servo function for a single axis; five could control five axes, and a hierarchy of processors would make up the entire system. Significantly, the trend is toward a set of general-purpose hardware that can be reproduced in quantity at low cost. The applications engineering is left to programing.

This may sound far away from the minicomputer approach of today. However, the trend is evident. The tendency is to perform more functions in general-purpose hardware to improve performance and ease the programing burden. It is safe to say that the numerical-control industry and the computer industry will follow convergent paths. This opens up additional challenges to the suppliers of equipment and continuing gains for the user. □

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MM 5330	32x8	50	Open Collector	$ 20.00	MM 5230
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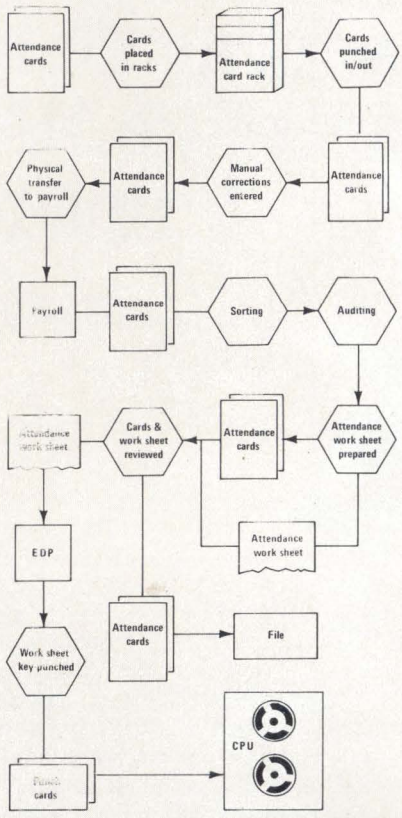

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Polysilicon-filled notch produces flat, well-isolated bipolar memory

A space-saving way of isolating the active elements on a bipolar memory is to etch a notch around them; in Polyplanar devices, that notch is lined with silicon dioxide and filled in with polysilicon to smooth the surface

by Thomas J. Sanders and William R. Morcom, *Harris Semiconductor Division, Harris-Intertype Corp., Melbourne, Fla.*

☐ Just about every semiconductor manufacturer is trying to develop a viable process for producing high-density bipolar memories, which have become the hottest product area in today's technology. All their attempts revolve about the notion of passive isolation—substituting some passive material for the active pn junction regions that electrically isolate active devices on a conventional bipolar memory.

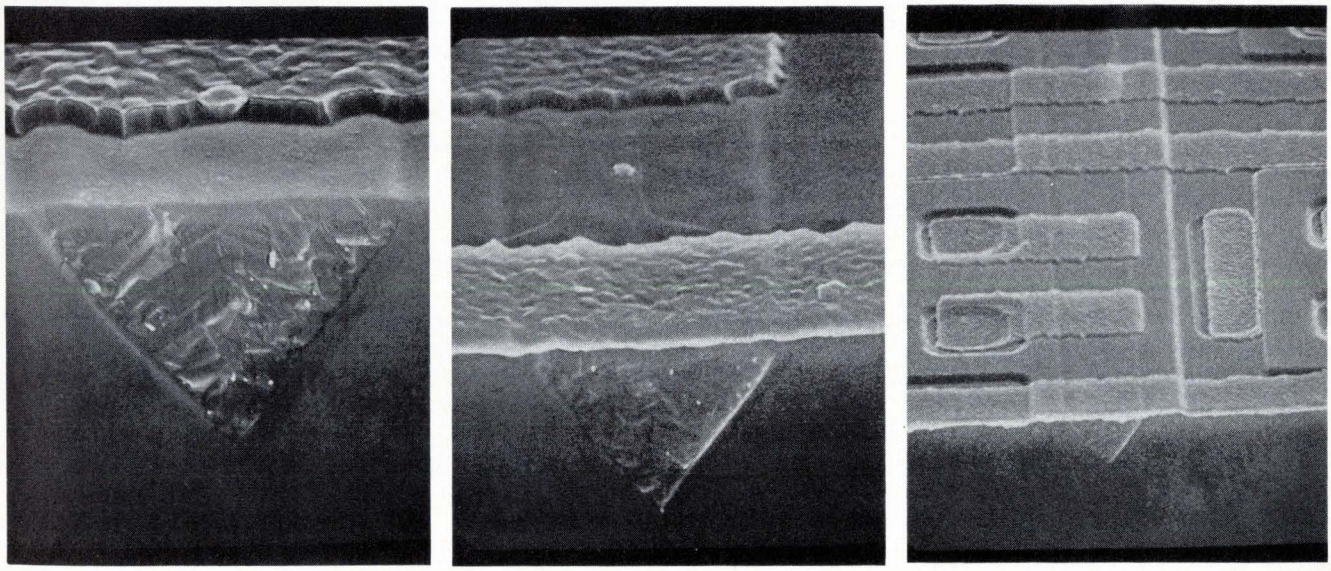
The candidates include a thermally grown oxide and notched rings filled either with air or with some kind of solid insulating material. One notch process is particularly attractive: the notch is lined with silicon dioxide and then filled up with polysilicon backfill to keep the device topography flat.

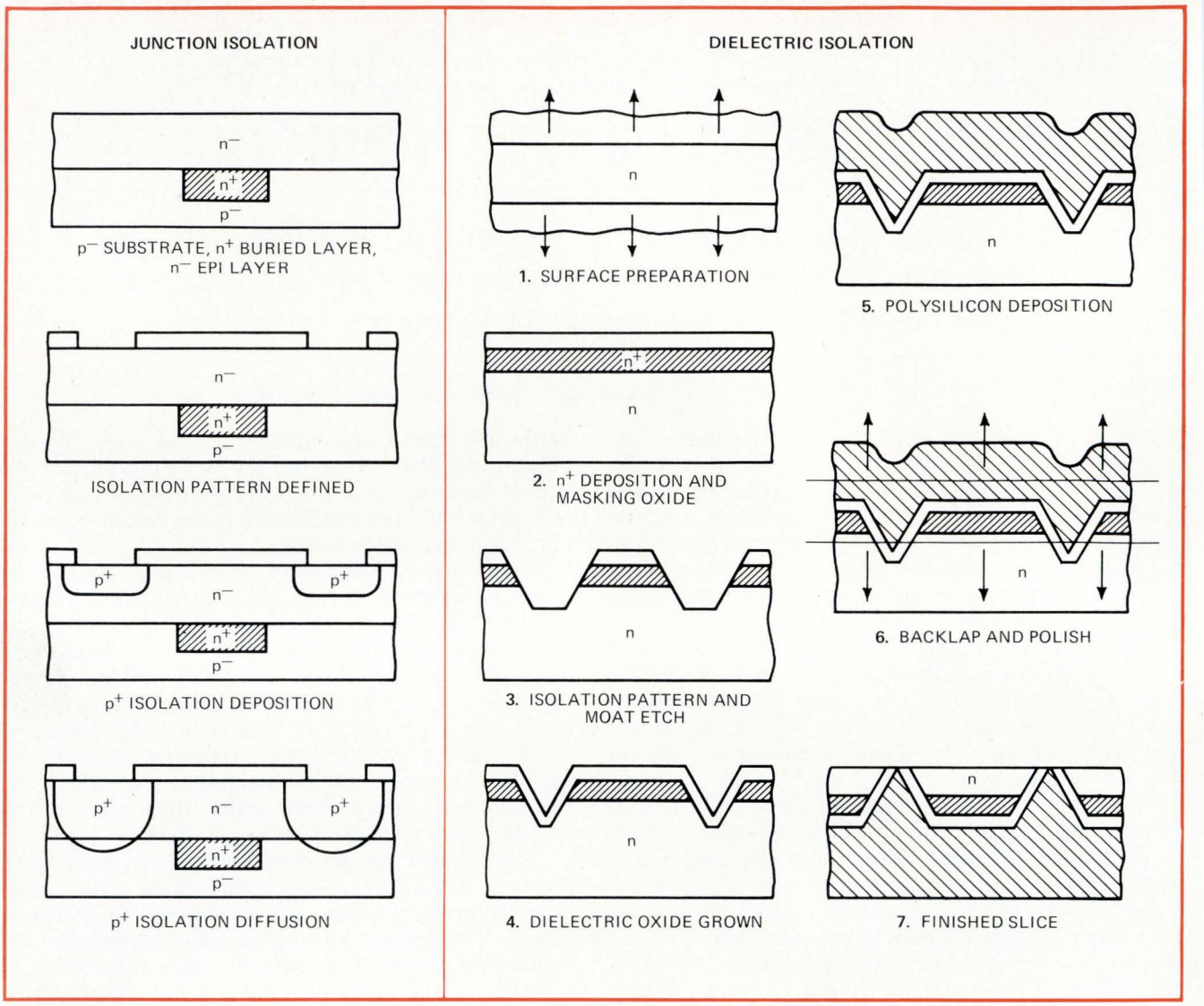
Called Polyplanar, the process achieves the desired planarity and high yields of the oxide-isolation technique, and at the same time attains the sought-after small cell size—as low as 6 square mils—of the notch techniques. In production already is a 2,048-bit programable read-only memory [*Electronics,* Jan. 4, p. 115] that fits onto the same size of chip as an earlier 1,024-bit PROM. Coming soon are 256-bit and 1,024-bit random-access memories having arrays that occupy only a quarter the chip area of conventional devices. And most significant, the Polyplanar process is applicable equally well to logic and linear circuits, pointing to subnanosecond LSI logic and smaller and faster multipliers, multiplexers, and analog switches.

Historically, IC technology has been dominated by two isolation processes: junction isolation, and dielectric isolation (Fig. 1). Junction isolation, the older of the two, is simple and inexpensive. Active pn reverse-biased junctions form the sidewalls of each device, and the substrate defines the bottom of the device. Unfortunately, chips processed in this way suffer from unwanted capacitances, which are temperature- and voltage-sensitive. Even more devastating to memories is the side diffusion of the isolation walls, which makes it impossible to achieve high packing densities.

In an effort to escape from these design limitations, dielectric isolation was introduced. Here an epitaxial layer, normally of silicon dioxide, replaces the diffusion process as a method for isolating devices. Because the dielectric isolation forms both the sides and bottom of each device, the process produces a low-voltage structure with better packing densities than junction isola-

Crowded plane. In the Polyplanar process, the active elements on a bipolar device can be packed closely together, being isolated by a notch lined with silicon dioxide and backfilled with polysilicon for surface smoothness. V-shaped notch, magnified 10,000 times, is shown at left; in middle is cross section of aluminum interconnect and Nichrome fuse, and on right is portion of completed memory.





1. The old ways. In junction isolation, active pn junctions form the sidewalls of each active element, while the substrate forms the bottom; arrays occupy large areas and also are voltage- and temperature-sensitive. Dielectric isolation, in which silicon dioxide replaces the active diffusions, solves the instability problem but, relying on large moats filled with dielectric, wastes space and is a complex process

tion. But at the same time, it requires larger chips because it relies on large dielectric moats on the silicon surface. In addition, the process is altogether more expensive and complex.

On the level

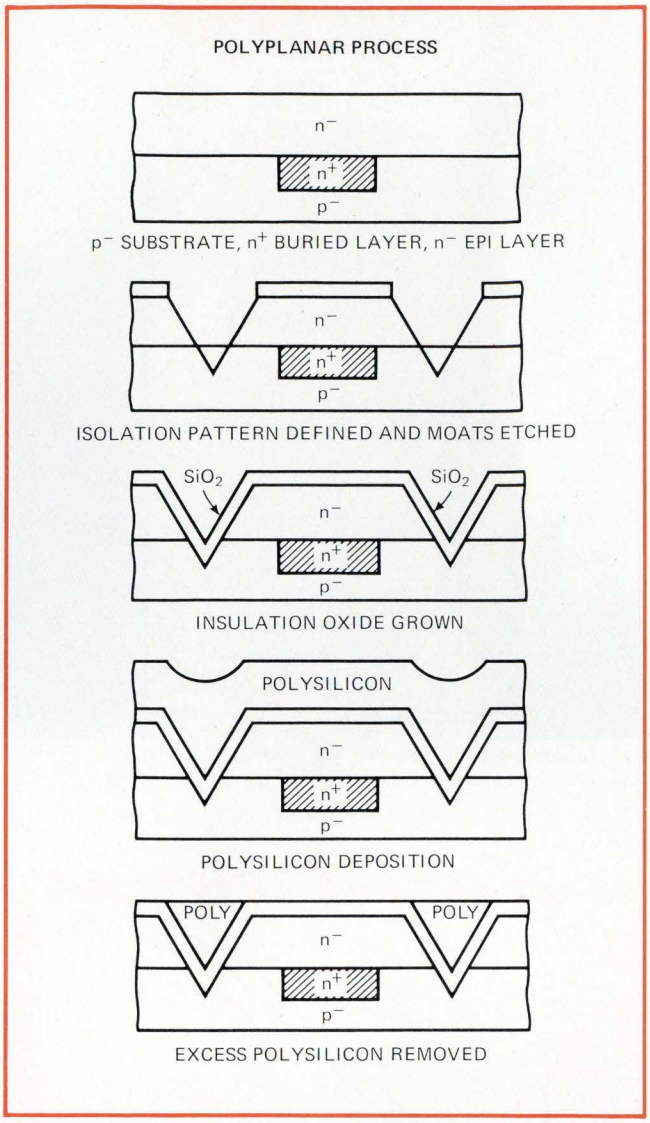
The Polyplanar process, like other new bipolar processes such as Isoplanar and V-ATE, is intended to free circuit design from the tyranny of these process limitations. As in junction isolation, the Polyplanar process starts with a p-type substrate (Fig. 2), on which a selective buried layer is diffused, followed by growth of an n-type silicon layer. Then an oxide layer is grown, an isolation pattern is defined by normal photoresist techniques, and a silicon etch is performed on the exposed silicon to form moats.

Next, sufficient silicon dioxide is grown in the moats to form the required dielectric isolation. But then, unlike the other processes that rely on etched moats, polysilicon is deposited on the silicon wafer until the moats are full. Excess polysilicon is polished off, leaving a planar surface. The device walls are now fully defined, and all the following processing steps are conventional.

Note that in the Polyplanar process, the isolation moat is formed by using an anisotropic etch in 1-0-0 orientation silicon. The depth of the moat is geometrically related only to the width of the aperture cut into the masking material on the surface of the silicon. The wider this aperture, the deeper the groove that is etched. Therefore, the moat can be made any depth simply by adjusting the isolation aperture width.

The advantage of Polyplanar's backfill polysilicon approach over the air-filled-moat approach becomes clear. In the air-isolation process, because the moats are not refilled, a complex metal system is necessary to cross through the steep valleys separating the devices. The flatness of Polyplanar devices, however, allows use of conventional metalization systems—in addition to simplifying multilevel interconnects and increasing reliability generally.

What's more, in contrast with other filled-moat ap-



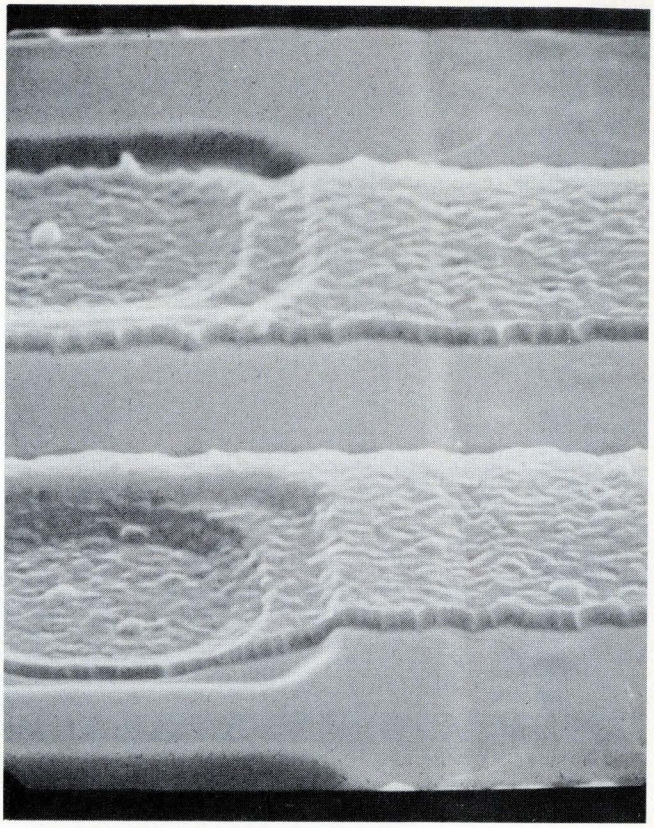
2. The new way. The Polyplanar process overcomes the deficiencies of the methods shown in Fig. 1 with a space-saving notch defined by silicon dioxide, filled with polysilicon, and polished flat.

proaches, such as VIP, the Polyplanar isolation material is silicon dioxide instead of silicon nitride. To achieve planar characteristics with silicon nitride techniques, only very thin epitaxial layers of less than 0.1 mil can be isolated—efforts to exceed 0.1 mil result in breakdown. But with silicon dioxide, various depths of epitaxial layers can be accommodated.

Indeed, epitaxial layers can be isolated that are up to several hundred micrometers thick, and this makes it easy to construct circuits that require voltage capabilities of 30 to 40 volts, such as field-programable read-only memories and linear circuits.

Fewer stray picofarads

Finally, the parasitic capacitance of the Polyplanar cell is lower than that of conventionally built bipolar structures because (1) the cell is smaller, and (2) its sidewalls, being a dielectric, have almost zero capacitance. In other words, the collector-to-substrate capacitance is practically zero, and the collector-to-base and emitter-to-base capacitances are lower because the sidewalls of



3. Levelled. A virtue of the Polyplanar process not found in other notch processes is the flatness of the devices it produces. Such a surface is easy to metalize with high reliability. The above cell's independence of notch depth adds further to reliability.

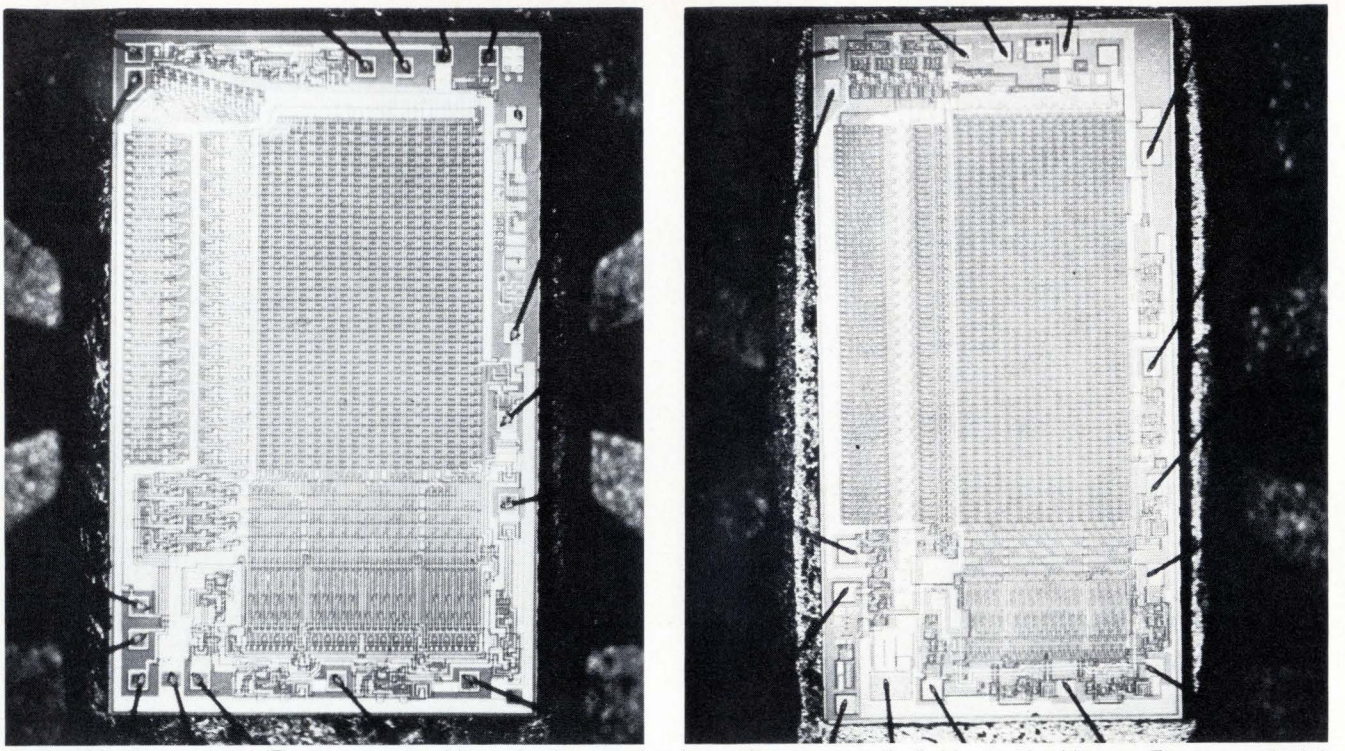
these junctions are formed by low-capacitance silicon dioxide instead of high-capacitance silicon nitride. All three capacitances add up to only a few picofarads, meaning that Polyplanar logic circuits could easily operate at 1 ns and less, and 1,024-bit memory circuits could operate with access times of less than 20 ns.

Examples of the flat surface obtained by Polyplanar are shown in Fig. 3. Significantly, the planarity of the surface is not dependent in any way upon the depth of the moat or thickness of the epitaxial layer to be isolated, because in all cases the moat is totally filled with polycrystalline silicon.

The small cell size of Polyplanar isolation can also be readily seen in Fig. 3 where the oxide stripes are spaced 2 to 3 mils apart. The area required by this technique is limited only by the thickness of the epitaxial layer and the isolation width, which can be defined in the passivating material. A RAM cell size of about 6 mil^2 can be expected when the process conditions are optimized. Moreover, any device suitable for junction isolation—npn and pnp transistors, Schottky-clamped transistors, MOS transistors, pn and Schottky diodes—can be built by the Polyplanar process, but with greatly superior packing densities and potentially lower chip costs.

New arrival

The first application of Polyplanar is a 2,048-bit programable read-only memory. Although the HPROM-2048, with its large static memory matrix, is not the optimum device for displaying Polyplanar's potential,



4. Two bits for every one. The two programable read-only memories shown above are practically identical in chip area. The one on the left is a 1,024-bit PROM made with conventional bipolar techniques and the other is a 2,048-bit PROM made with the Polyplanar process. Like its predecessor, the Polyplanar device, which is fabricated with Nichrome fusible links for programability, comes in a 16-pin package. It is organized as 512 words of four bits each and is available with either three-state or open-collector outputs.

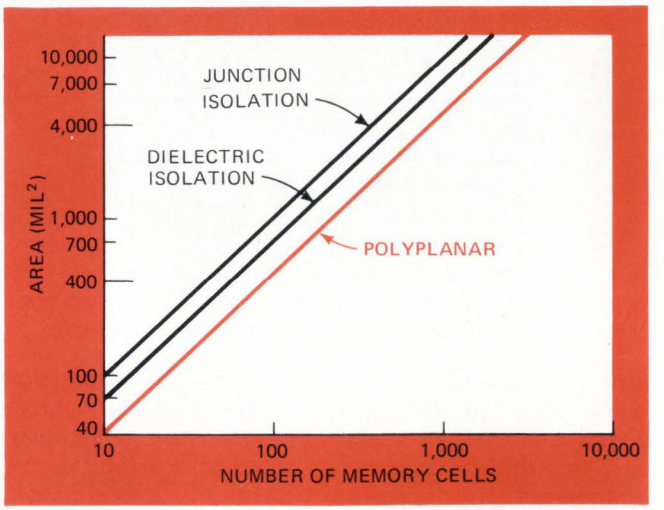
much greater packing densities and smaller chip areas were obtained with the Polyplanar process than could be obtained with conventional processing. For example, npn bipolar transistors were fabricated in an area as small as 0.50 mil², including the isolation which surrounds the device. An equivalent transistor required over 7 mil² only a few years ago.

Figure 4 compares the new 2,048-bit device with a 1,024-bit device built with conventional process techniques. Although some variation exists in the XY axes, both chips have exactly the same real estate. Similarly, the new programable ROM dissipates the same total power as the 1,024-bit device, has the same access time (50 nanoseconds typical), and is also DTL/TTL compatible.

The more dynamic an IC is, that is, the larger the number of active devices it contains, the greater its potential for saving on real estate if it is built by the Polyplanar process. The HPROM-2048, with its large static memory matrix, is therefore not the best demonstration of the process's capabilities. The natural Polyplanar application is the RAM.

While target specifications for a RAM are still unsettled, it is fully conceivable that Polyplanar will soon be producing a 1,024-bit RAM on chips of 100 mils per side, almost half that of today's production 1,024-bit bipolar devices. A comparison of memory cells available through junction isolation, diode isolation, and the Polyplanar process is given in Fig. 5. A Polyplanar 1,000-cell array could fit in an area of about 4,000 mil², compared to about 6,000 mil² with dielectric isolation and 8,000 mil² with junction isolation.

Polyplanar is equally applicable to complementary-MOS and linear devices. Development efforts are under way to couple this substrate isolation technique to an already existing diode-isolation/C-MOS logic and linear-circuit line. □



5. Denser yet. The goal of passive-isolation techniques is to put as much memory on less chip. A 1,000-cell array, if made by the Polyplanar process, will fit in an area of about 4,000 mil² as against 6,000 mil² for dielectric isolation or 8,000 mil² for junction isolation.

Closing the loop

Readers who want to learn more about Polyplanar can call Tom Sanders on April 9 or 10 between 10 a.m. and 12 noon or between 2 and 4 p.m. at (305) 727-5407.

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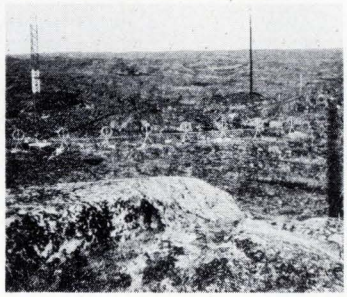

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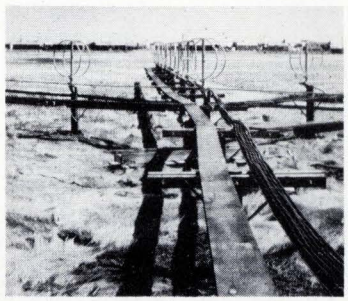

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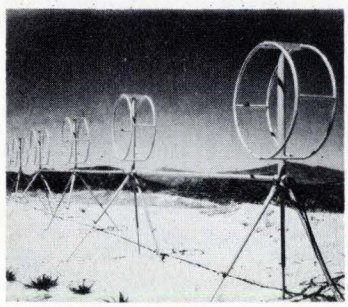

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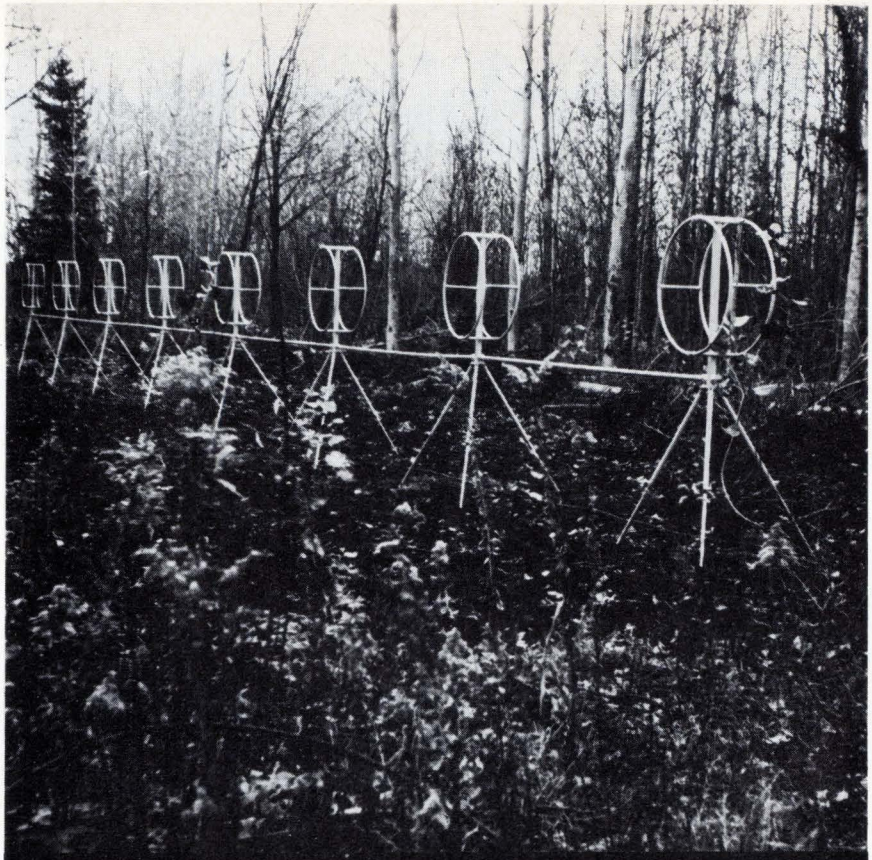

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POWER SUPPLIES

Doubling the frequency of switching regulators

by Leo Lehner
Motorola Semiconductor Products Inc., Phoenix, Ariz.

A new breed of switching power transistors is making possible smaller and lighter designs that cost less and are more efficient. In some cases, one of these transistors can replace a pair of older transistors and yet provide better efficiency. Moreover, the frequency of switching-regulator power supplies can now be raised from the audible 10-kilohertz region to the quiet 20-kHz region. The devices even can handle kilowatt loads at this higher frequency.

There are three of these triple-diffused 125-watt silicon transistors from which to choose—types 2N6306, 2N6307, and 2N6308. They have a collector current rating as high as 8 amperes and a breakdown voltage rating (BV_{CBO}) of up to 700 volts. Their switching rise time is 0.6 microsecond, and their switching fall time is 0.4 μs. Hundred-unit pricing is \$3 to \$5.

It is well known that operating on a signal at a high frequency permits the size of inductors and capacitors to be minimized. The benefits of this technique are particularly noticeable when the switching-regulator type of power supply is compared with the dissipative series-pass-regulator type of power supply.

The switched supply is significantly lighter and less bulky. It can use a small high-frequency transformer instead of the large and heavy power transformer needed to make voltage transformations at the 60-hertz line frequency. Filter chokes and filter capacitors can also be smaller. And, because its efficiency is better, not as much heat must be dissipated, allowing literally pounds of heat sink to be trimmed from a power-supply package, as illustrated by the photos (Fig. 1) of two 500-watt supplies.

An example of a power supply that operates at 20 kHz is shown in Fig. 2, both as a block diagram and as a detailed schematic. Of course, the heart of this inverter circuit is the switching power transistors—two type 2N6308 devices. Since they can switch 220-V rectified ac directly, there is no need for a bulky and power-consuming 60-hertz input power transformer. Additionally, switching losses are reduced to a minimum because of their submicrosecond switching speed.

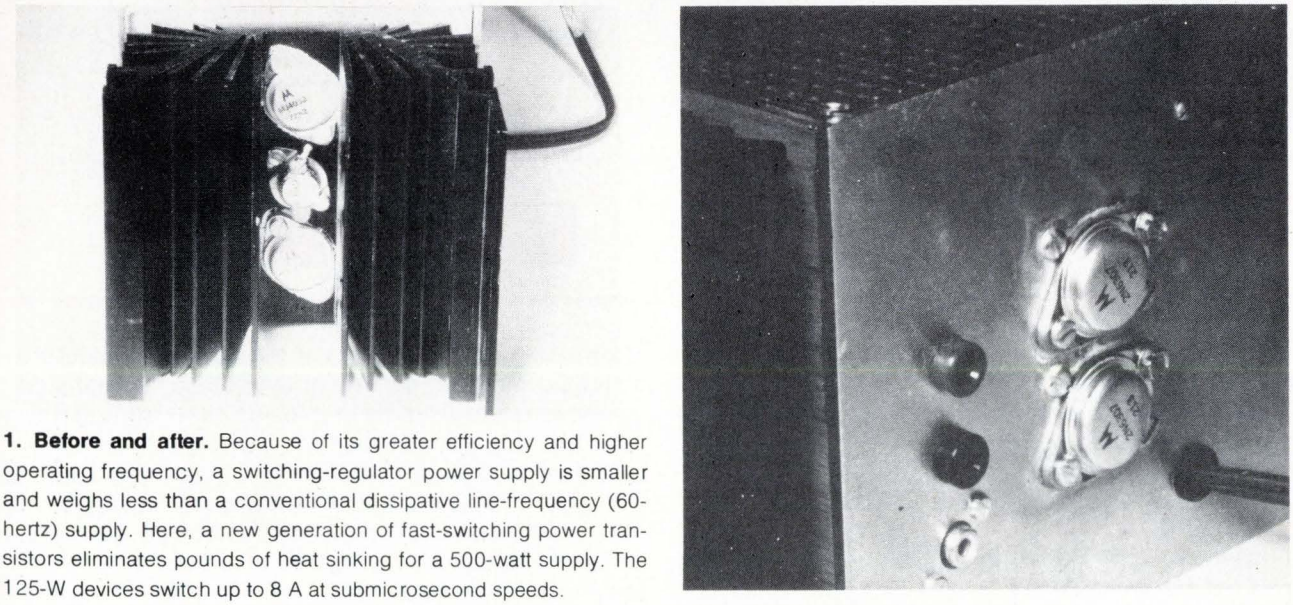
The operating frequency of the circuit is determined by the clock control circuitry, which consists of a temperature-compensated unijunction transistor and a J-K flip-flop that acts as a phase splitter. This phase splitter is driven by an RC oscillator and produces the push-pull control signal for the switching transistors.

A pair of three-input NAND gates passes the complementary square-wave control signals from the flip-flop to the Darlington drivers of the switching power transistors. These NAND gates process the complementary control signals, the pulse delay signal, and the crossover sense signal for proper firing of the inverter.

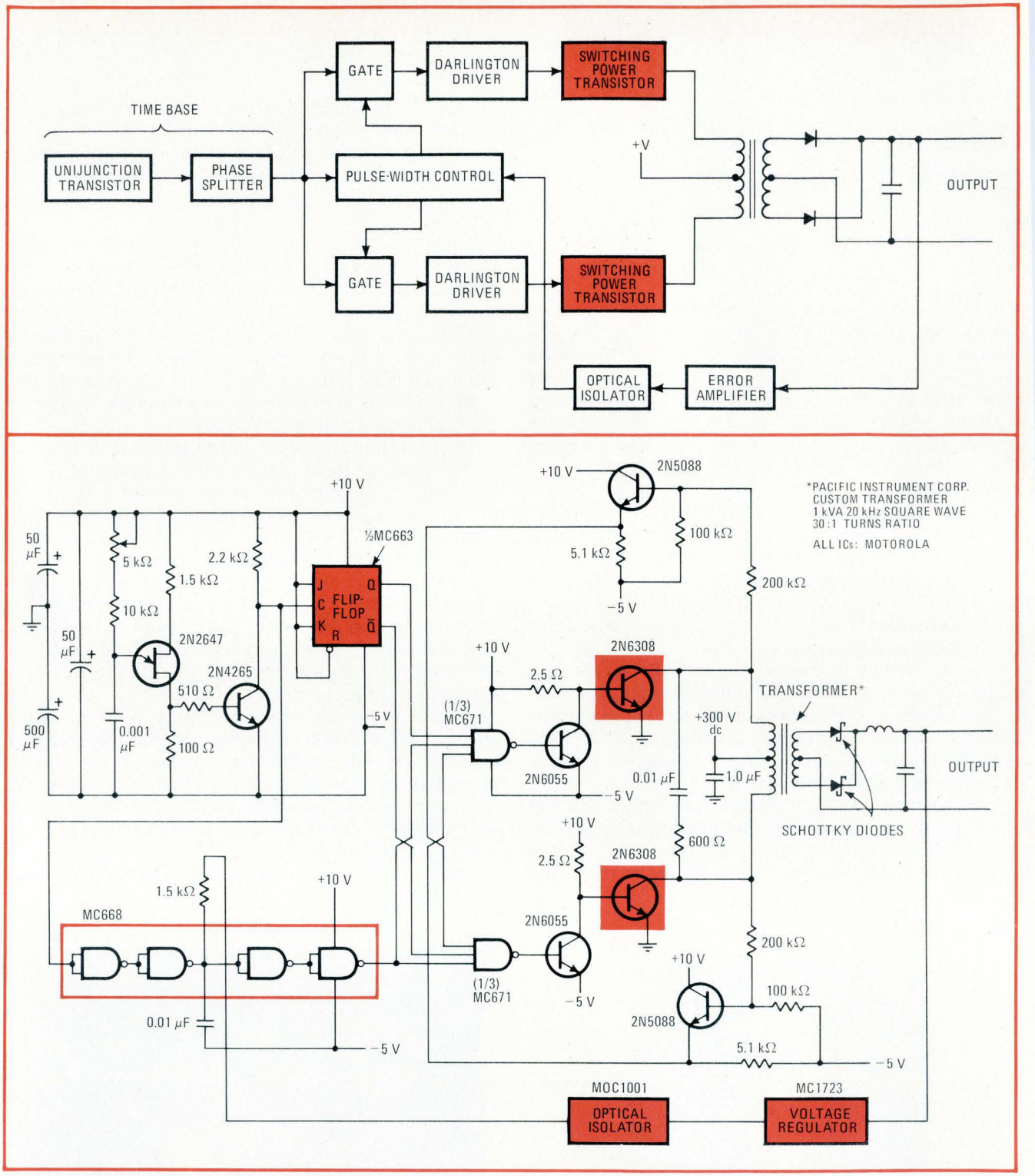
A quad two-input NAND gate package controls the on-time pulse width duration of the high-voltage switches. Variable-duty-cycle regulation is accomplished in the feedback loop by introducing the proper delay for the leading edge of the pulse delay signal, which is applied to the three-input NAND gates along with the other control signals.

Highly efficient low-voltage Schottky-barrier diodes

DISSIPATIVE SUPPLY **SWITCHED SUPPLY**



1. Before and after. Because of its greater efficiency and higher operating frequency, a switching-regulator power supply is smaller and weighs less than a conventional dissipative line-frequency (60-hertz) supply. Here, a new generation of fast-switching power transistors eliminates pounds of heat sinking for a 500-watt supply. The 125-W devices switch up to 8 A at submicrosecond speeds.



2. Switched supply. New type of switching power transistors can operate at twice the speed of older types, raising inverter switching frequency from an audible 10 kilohertz to a quiet 20 kHz. This higher frequency means better efficiency and a smaller transformer. The 20-kHz inverter shown (in both the block diagram and the schematic) makes use of an optical isolator in its feedback loop.

are used to rectify the 20-kHz signal coming from the transformer's secondary. For low-voltage (around 5 V) power-supply applications, the small forward voltage drop (approximately 0.4 V) of the Schottky diodes provides a significant increase in over-all supply efficiency, as compared to a supply employing conventional silicon rectifiers.

A feedback loop containing a voltage regulator and an optically coupled isolator supplies the regulation information needed for pulse-width control. The optical isolator, which has a phototransistor output, also provides ground isolation between the output dc voltage and the input control circuitry. □

Scope-face graticule highlights 3-dB signal points

by Donald F. DeKold
Santa Fe Community College, Gainesville, Fla.

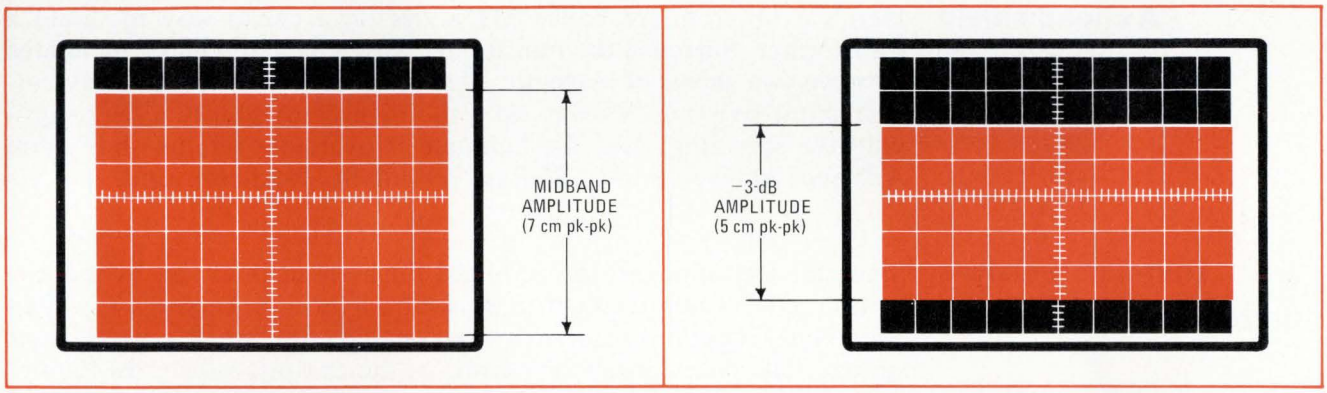
A number of standard laboratory oscilloscopes have rectangular CRT graticules measuring 8 by 10 centimeters. A little-recognized feature of the 8-by-10 graticule is the ease with which it allows rapid and fairly accurate determination of the -3-decibel levels of ac signals.

Normally, the midfrequency voltage of a signal is displayed on the scope face at some convenient level. Then, the 70.7% level of the displayed signal amplitude is computed so that the signal's -3-dB point can be known. As signal amplitude drops, its level must be constantly monitored by repeatedly positioning the displayed trace against one of the horizontal graticule lines to measure the magnitude of its amplitude.

This approach is inconvenient because it involves a calculation and requires concentrated attention on the scope display to observe when the -3-dB level is reached. However, if the midfrequency level is adjusted to span exactly 7 cm peak to peak, then the -3-dB level will be indicated by a display trace that covers 4.95 units (70.7% of 7 cm) of vertical deflection. Now, the horizontal graticule lines can be put to convenient use.

A "band of light" can be made to fill the screen (using a slow sweep rate) between the 0- and 7-cm lines, as shown, by first adjusting the signal's midfrequency amplitude to be 7 cm peak to peak and then vertically positioning the display. When the amplitude of the displayed signal approaches -3 dB, the "band of light" will just fill the space between the 1- and 6-cm lines, as shown. Actually, this 5-cm-high display implies an attenuation of -2.92 dB, or a nominal attenuation of -3 dB.

With this method, only one vertical-positioning operation is needed, no calculations are required, and the signal's -3-dB point is easy to spot. □



Measuring the midband. Graticule lines on scope face can aid in locating a signal's 3-decibel points. For 8-by-10-centimeter grid, adjust the displayed midband voltage to fill 7 cm. The signal is down by 3 dB when its display spans 5 cm, which represents 70.7% of 7 cm.

Thermally adjacent diodes balance transistor conduction

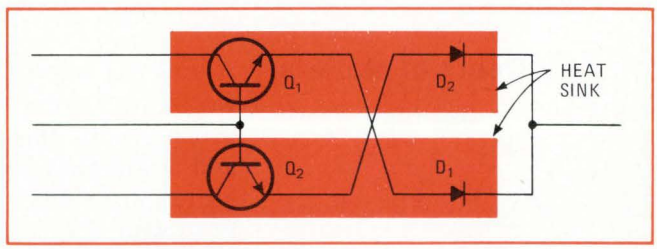
by Oliver C. Stanley
San Diego, Calif.

When a high-power load must be divided between two transistors, current conduction between the transistors must be balanced to prevent one of them from overheating due to mismatch. Generally, matched transistors, balancing resistors, or balancing circuits are used.

But the right corrective feedback can be obtained by the judicious placement of two ordinary diodes. As shown in the diagram, each transistor is mounted on its own heat sink, along with a diode that is connected to the emitter of the other transistor. This provides a balancing action because diode junction voltage drops with increasing temperature.

For example, suppose more current passes through the path of transistor Q_1 and diode D_1 than through the path of transistor Q_2 and diode D_2. The excessive heat generated by transistor Q_1 reduces the junction voltage of diode D_2, thereby turning transistor Q_2 more fully on. And the cooler heat sink of transistor Q_2 lessens diode D_1's self-heating effects. □

Engineer's notebook is a regular feature in Electronics. We invite readers to submit original design shortcuts, calculation aids, measurement and test techniques, and other ideas for saving engineering time or cost. We'll pay $50 for each item published.



Balanced conduction. Diode location prevents two load-sharing transistors from overheating. A diode and a transistor are mounted on the same heat sink, but the diode is electrically connected to the other transistor. As temperature goes up, diode voltage goes down.

Engineer's newsletter

When it comes to regulation, listen to your audio man

Designers of industrial control systems could take a hint from audio-equipment designers, who for years have used **unregulated power supplies to handle the large surges of power at an amplifier output,** instead of regulated supplies that must be called out at a system's highest power rating. Regulation is expensive at these high average powers, but unregulated supplies are cheap and well able to accommodate the surges of power needed to drive motors and activate solenoids in industrial systems.

The output semiconductors won't blow out, since they are normally designed to handle large current surges for several milliseconds without risk of damage.

A cheap shield for a transformer

Here's a tip from Ad-Vance Magnetics on a cheap way to shield a transformer. **Surround the transformer with a band of copper laminated between two sheets of magnetic alloy.** The copper forms an eddy-current shunt ring, which teams with the high-permeability alloy to provide the shielding. And the laminate is available off the shelf from AdVance Magnetics Inc., 226 East Seventh St., Rochester, Ind.

Thin-film resistors come on silicon chips

Since the thin-film resistors required for high accuracy on hybrid circuits aren't too compatible with thick-film hybrid processes, users often add their accurate resistor networks on separate, small ceramic substrates. This raises production costs, as the ceramic substrates require different handling from the silicon chips. So now several companies, including Hybrex division of Burr-Brown and Motorola, are supplying **thin-film resistors on silicon substrates, which can be bonded and handled just like the semiconductor chips.**

How to keep an even heat in voltage regulation

Want practically the ultimate in temperature stability in voltage regulation? **Take a quad transistor array,** and set aside two of the transistors for a temperature-compensated zener diode (one of the transistors acts as the zener, the other as a conventional diode). Hook the third transistor to the supply voltage and let it act as a chip heater. Connect up the fourth transistor as a regular diode for use as a chip-temperature sensor. The result: **a zener-regulated output voltage, with the chip always operating at the same temperature.** For more detail, see p. 103.

Users of plotters, displays, unite

If you use a graphic plotter and want to find out more about how it works with computers, Hewlett-Packard has just the thing—a plotter-users' group. **Join, and get a free catalog of user-contributed programs and a quarterly four-page newsletter.** If you're interested, the place to write to is: Plotter Inquiries, Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif.

And if displaying information is one of your concerns, Tektronix Inc. may also be forming a users' group to meet on a national and regional basis and exchange information and ideas. Write: Users' Group, 81-872, Tektronix Inc., P.O. Box 500, Beaverton, Ore.

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Also helping to maintain the high production levels at AMI are a series of stand-alone MD-100 MOS/LSI Memory Exercisers, some of which are used with probers for testing at the wafer level. Both Macrodata systems allow testing at the wafer level or in the final package.

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3M cartridge steps up challenge

More U.S. companies adopt ½-inch unit; but Philips cassettes enjoy boom in Europe, and Netherlands firm plans two-track head, other improvements

by Marilyn Offenheiser, Assistant Editor

When the giant Philips Gloeilampenfabrieken adapted its audio cassette for use in computer reader-recorders, it also established a standard that remained virtually unchallenged until the Minnesota Mining and Manufacturing Co.'s Data Products division, Camarillo, Calif., put a new digital cartridge into pilot production a couple of years ago. The result has been ferment among United States tape-equipment makers, and just recently a sizeable group of U.S. companies have jumped on the 3M bandwagon.

It's a different story in West Europe, where Philips reports a booming demand for its cassettes.

The U.S. companies that have moved over to the 3M cartridge include Brush Instrument Systems, Conrac, the Kennedy Co., Bell and Howell, Mohawk Data Sciences, and Omni Electronics Corp.

Making their own. Other companies such as Tri-Data Corp., Mountain View, Calif., Digitronics, Southboro, Mass., and Teletype Corp., Skokie, Ill., have developed their own cartridge systems with support hardware [*Electronics*, July 31, 1972, p. 71]. Meanwhile, Philips' mainstays in the U.S. remain Ampex Corp., Redwood City, Calif., and International Computer Products, Dallas, Texas. In Loveland, Colo., Hewlett-Packard Co. is "evaluating" the 3M cartridge, which Jack Dunn, factory support manager there, describes as "an interesting device."

Although the industry practice is to call the Philips assembly a cassette and everything else a cartridge, technically the 3M unit is a cassette, a reel-to-reel mechanism enclosed in a housing. Units such as those made by Tri-Data and Digitronics are truly cartridges. Each has an endless loop of tape with one hub in the housing and the other in the hardware.

Filling the gap. Says 3M product marketing manager Ed Crosby, "We are aiming the cartridge at applications to fill the gap between the Philips cassette and the nine-track-type IBM computer tape. We see Philips units becoming paper-tape replacements mainly."

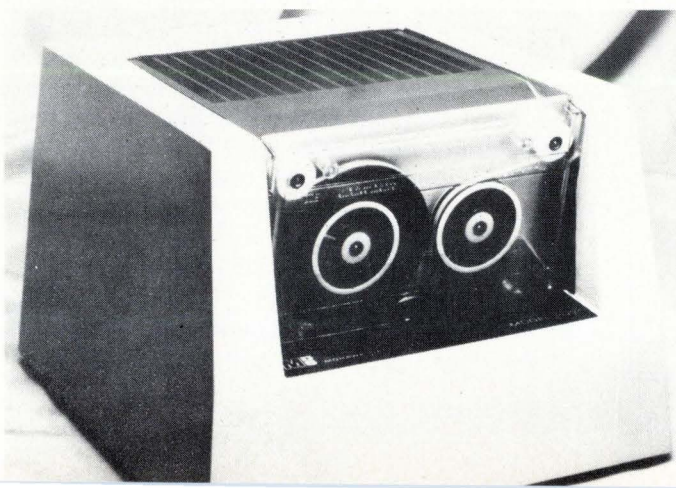
Criticism of the Philips ⅛-inch tape has been that its audio grade makes it unsuitable for computer applications. Detractors say the unit can't handle high bit densities or high tape speeds and that the tape is too thin and narrow, so that minor mishaps result in a salad of tape on the floor.

Inside job. 3M's answer is a ¼-inch tape in a cartridge driven by a large capstan and an elastic band that contacts both reels on the periphery of the cartridge. Thus, in effect, the transport is in the cassette and no external guidance, tension, or handling is needed, and no deck components penetrate the cartridge. The only drive that is needed is a constant-speed motor for the capstan. The company is also introducing its own deck, the DCD-3, which comes in two versions and costs about $350 in quantity (see p. 167).

The Conrac Co.'s Cramer division, Old Saybrook, Conn., has introduced a metal cassette, the CM-300, which is a Philips-type precision cassette. However, says product manager Ron McClure, "This cassette serves an interim need. In the long run, we believe, the 3M cartridge will better serve the longer-term need; we plan to develop and introduce a line of tape transports for the 3M cartridge."

Four tracks. Mohawk Data Sciences, King of Prussia, Pa., introduced the model 2021 recorder for the 3M cartridge last August and this month launched the 2022 model. It carries the same specifications as the 2021 but, instead of parallel record, the unit offers serial record on any combinations of the one, two, or four tracks. Price is as low as $135 in stripped-down OEM quantities, and unit price of the desk-mounted version with four tracks is about $880. Says marketing manager Jack Koelle, "When we decided to go into this business, we checked both the Philips cassette and the 3M cartridge and found the cartridge to be more reliable. In addition to a higher packing density, the 3M unit has a

Compact. Mohawk desktop tape handler uses 3M cartridge.



single-point drive, which is a great plus."

Brush Instrument Systems, Cleveland, Ohio, and Bell & Howell, Electronics and Instruments group, Pasadena, Calif., have already introduced 3M hardware. So has the Kennedy Co., Altadena, Calif., one of the first to join the 3M parade. Marketing manager Russell Bartholemew states, "The 3M cartridge won't wipe out the Philips cassette because it's not cheap enough. But it will be used where there is a need for data integrity. There will also be a big market in point-of-sale equipment, other terminals, and for applications requiring storage but not necessarily IBM compatibility."

Kennedy model 330 tape deck exhibits typical specs for 3M cartridge hardware—25 in./s read-write speed, and a data transfer rate of 40,000 bits at 1,600 cm/s recording density—and a price tag of $1,075. An OEM version costs $200.

Omni Electronics Corp., Woodside, N.Y., has recently developed two versions of a tape transport with 3M cartridges: the model 770S, a 1,600-bit/in., phase-encoded unit with a 90-in/s search rate, and the model 770L, an 800-bit/in., complementary NRZ-encoded unit with a search rate of 150 in./s bidirectional.

Philips developments. But Philips has not been standing still while all this has been going on. The company has been making a precision version of the standard cassette in which the reel hub rotates on ball bearings and the tape guides have axles molded into plastic so the tape remains on an even plane without touching the case. Paul Weber, marketing manager at Ampex, says the company has a Philips cassette now in the sample stage in which the tape runs around three sides of the cassette and all the way up the right side, wrapping on the second wheel at a constant angle. Cost is $10 for a single unit; $7.60 each for 200 to 499. "Competing units won't replace us," Weber says, "there's too much tooling built around Philips for that." Adds Thom Harleman, marketing manager for Ampex Computer Products division, "Eventually the 3M cartridge will be used for special applications and the floppy disk for large systems and small-computer programs."

Boom in Europe. Anton Weyts, head of Philips Electro-Acoustic division's professional recording department, emphasizes that there is no dissatisfaction with Philips cassettes in Europe. In fact, the market is booming. Weyts adds that the company is constantly making improvements. For example, the current DCR recorder has a three-motor drive: one for the capstan, one for each wheel hub. And, a control compensates for speed changes.

Weyt admits that there is a gap between the Philips ⅛-inch tape and the reel-to-reel tape used for big computer applications, and says that Philips rejected a proposed joint project with 3M to develop the ¼-inch cartridge in favor of filling the gap itself. Weyt states, "The 3M way is not the way to go at present because, for one thing, the cost of the cartridge is too high." Philips' next step will be a DCR with a two-track head and, further down the line, recorders with 1,600-bits/in. data density.

David Griffin, marketing manager at International Computer Products in Dallas, says his company supports the Philips approach. "We haven't seen an impact from 3M yet and don't expect this to change until 3M liberalizes its licensing," he remarks. "Eventually there will be a separate market for each product: the Philips cassette will be a paper-tape replacement, and the 3M cartridge will be used for high-performance minicomputer peripherals."

In Japan, both TDK and Matsushita are sticking with Philips, and the Japanese government's Ministry of International Trade and Industry is supporting the Philips standard by sponsoring a project to improve the Philips cassette. The improved system will use a reel drive to eliminate tape deformation. □

Reporting for this story were Arthur Erickson, Paris; Charles Cohen, Tokyo; Paul Franson, Los Angeles; and George Sideris, San Francisco.

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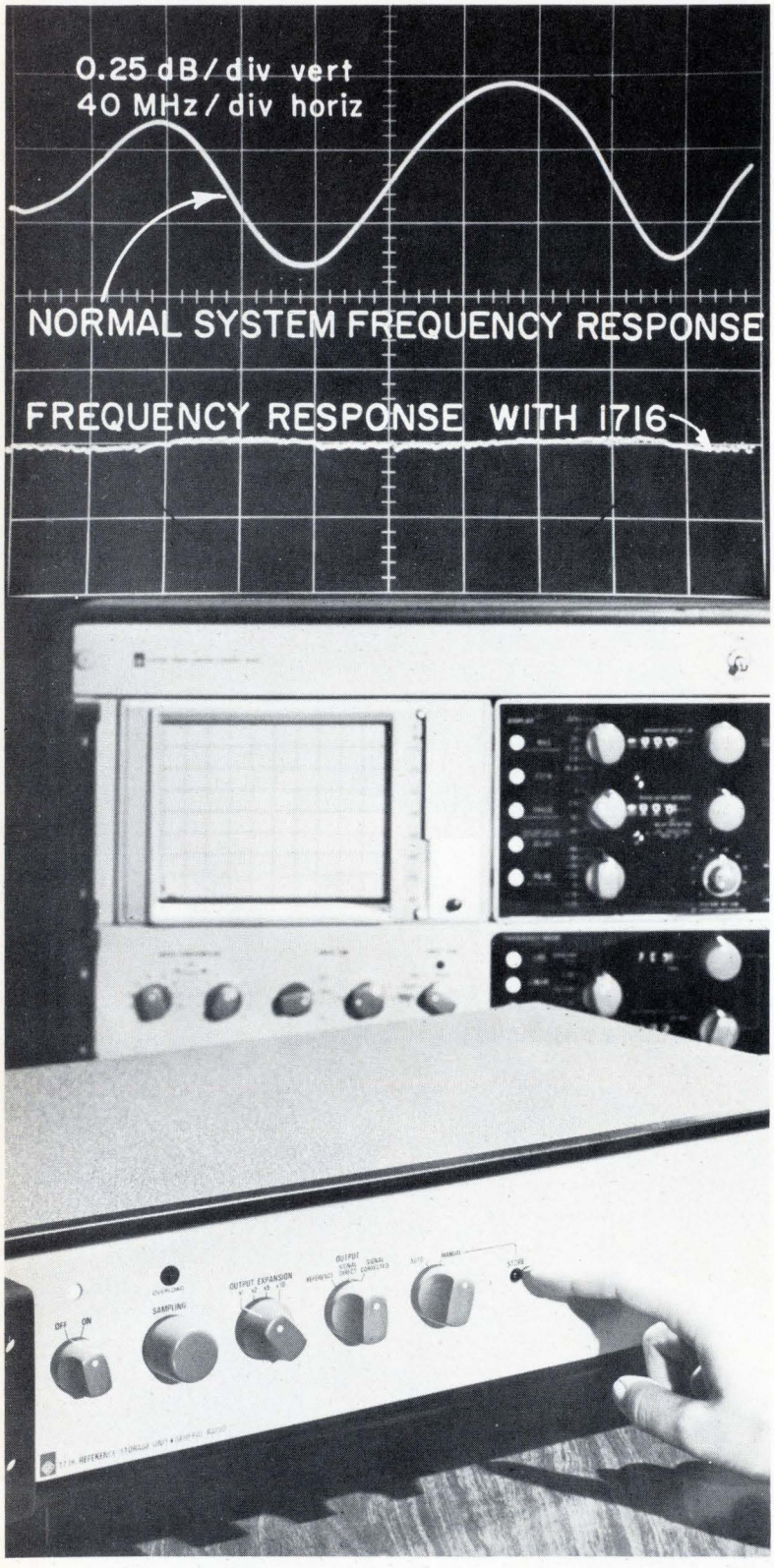

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Subassemblies

Angle converter resolves 21 bits

Aimed at rotary-encoder market, unit operates at 500 ns, gives BCD output

A converter with 21-bit resolution? Yes, the DD 107-7 from Interface Engineering is only part of an analog-to-digital converter, but it has enough resolution and speed to make many users happy.

The DD 107-6 and -7 translate binary-angle data to scaled-BCD output. "A lot of customers out there using optical shaft encoders could get 20-bit raw data off the shaft easily enough," says Thomas J. Scanlon, sales manager. "But many weren't able to make use of it without computerized conversion. That was not only costly, but it took time. The DD 107s are fast at 500 nanoseconds, and they cost less than the most inexpensive minicomputers."

Scanlon says the market is clustered in military research and some commercial applications around resolutions of 19 bits—but resolution needs keep climbing. Therefore, the firm decided to go to 21-bit resolution with the DD 107-7.

The DD 107-7 accepts 21 bits of binary data, which is converted to seven-digit, 23-line BCD, making for readouts good to 359.9995° full-scale and accurate to within 0.00035°. Its companion DD 107-6, a lesser device, accepts up to 20 bits of input binary-angle data and provides a six-digit, 22-line BCD output with an accuracy to within 0.00055°, and a full scale of 359.999°.

Buyers will be those with applications that are ultrahigh-accuracy shaft-oriented—industrial users who wish to know with high resolution the angular position of a given shaft, perhaps in nearly real time, and who would like to control this in servo fashion with a binary output device. The DD 107s act as translators between the binary and BCD "speaking" parts of the system. And while aimed at the rotary-encoder market, the units can manage conversion from binary to scaled-BCD in other applications areas.

Perhaps the largest military and research application will be in conversion of optically encoded shaft-position data to BCD for display or recording. One example might be display of azimuth and elevation positions of precision-tracking radar antennas.

Device speed is a function of a proprietary algorithm. The modules operate with standard TTL. Translation from one format to another takes only 500 nanoseconds. The speed allows the modules to be used in multiplexed applications, as well as dedicated ones.

Packed in modules 3 by 4 by 0.4 inch, the devices are available for delivery within one month. The 20-bit DD 107-6 costs $270, and the DD 107-7 with 21-bit resolution costs $300. Prices are $230 and $255, respectively, for 100-unit lots.

Interface Engineering Inc., 386 Lindelof Ave., Stoughton, Mass. [381]

Analog multiplier module gives bandwidths to 10 MHz

The developer of a FET analog multiplier module agrees that integrated-circuit multipliers satisfy run-of-the-mill requirements, but adds that his version will appeal to companies with more severe requirements. Allen Roth, president of Small Signal Laboratories, says the technique can give bandwidths to 10 megahertz and dynamic range to 80 decibels. It uses two sets of FETs in a balanced modulator arranged so that the nonlinearity in one cancels the error in the other. Monolithic FETs reduce offset drift to 3 millivolts/°C standard (1 mV optional). The company has been making the multipliers for special application and is now bringing them to the general market.

The standard model 314 multiplier, which sells for $99 in unit quantity, offers linearity within 0.3% for variable X input, and 0.6% for Y input, with optional performance to 0.15% for X. Bandwidth is 100 kilohertz, with 1 megahertz optional. Offset is ±50 millivolts, scale factor accuracy ±1%, and both short circuit and reverse voltage are provided. The multiplier operates at ±15 volts. Standard temperature range is 0 to 85°C.

Signal Laboratories Inc., 187 N. State College Blvd., Orange, Calif. 92668 [382]

Transducer amplifier can be used as signal conditioner

The model 611 transducer amplifier is suitable as a signal conditioner for high-impedance transducers, and it can also be used as a preamplifier for oscilloscopes, oscillographs, chart recorders, and voltmeters. Specifications include an input impedance of 100 kilohms, an output impedance of 1,000 ohms, a typical

broadband noise of 10 microvolts rms, and gain ranges of 1, 10, 100, and 1,000. Gain bandwidth is 10^6. Operation is ac or coupled, and the unit offers self-contained power. Price ranges from $58.50 to $68, depending on quantity.

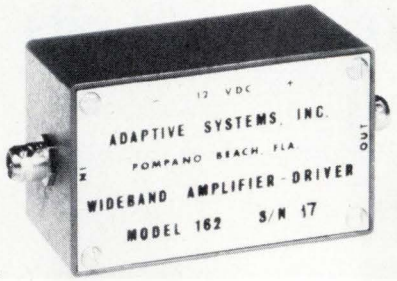
Mecca, 270 North 4th West, Hyrum, Utah [383]

Wideband amplifiers offer up to 60-dB gains

Each of two wideband amplifiers, the models 161 and 162, makes a complete optical receiver when used with a light detector, and it can drive a light-emitting diode for digital communications or multichannel amplitude modulation. Gain for the 161 is 40 dB, and for the 162 it is 60 dB. Other specifications include

New products

50-ohm input and load impedances, a size of 3.5 cubic inches, and 12-v dc operation. Bandwidth is 10 kHz

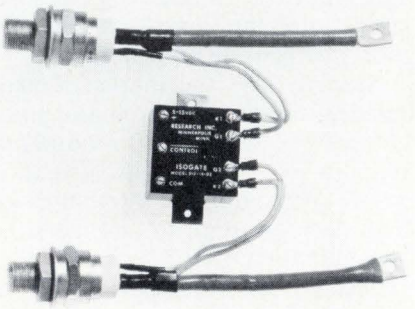


to 25 MHz. Price of the 161 is $43, and the 162, $74.

Adaptive Systems Inc., Box 1481, Pompano Beach, Fla. 33061 [385]

SCRs can be gated with logic commands

All commonly used SCRs or triacs can be gated with TTL or DTL logic commands by the Isogate, which can also operate directly from dc signal of 10 to 15 v. The unit pro-



vides dc isolation greater than 2,500 v between logic terminals and gating terminals and isolation greater than 2,500 v between the gating terminals. The gating voltage supplied by the unit rises to 90% of final value in 200 nanoseconds. Price is $32.

Research Inc., Box 24064, Minneapolis, Minn. 55424 [386]

Wide-range amplifier includes own heat sink

The model AM-101 amplifier covers a wide dynamic range, operates from 5 to 500 MHz, has 10-dB gain,

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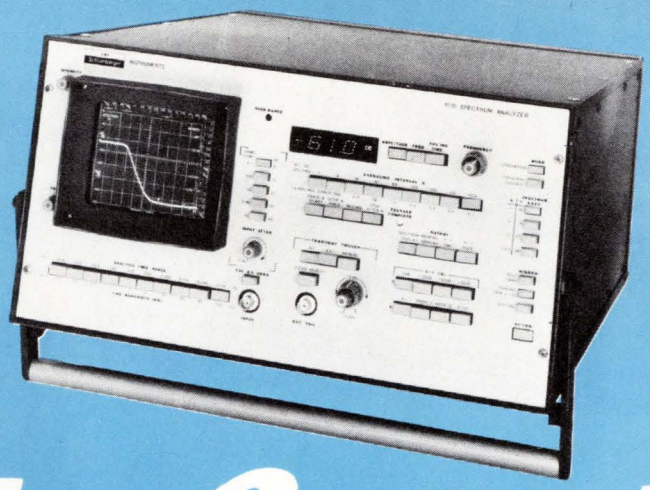

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To be "ubiquitous" or not to be... that was the question. We decided that being "everywhere at the same time" was pretty impressive, but "being possessed of universal or complete knowledge" was more to the point. We chose "Omniscient Spectrameter" as the formal name of our new EMR Model 1510 Real-Time Spectrum Analyzer. But we're not playing a name game. Compare specs and features and then compare prices. The EMR Model 1510 has the best name, the best specs, the best price, and is the best real-time Spectrum Analyzer for the money.

Why, it's practically "Omnipotent"!

Write for complete technical data. Better yet, call for a demonstration.

Significant Specification	Federal Scientific Models UA-10A & 1010	EMR Model 1510	Saicor Honeywell SAI-51A	Spectral Dynamics SD-330
Implementation	analog/digital	all digital	analog/digital	analog/digital
Frequency Range	0-50 kHz	0-25.6 kHz	0-20 kHz	0-20 kHz
No. of Lines	200	256	200	250
Dynamic Range	50 dB	60 dB	50 dB	48 dB
Frequency Response	±0.7 dB	±0.2 dB	±1 dB	±1 dB
Spectrum Accuracy	larger of: ±0.5 dB or 0.25% of fs	0.1 dB + 0.1% of fs	Larger of: ±1 dB or 0.5% of fs	Not stated in literature
LED Readout of Frequency & Amplitude	NO	YES	NO	NO
Frequency Accuracy	±0.5% fs	±0.1% fs	±0.5% fs	±0.4% fs
Spectral Averaging	YES	YES (1024 spectra)	YES (512 spectra)	YES (512 spectra)
Display Scope	NO	YES	NO	YES
PRICE	$10,750	$8,800	$11,500	$8,900

Specification information obtained from published specifications.

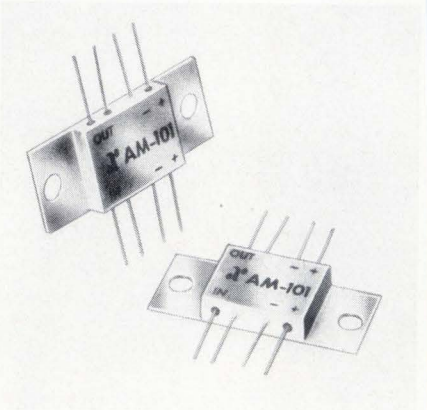
EMR
Schlumberger

EMR TELEMETRY
BOX 3041•SARASOTA, FLORIDA 33578

Circle 135 on

New products

and provides its own heat sink. It comes in a subminiature flatpack measuring 0.140 inch high and weighs 0.09 ounce. The unit provides a typical output of 100 milli-

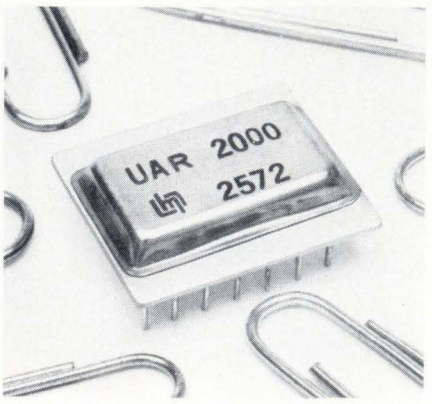


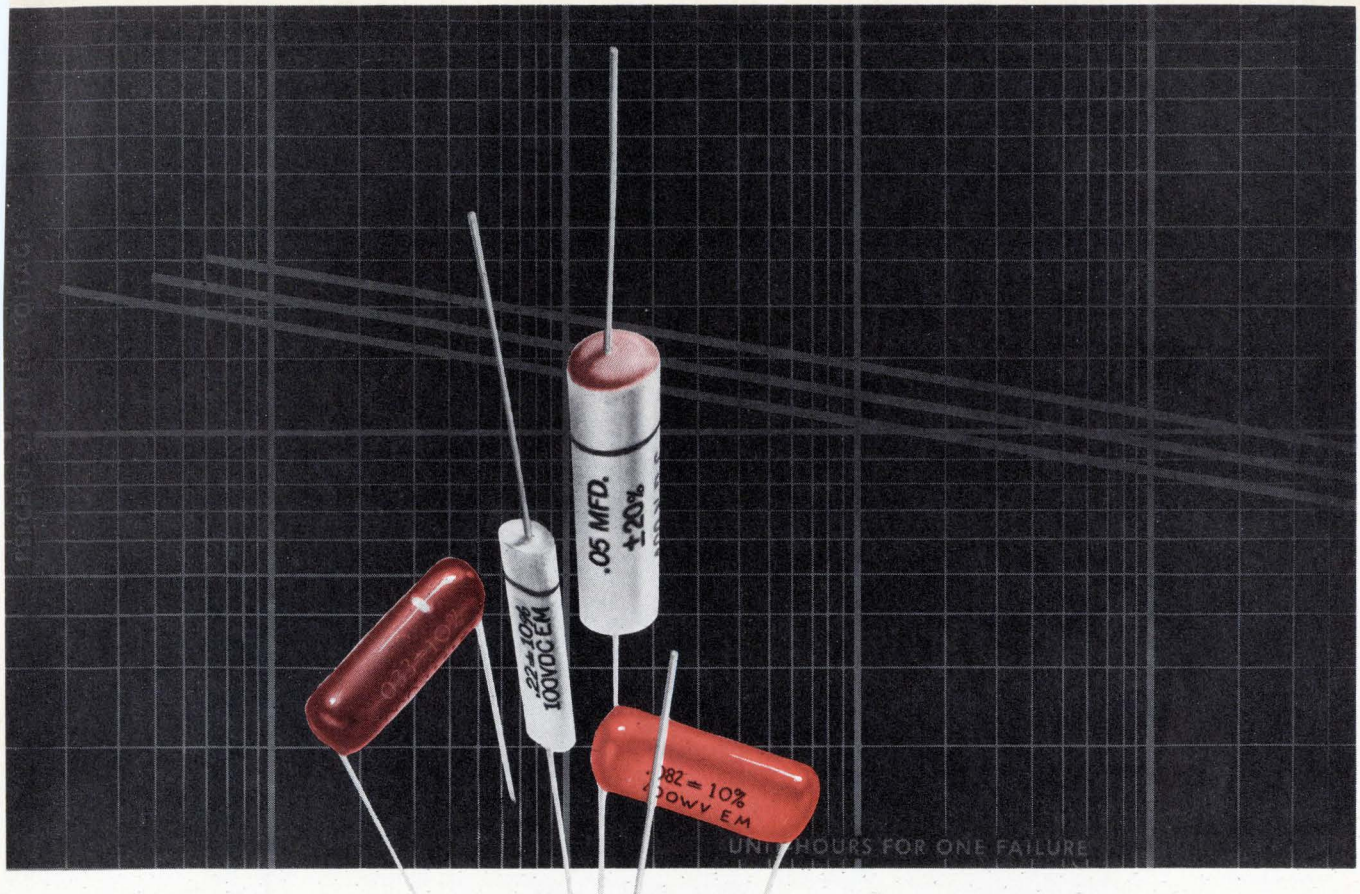
watts and power drain is typically 900 milliwatts. Typical noise figure is 4.5 dB. The device uses hybrid film techniques in conjunction with a special method of feedback stabilization. Temperature range of the amplifier is −55° to +85°C. Price for one to five pieces is $125 each.

Anzac Electronics, 39 Green St., Waltham, Mass. 02154 [384]

Universal active filter includes extra op amp

Operating from ±12- to 15-volt supplies, the model μAR2000 universal active resonator provides an output swing of ±10 V from dc to 10 kHz. Designed for oscillator timers and active filters, the unit contains a state-variable active resonator, plus a fourth uncommitted operational amplifier. When used as a filter, the center or corner frequency is set by





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A glance at some of the El-Menco rolled types, shown here actual size, tells you the space these compact capacitor packages can save. They are available in several dielectrics, in capacitance ranges from .001 to 1.0 mF, in voltage ratings from 50 to 2000 V, with axial or radial leads, and in operating temperatures as low as −55°C and as high as +125°C.

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- Mylar, dipped, epoxy, flat (Type MDEF)
- Mylar-paper, ceramic tube, epoxy end fill (Type MPCE)
- Paper, ceramic tube, epoxy end fill (Type PCE)
- Mylar, impregnated, dipped (Type MDR)
- Mylar, Mylar wrap, round (Type MWR)
- Mylar, Mylar wrap, flat (Type MWF)
- Polypropylene, dipped (Type PPD)

El-Menco

THE ELECTRO MOTIVE MFG. CO., INC.
Willimantic, Conn. 06226
West Coast: Collins and Hyde Co.
Nationwide: Arco Electronic Distributors

adding two external resistors. A third resistor determines the filter Q. Operation as an oscillator similarly requires minimal external parts. Price is $12.85 each in 100-lots.

Integrated Microsystems Inc., 16845 Hicks Rd., Los Gatos, Calif. [389]

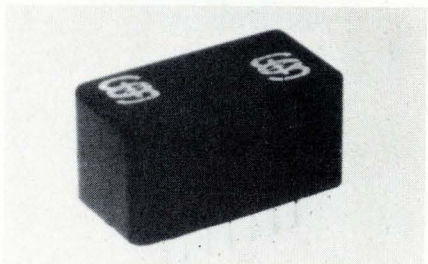
Display is aimed at clock applications

A display for clock applications, the model SP-151, features four ½-inch-high numeric digits, a colon and alpha readouts, in a.m. and p.m. It interfaces with MOS LSI clock chips and the planar gas-discharge unit can be used in all dc or multiplexed applications, with or without blanked zeros. A keep-alive cathode provides an internal ion source that reduces re-ionization time to less than 30 milliseconds. Character height is 0.50 in. with centerline spacing at 0.160 inch. The display face measures 1.593 in. by 1.120 in. Price is $1.75 per digit in 1,000-lots.

Sperry Information Displays, Box 3579, Scottsdale, Ariz. 85257 [388]

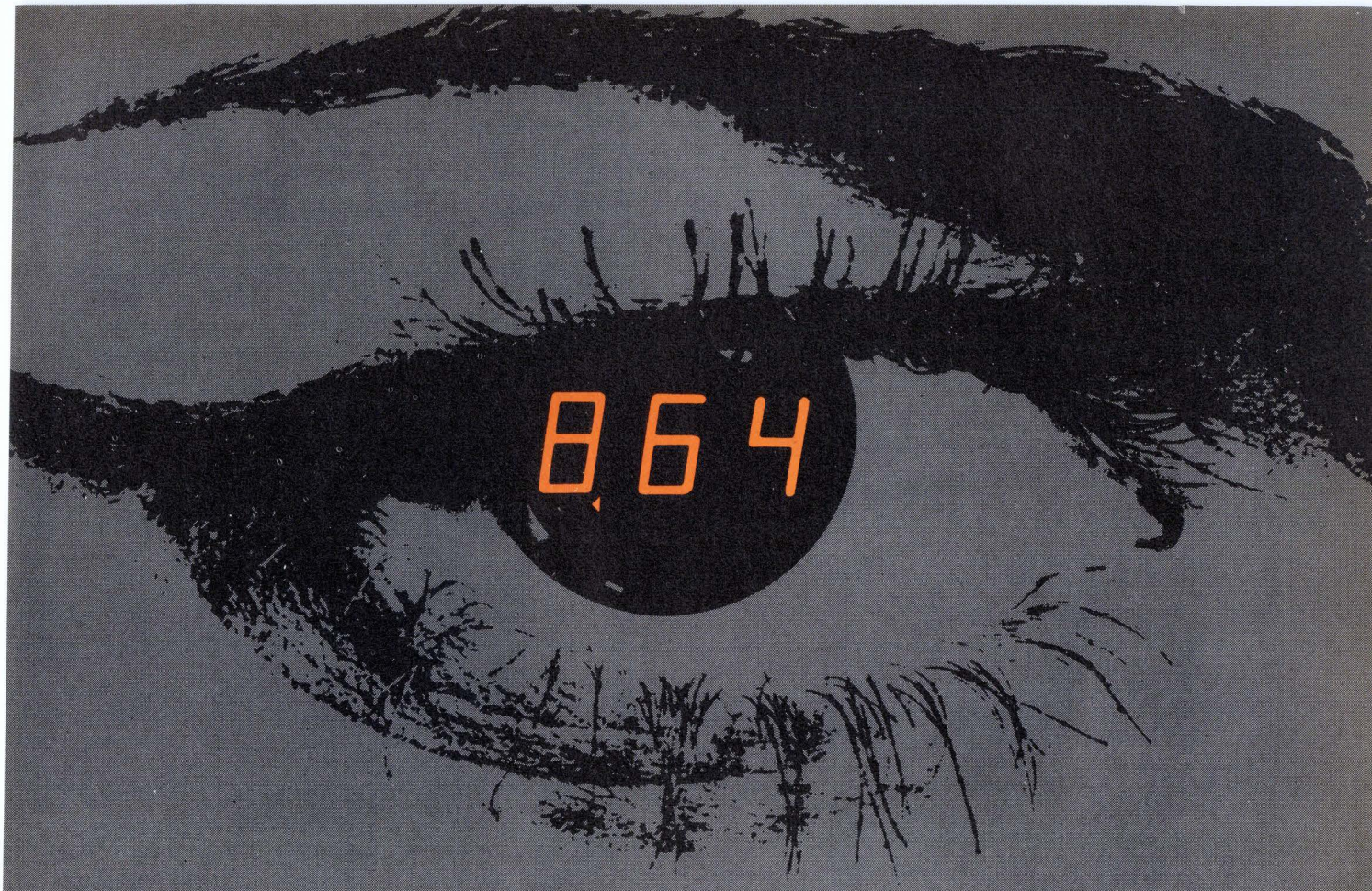
Programable oscillator provides 13 frequencies

The model PCXO-116 crystal-controlled oscillator provides 13 frequencies, which are externally programable via binary-encoded signals. Frequency-selection extends from 1 MHz down to 0.01 Hz in dec-



ades. Packaged in a dual in-line case, the unit is TTL/DTL-compatible and operates over the temperature range of from 0°C to +70°C. Price is $98 each in quantities of 100.

Solid State Electronics Corp., 15321 Rayen St., Sepulveda, Calif. 91343 [390]



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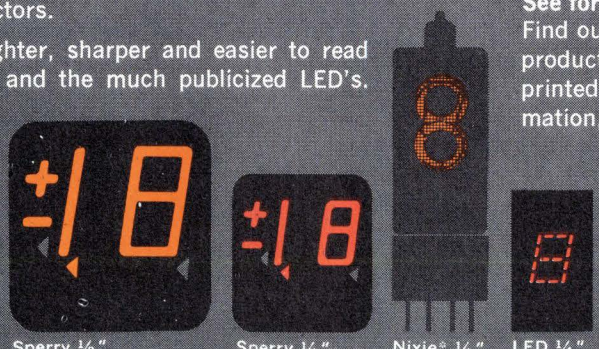

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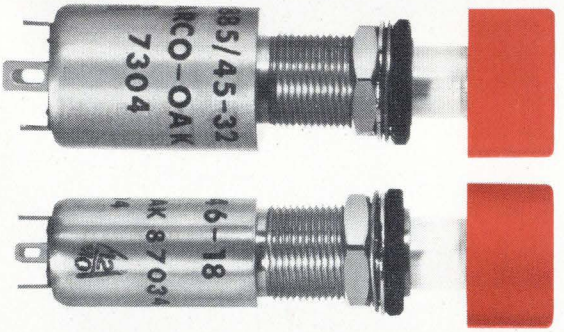

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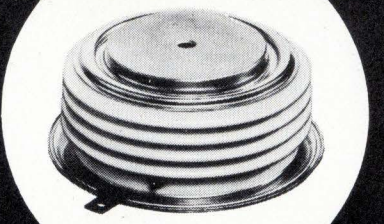

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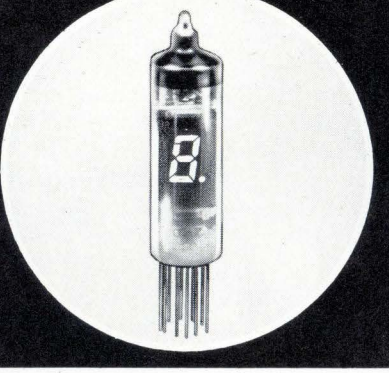

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Circle 199 on reader service card

Circle 140 on reader service card

Instruments

Meter displays to 5,000 counts

Portable digital multimeter for logic, industrial jobs has 3 digits, 500% overrange

Data Technology's new portable digital multimeter has 3 digits plus 500% overrange at a price competitive to the usual DMM with 3 digits plus 100% overrange. But since the term "3½-digit" has been pre-

empted by makers of the latter type of instrument, Data Technology calls its model 30 a "true 3.5-digit meter." It displays to 5,000 counts (4,999) instead of 2,000 (1,999), which product-marketing manager John Dunn says will satisfy about half the $10 million market for 4½-digit instruments.

His studies indicate that about half of all measurements require a first digit between 2 and 5, and to get 4-digit resolution, it has been necessary to buy a 4-digit meter. Examples of such applications are 5-v and 20-v logic, 20- and 30-v telephone, 24-v industrial supplies, 28-v aerospace and 230/440-v European line voltages.

Dunn also says the instrument is competitive in price with present 3½-digit portable DMMs at $279, with $20 extra for rechargeable batteries. But it offers a number of features besides the extra display. For one, the batteries can be added at any time simply by unscrewing two screws, and battery life is 10 to 12 hours with four C-size nickel-cadmium batteries. The instrument can be used with or without the batteries, and it can be operated while the batteries are being recharged. The meter has a battery-check position, and it automatically stops operating if the voltage drops too low, to protect the batteries and prevent incorrect readings.

The instrument has five functions (dc and ac voltage and current, and resistance), using a high-input field-effect-transistor amplifier (1 gigohm on dc voltage basic range) and dual-slope integrator. It uses the Sperry ⅓-inch display and Mostek 5002 meter circuit. Dc voltage ranges extend to 1,200 v, ac to 1,000 v, resistance to 50 megohms, and current to 2 amperes. Range switches are gold-plated wafers, rather than push buttons, often a nuisance in lightweight instruments, since the unit must be held down to change range. If the input exceeds the 4,999 count capability, the display flashes, but it continues to operate with reduced accuracy to 5,999. Common-mode rejection is a minimum of 100 decibels.

Dc and resistance response time is 400 milliseconds, with ac response 3.5 seconds. Worst-case accuracies specified for 90 days at 20°C to 30°C are to within ±0.1% of reading plus 0.06% of full scale on dc voltage. Others are slightly poorer. Calibration takes only 15 minutes.

The instrument is packaged in a high-impact plastic case, with a tilt-up bracket and handle. Only two input jacks are required, and the instrument, which is 2.5 by 6.25 by 9 inches and weighs less than 4 pounds, fits in a briefcase.

Data Technology, Inc., 2700 South Fairview Ave., Santa Ana, Calif. 92704. [351]

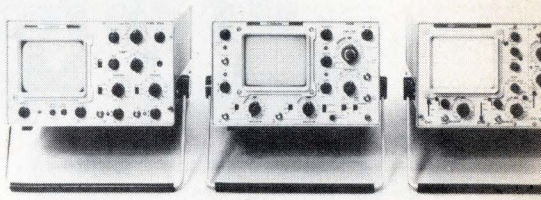
Trio of scopes stresses price/performance ratio

In an instrument for making routine measurements, good performance is relatively easy to achieve. The trick is to get it at the lowest possible price. This is the aim of Ballantine's new family of oscilloscopes, which don't set any records in bandwidth or sensitivity, but do provide the kind of performance that most oscilloscope users need, at prices that most can afford.

The model 1066B best epitomizes this high-value attitude. At $745, this scope is not only $100 cheaper than its predecessor—the 1066A—it has greater bandwidth (20 megahertz vs 15 MHz), a larger display (8 by 10 centimeters vs 6 by 10 cm), and more flexible triggering circuitry.

The 1066 B has two TV trigger coupling modes—TVF and TVL. The TVF mode optimizes frame-rate triggering on video signals, while the TVL mode optimizes line triggering. This specialized TV triggering capability will have particular appeal to broadcasters, manufacturers of video terminals, servicers of those terminals, and the cable TV industry.

The top-of-the-line scope, the model 1040A, is a 40-MHz instrument with a sensitivity of 5 millivolts/cm on each of its two identical vertical channels. Its delayed- and mixed-sweep capability makes it ideal for working with complex pulse trains like those encountered in the design and servicing of computer peripherals. Like the 1066B, the 40-MHz scope has a built-in delay line that allows viewing of the



leading edge of the triggering waveform, even at the scope's fastest sweep speed. For the 1040A, the fastest sweep speed is 200 nanoseconds/cm, expandable to 20 ns/cm with a 10× magnifier.

Sensitivity is also expandable. A simple switch can expand the vertical sensitivity to 1 mV/cm for frequencies up to 10 MHz, or the two vertical amplifiers can be cascaded for an even greater sensitivity of 50 microvolts/cm with a further reduction in bandwidth. The 1040A is priced at $1,200.

At the low-cost end of the price

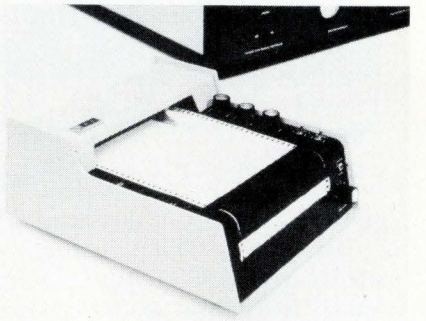
New products

range, the model 1010A is a $495 dual-channel scope with a bandwidth of 10 MHz and a sensitivity of 5 mV/cm. This unit's price, performance, and low weight (17 lb) make it suitable for many field servicing applications. It has a maximum sweep rate of 1 μs/cm, expandable to 100 ns/cm with a 10× magnifier.

Ballantine Laboratories Inc., P. O. Box 97, Boonton, N.J. 07005 [352]

Laboratory recorder has 5-inch scale

The model A-5 potentiometric type recorder with a 5-inch scale operates with a variety of laboratory instruments. Chart speeds are 0.5, 1. 2, 5, 10, and 20 cm/minute and



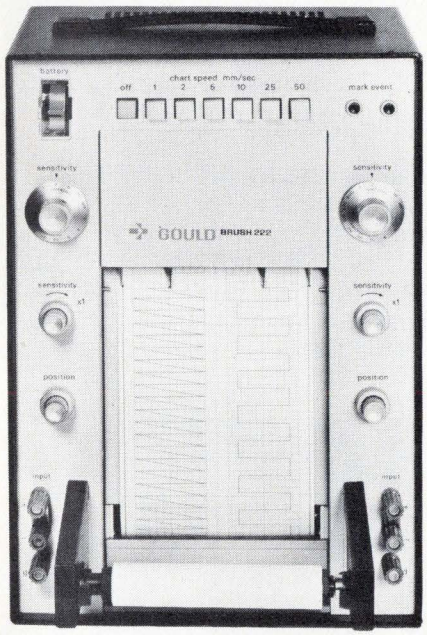
cm/hour. Full-scale ranges are 1, 10, 100 mV and 1 V. Pen-response takes 0.35 second, and accuracy is to within 0.5% of full scale. Input is single-ended, and floating and input resistances are greater than 10 megohms. Price is $595.

Varian Instrument Division, 611 Hansen Way, Palo Alto, Calif. 94303 [355]

Digital test oscillator generates 10 Hz to 10 MHz

The model 110 series of programmable digital test oscillators are designed to fill all sine-wave source re-

Why we think the Brush 222 is your best choice in a 2-channel battery-run portable recorder.



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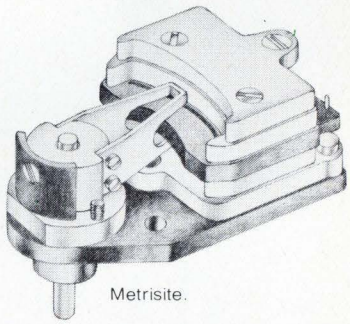
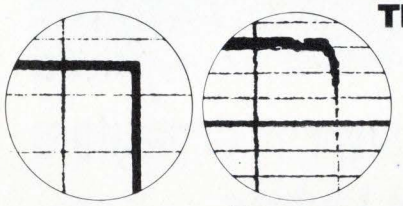

Metrisite.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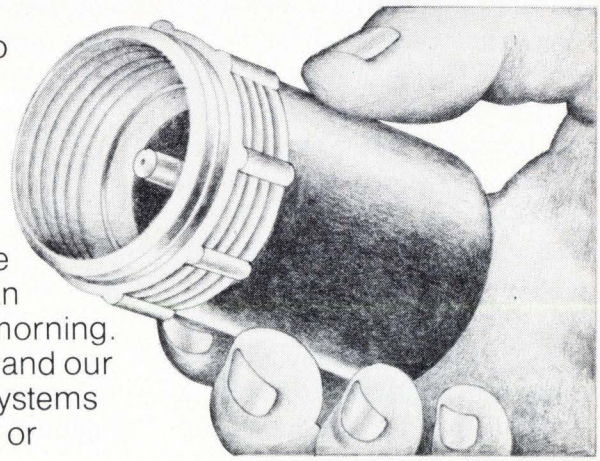
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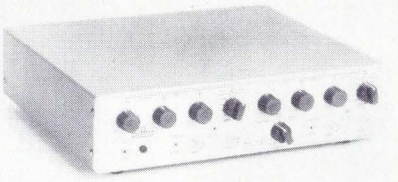
quirements from 10 hertz to 10 megahertz. The unit features digital frequency-selection and maintains constant output amplitude throughout the full frequency range. Both the 50- and 600-ohm outputs are protected against short-circuiting. As a voltage-controlled generator, the oscillator features frequency modulation and amplitude modulation, both inputs of which are dc coupled. Price of the oscillator is under $1,000.

Progress Electronics Co. of Oregon, 5160 N. Lagoon Ave., Portland, Ore. 97217 [356]

Variable active filter is accurate to within ±2%

A digitally tuned variable active filter called the AF-420L has Butterworth and time-domain responses of 24 and 48 dB/octave, and a cutoff frequency range of 0.001 Hz



to 9.99 kHz, held to ±2% error on all ranges: high-pass, band-pass, low-pass, band-reject, and by-pass functions. All functions are performed by front panel switches, eliminating the need for patch cables. Attenuation is 80 dB minimum to 1 MHz.

Multimetrics Industries, Division of Daysam Corp., 120-30 Jamaica Ave., Richmond Hill, N.Y. 11418 [358]

Instrument helps diagnose hardware, software faults

The Register Recorder, which provides a trace of the hardware and software operations of real-time systems, is used in much the same way as a flight recorder carried on an aircraft. Subsequent computer analysis of the information provided by the Register Recorder allows failures to be diagnosed. The unit can serve as a debugging tool, and it provides se-

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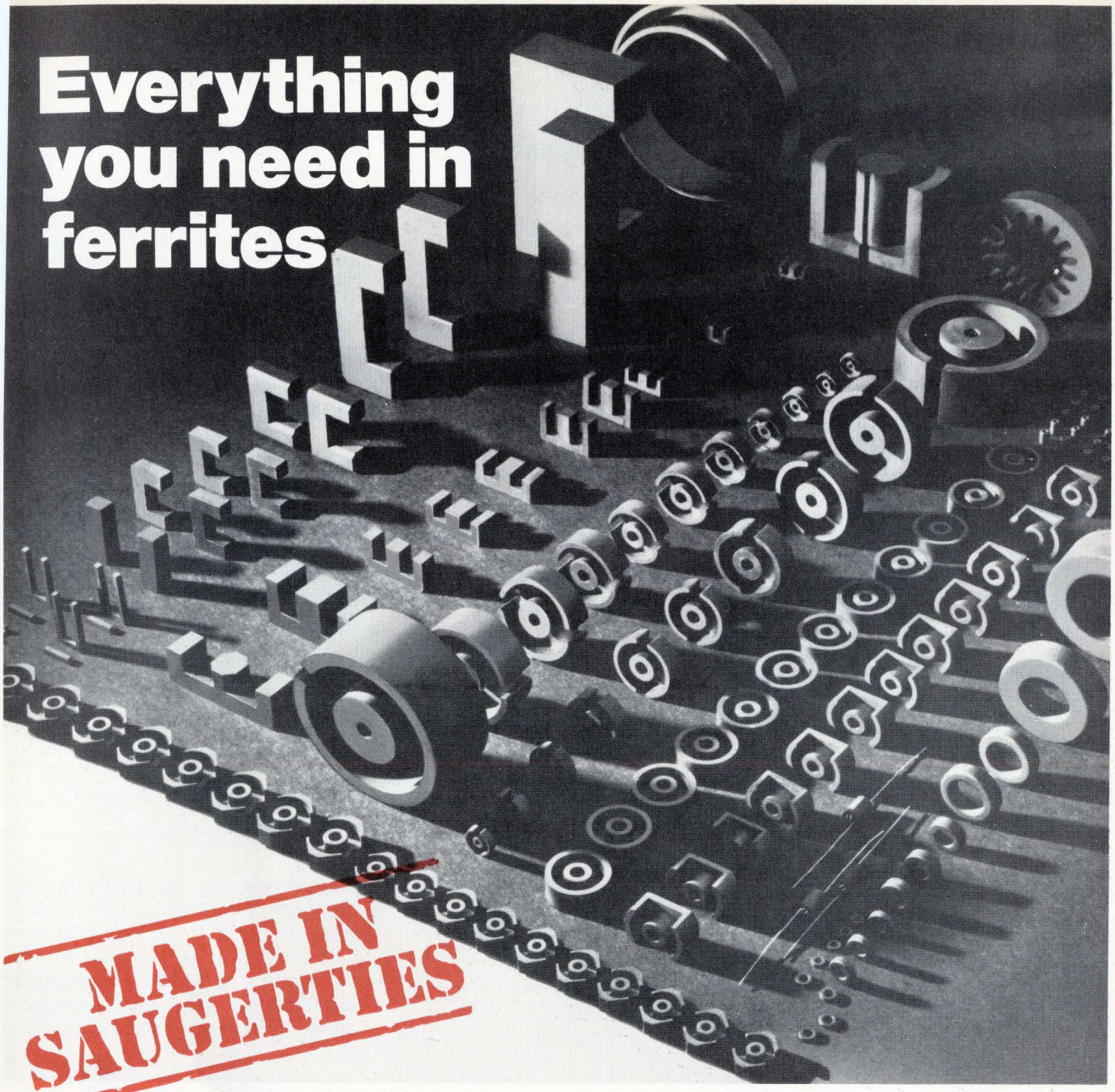

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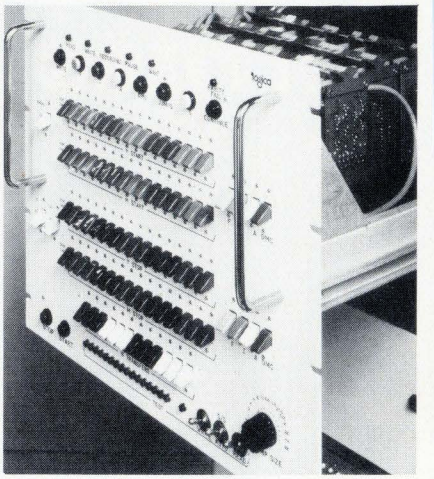
lected programs or functions to be examined by type and quantity. A modular semiconductor memory is

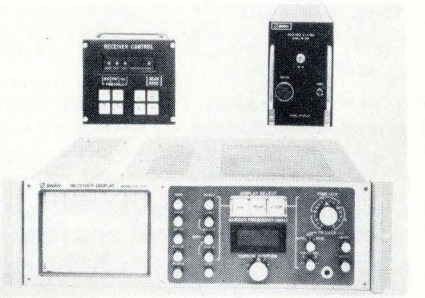


available in 512-word blocks up to a maximum of 8,192 words. Word length is variable to suit a number of different computers.

Logica Ltd., 31-36 Foley St., London W1P 7LB, England [359]

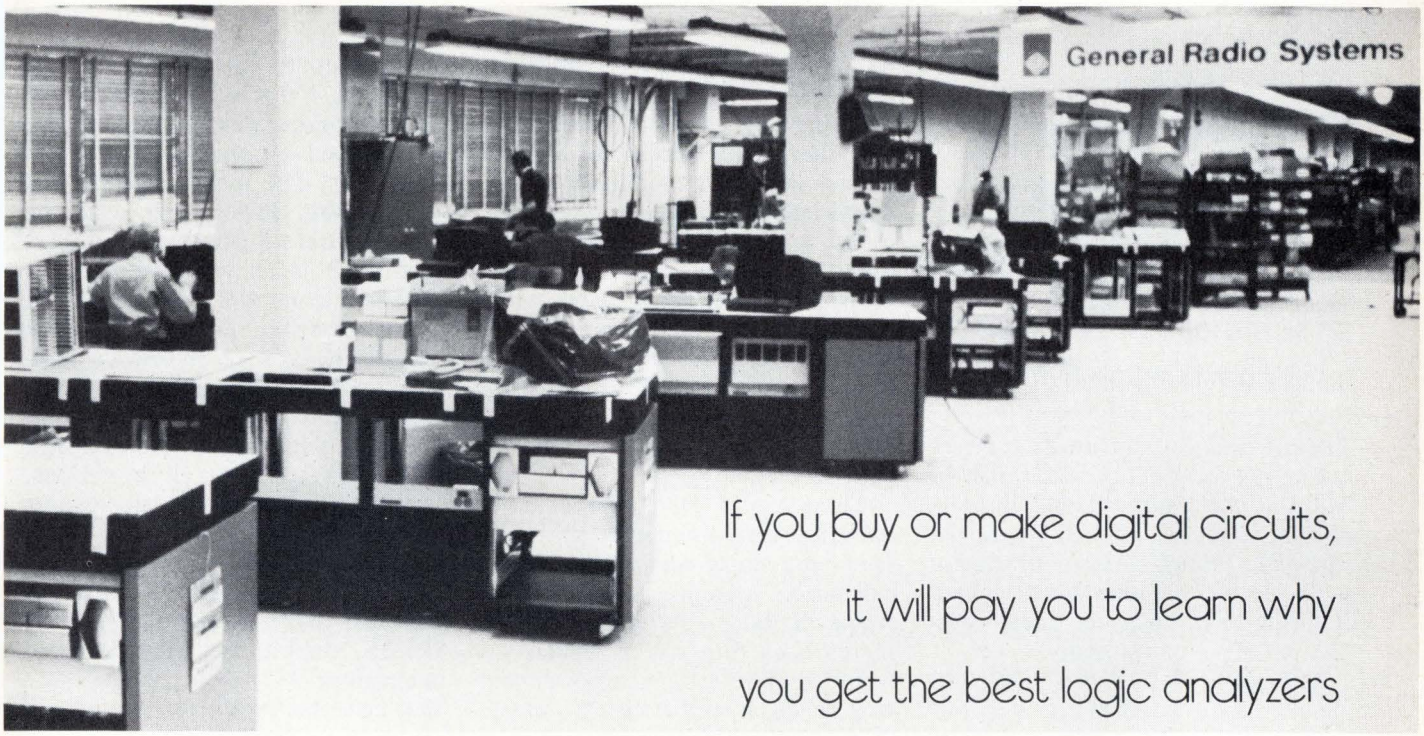
Receiving system made for broadband spectral analysis

A receiving system, designed for broadband spectral analysis of the range from 0.5 to 18 GHz is designated model 3100. The unit covers the octave bandwidths with parallel instantaneous frequency measurement and sweeping tuned radio-fre-



quency subsystem. The 3100 consists of display, receiver-control, and receiver units. It can detect simultaneous emissions, thus eliminating spurious intermediate-frequency responses. Pulsed waveforms are displayed in an amplitude vs time format.

Probe Systems Inc., 665 N. Pastoria, Sunnyvale, Calif. [360]



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Semiconductors

C-MOS array is for linear tasks

Three transistor pairs on one substrate designed as system building block

The art and craft of linear complementary circuitry, developed through the years around discrete bipolar devices, is being nudged into the integrated-circuit realm with the introduction by RCA of a building-block array of linear complementary-MOS transistors.

The new array, the CA3600E [*Electronics*, March 29, p. 26], consists of three C-MOS transistor pairs on a silicon substrate that have been characterized for linear operation. Although some linear devices are available in C-MOS, the RCA array is the first basic building block, analogous to the bipolar-transistor arrays marketed by RCA and others, to be available in the complementary technology. Until now, C-MOS has made its impact almost exclusively in digital applications.

The CA3600E array is operable in the same 3-to-15-volt supply-voltage range as its digital relatives, and RCA says that each transistor, which can conduct currents up to 10 milliamperes, is useful at frequencies up to 5 megahertz (untuned). The unit also features the characteristics common to enhancement-type MOS. These include exceptionally high input resistance—100 gigohms is typical, RCA says—and a gate-terminal current of typically 10 picoamperes. And the array has none of the burst or "popcorn" noise common to most bipolar arrays, RCA points out. Other features are the square-law characteristics of the MOS transistors, and cross-modulation performance and dynamic range better than bipolar units can provide.

The new array makes possible a host of applications, including general-purpose amplifiers with high input impedance, preamplifiers and differential amplifiers, operational amplifiers and comparators, constant-current sources, micropower amplifiers and oscillators, controllers for lamps, light-emitting diodes, relays and thyristors.

But RCA is looking even further down the road. "It will expose systems people to linear COS/MOS technology and get them familiar with it," says Richard L. Sanquini, manager of linear IC engineering. "Then when we introduce real complex subsystems, they won't be hit cold."

These could be complex large-scale integrated circuits—entire systems on a single chip, similar to the calculator systems fabricated on single digital p-MOS chips, he says. Doing such things with bipolar ICs would require too much power and chip space, as well as cost too much. A great advantage, Sanquini points out, is that RCA uses its standard digital-device process to produce its matched linear C-MOS devices.

The CA3600E is available in a 14-lead dual in-line plastic package. The price for 1 to 99 is $2.35 each, and for 100 to 999, it is $1.55.

RCA Solid State Division, Rte. 202, Somerville, N.J. 08876 [411]

Low-priced transistors housed in steel TO-3 cases

A line of low-cost commercial single-diffused power transistors, type 2N3055, is aimed at applications in rugged environments. The high-power npn silicon transistors designated K3055 meet or exceed the characteristics of similar plastic devices, are packaged in steel TO-3 cases and are comparably priced at up to 43 cents each in 1,000-lots.

Kertron Inc., 7516 Central Industrial Dr., Riviera Beach, Fla. 33404 [412]

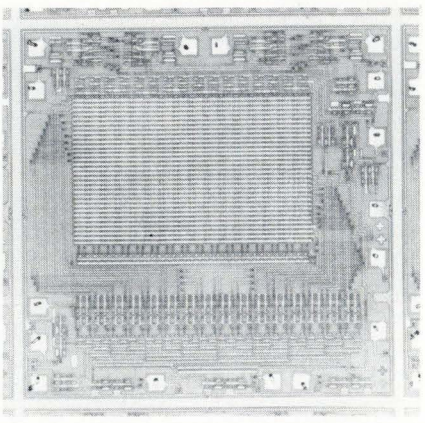
Monolithic registers have low power ratings

Three successive-approximation registers are available with low power ratings: the two eight-bit units dissipate 110 milliwatts, and the 12-bit, 150 mW. Applications for the monolithic devices include use in successive-approximation a-d converters. The model Am25L02 is an eight-bit device with serial or parallel data output, the model Am25LO3 is an eight-bit unit for expendable parallel data output and input enable, and the model Am25LO4 is a 12-bit device with both serial and parallel output and input enable. Operation is typically at 5 MHz. The eight-bit units make a comparison in nine clock periods, and the 12-bit version performs this function in 13 periods. All units have synchronous start and the capability for truncation. Price for 100-lots ranges from $7.10 to $28.35, depending on type and packaging.

Advanced Micro Devices Inc., 901 Thompson Pl., Sunnyvale, Calif. [413]

C-MOS read-only memory stores 1,024 bits

A 1,024-bit C-MOS read-only memory is the largest so far in Motorola's MCMOS standard logic family. Designated the model MC14524AL/CL, the unit is mask-programable, therefore is available as a factory-programed memory. The ROM pattern is specified by the user by punched cards or by a truth table. Organization is 256 by 4 bits, and dc operating voltage to the memory may be in the range +18 to +3.0 V dc for the A-suffixed part and +16 to +3.0 V dc for the C-suffixed part. Latches at data outputs



Raytheon Semiconductor announces two super products that just made us No.1 in voltage regulators.

No gimmicks. Just proof.

Here they are. Adjustable and fixed dual-tracking voltage regulators that are so simple to design into your system you can forget about your slide rule and calculator. They require fewer external components so they take up less space. Compared to other voltage regulators, they provide more than twice as much current. Which means you can supply a lot more systems for a lot less money in the long run. And they are the first voltage regulators to provide thermal shutdown protection for both outputs at a junction temperature of +175°C.

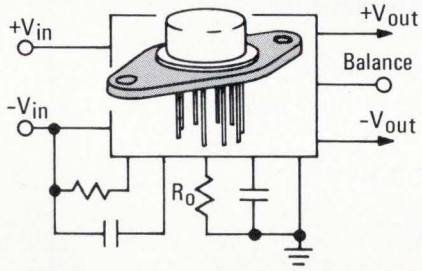
Adjustable 4194

With the 4194 you get both positive and negative outputs from 50mV to 42V — the widest range available today. All it takes is one external resistor (R_O) to ground for setting the desired output voltage. And to find out the value of R_O you just use this simple formula: $2.5 \times V_O = R_O\ (K\Omega)$.

Or if you want to program the outputs simultaneously, use one pot calibrated for 2500 ohms/volt.

Depending on the application, you'll only need from 4 to 6 external components — compared to 8 to 12 for other regulators.

The 4194 provides 200mA at both outputs simultaneously, with

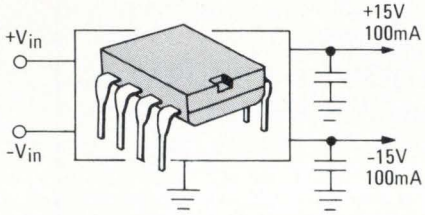


4194

0.2% load regulation over the entire voltage range. You need just one resistor to provide asymmetrical tracking voltages for the popular 710, 711, 702, 106 or the like. And with external pass transistors the 4194 can supply output currents to 10A.

Fixed 4195

Check these features against competition. The 4195 provides positive and negative 15V outputs at 100mA each. And it does it with only two bypass capacitors, compared to competition's six external components. That



4195

means you can power a lot more op amps for a lot less money.

The 4195 can be used as a single supply with an output of up to +50 volts. It comes in 3W and 900mW packages or — and this is another first — an 8-pin plastic mini-DIP!

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Mountain View
California 94040
Phone (415) 968-9211.

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- ☐ LM105/205/305
- ☐ LM109/209/309
- ☐ 723
- ☐ 4194
- ☐ 4195

NAME _____

TITLE _____

COMPANY _____

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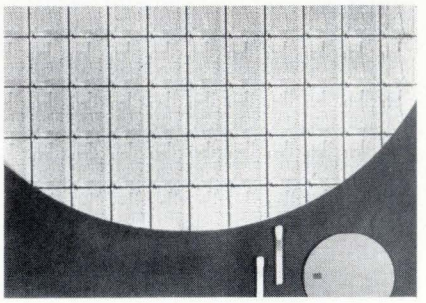
New products

are included on the memory chip as well as full address-decoding circuitry. A chip enable is provided for memory expansion. Price ranges from $13.75 to $29.95, depending on quantity and type. One-time programing mask charges are from $700 to $1,400, depending on quantity.

Motorola Inc., Semiconductor Products Division, Box 20924, Phoenix, Ariz. 85036 [414]

MOS LSI parallel processor cuts IC equipment costs

Reducing costs of IC electronic equipment is possible with an MOS LSI parallel processing system. Model-change lead time can also be reduced to weeks from a matter of months. The unit performs arithmetic and logic functions of a four-bit parallel microprocessor and is based on a one-chip MOS LSI central processing unit that is controlled by



ROM microprograming and possesses its own input/output capabilities. Predesigned compatible MOS circuits and a crystal-controlled clock generator circuit enable equipment designers to use building-block families of electronic systems for machines such as programable calculators, and terminals. Price is $500. Assembler and simulator programs are extra.

Rockwell Microelectronics Co., Box 3669, 3440 Miraloma Ave., Anaheim, Calif. [415]

Dual differential amplifier operates to 500 MHz

Designated the CA3102E, a dual high-frequency differential amplifier is aimed at low-power appli-

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Circle 200 on reader service card

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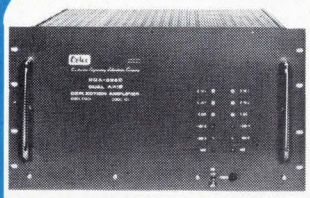

single source for all the most sophisticated precision display components you'll need for building your

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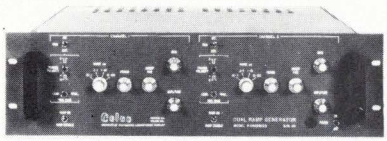

entire display system. All CELCO components are designed to perform exactly according to the requirements of your particular display, are fully compatible

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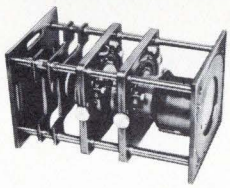
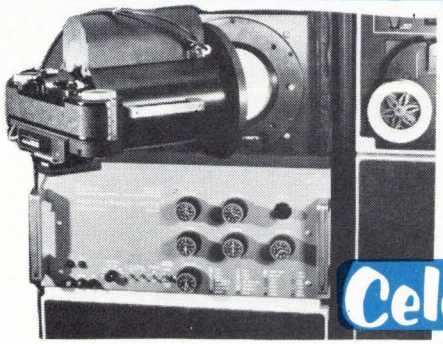


with each other, and create a harmoniously performing system.

CRT CAMERA DISPLAY SYSTEMS



Celco

CONSTANTINE ENGINEERING LABORATORIES COMPANY
UPLAND, CAL. 91786 MAHWAH, N. J. 07430

Circle 151 on reader service card

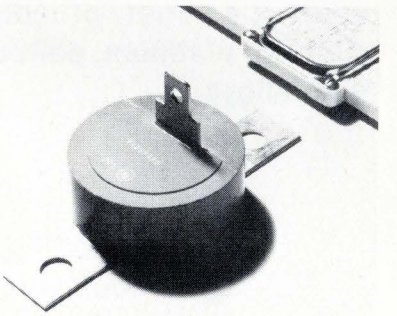
New products

cations up to 500 MHz. The device consists of two independent differential amplifiers with associated constant-current transistors on a common monolithic substrate. The six transistors that comprise the amplifiers are general-purpose devices with a gain bandwidth product above 1 GHz. Applications include vhf amplifiers, double-balanced modulators, and synchronous detectors. Price ranges from $1.80 to $2.75.

RCA Solid State Division, Box 3200, Somerville, N.J. 08876 [416]

Varistors provide up to 15-W power dissipation

Sixty-two models of the GE-MOV family of varistors called the Power-MOV series are being offered with a power dissipation of up to 15 W. They are designed for chassis mounting, and maximum energy



ratings range from 10 to 80 joules. Ten input voltage ratings are available ranging from 130 V rms, 170 V dc to 575 V rms, 780 V dc. Price in 10,000 quantities is $2.20.

General Electric Co., Semiconductor Products Dept., Syracuse, N.Y. [418]

Fast-settling FET op amp packaged in low-profile can

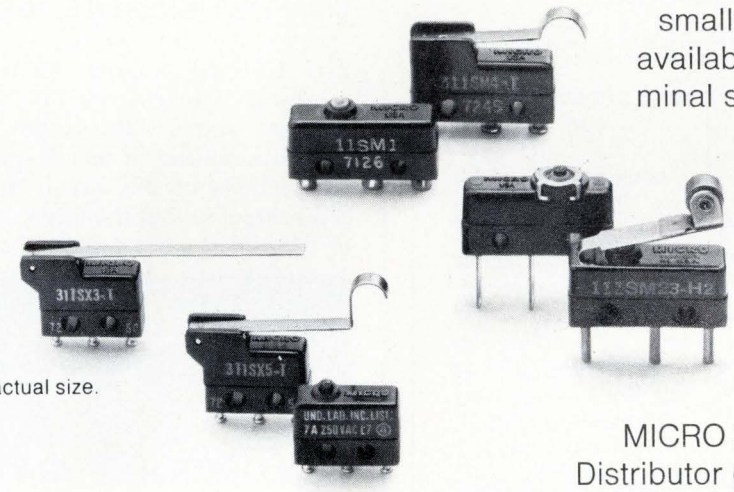
Housed in a hermetically sealed, low-profile TO-8 can, the model 1427 FET operational amplifier offers 7-megahertz bandwidth and a 900-nanosecond settling time of 0.01%. Performance features make it suitable for analog-to-digital and d-a converters, pulse height dis-

Maximum switching performance comes in two sizes: small and smaller.

MICRO SWITCH SM and 1SX subminiatures offer electrical capacity normally found only in much larger switches. The result is big switch performance in a smaller package.

Since both devices are extremely versatile, they can be used whenever space and weight are critical.

Choose from hundreds of versions, including some that meet MIL-S-8805. Our small SM (up to 11 amp capacity) and the smaller 1SX (up to 7 amp capacity) are both available with a variety of actuator and terminal styles. There's even a screw-terminal SM as well as a sealed-plunger version for wet or dirty applications. UL and CSA listings are standard. Low operating force, bifurcated gold contact and low differential travel types are available for your application.



Shown actual size.

For more information, contact your MICRO SWITCH Branch Office or Authorized Distributor (Yellow Pages, "Switches, Electric"). No request is too small for them to handle.

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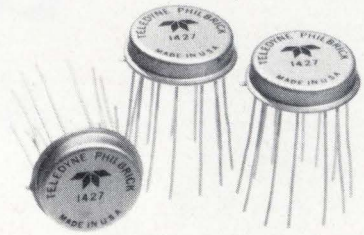
Circle 153 on reader service card

New products

criminators, high-speed peak detectors, sample-and-hold circuits, wideband buffers, fast integrators, and fast-response current-to-voltage converters. The low initial offset voltage of ±500 microvolts eliminates the need for external trimming. Offset voltage drift of the

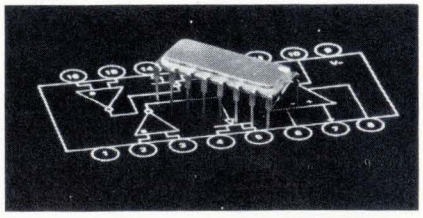


1427 is no higher than 50 μV/°C. The price is $19.50 in quantities of 100. Another model, the 142701, is specified at maximum drift of 25 μV/°C and is priced at $27 each in quantities of 100.

Teledyne Philbrick, Allied Dr. at Route 128, Dedham, Mass. 02026 [417]

'Universal' analog module combines IC and discretes

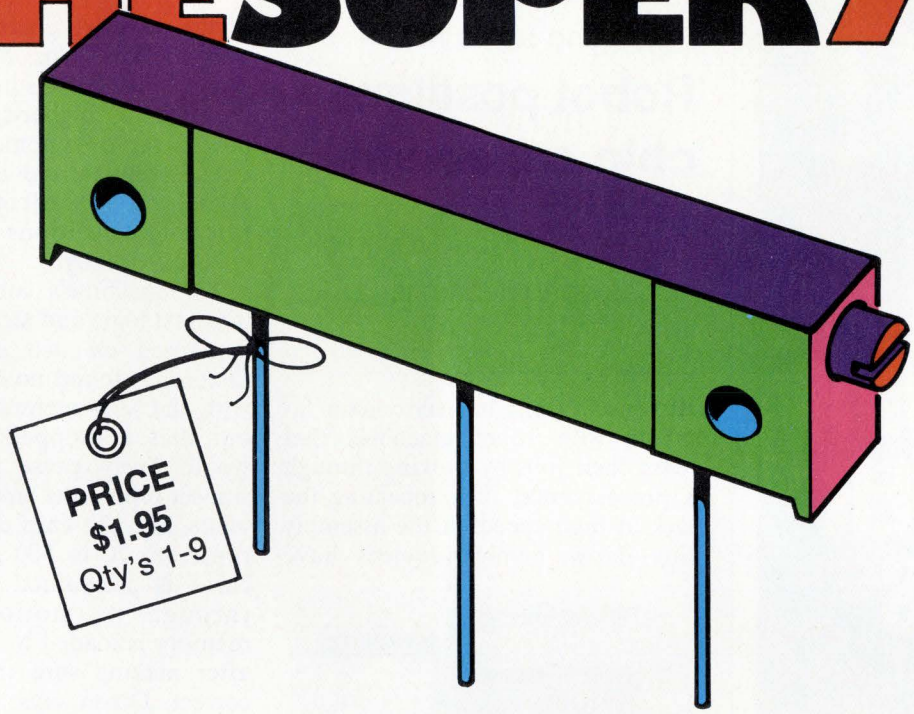
The CSH101 hybrid microcircuit combines two separate FET analog switches and an FET input operational amplifier in one 16-pin DIP. All sections of the circuit are uncommitted, so that the three sections of the circuit can be connected in a



variety of ways to meet a wide range of applications. A monolithic circuit interfaces with standard logic and drives discrete switching transistors. Typical uses are two-channel sample-and-hold, integrating sample-and-hold, and voltage-sensitive latching relay. Price ranges from $22 to $39.75 depending on version and quantity.

Teledyne Crystalonics, 147 Sherman St., Cambridge, Mass. 02140 [419]

THE SUPER 70



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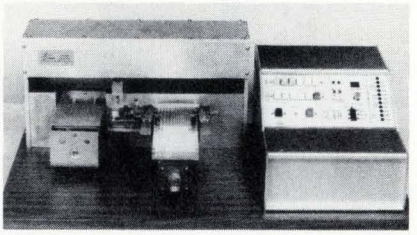
Packaging & production

Robot positions chip capacitors

Machine for hybrid assembly places up to 800 units an hour on substrates

Anyone working in electronics is familiar with robot machines that learn their jobs by walking through a process once, then repeating the task at high speed on the assembly line. Now, semiconductors have



made possible a $14,000 table-top chip-handler that does the same. The Dixon Automation chip-assembly robot automatically solder-dips and positions up to 800 ceramic-chip capacitors an hour on hybrid substrates, says president Kenneth Dixon, compared to 50 to 100 for the typical manual operator. The robot also can handle other components.

Dixon's robot places up to 15 chips in an area 4 by 4 inches, with 0.002-inch linear and 2° rotational resolution. Capacity can be expanded to 50 chips fairly easily, says Dixon. The machine also dips the ends of the chips in solder paste, which holds them in place during subsequent operations until reflow-soldering on a hot plate or infrared heater. A detachable chip-tray with a capacity of 15 rows of chips feeds them automatically.

Five variable axes are provided. Four control the position of the chuck, and one governs the in and out movement of the substrate table. A single substrate, or up to 15, can be placed on the table at once. Approximately 4½ seconds are required to position each chip. Four of the axes are controlled by stepping motors. The horizontal carriage, which travels up to 15 inches, requires a higher-speed, higher-power servo system. All position data is digital, and it is logged by digital counters. All of the axes have reference positions that can be checked visually.

The machine's controller, which uses MSI logic and MOS memories, is contained on two circuit boards. Dixon has found no noise problems with the MOS memories. He points out that a dropped or added bit would likely cause few problems, since it represents only 2 mils of distance, and the chip dimensions can run from 20 to 500 mils. The machine is programed by running it through its motions, and the memory is loaded by a push button after making sure the program is correct. Dixon says a skilled operator needs only 15 minutes to a half-hour to load a program, but programs can also be stored on tape cassettes for later use. For reliability, the storage is a frequency-shift-keyed type using audio tones on audio tape, rather than a digital-type storage. Because no mechanical adjustments are provided or necessary, any line operator can set it up, and a self-test program is included.

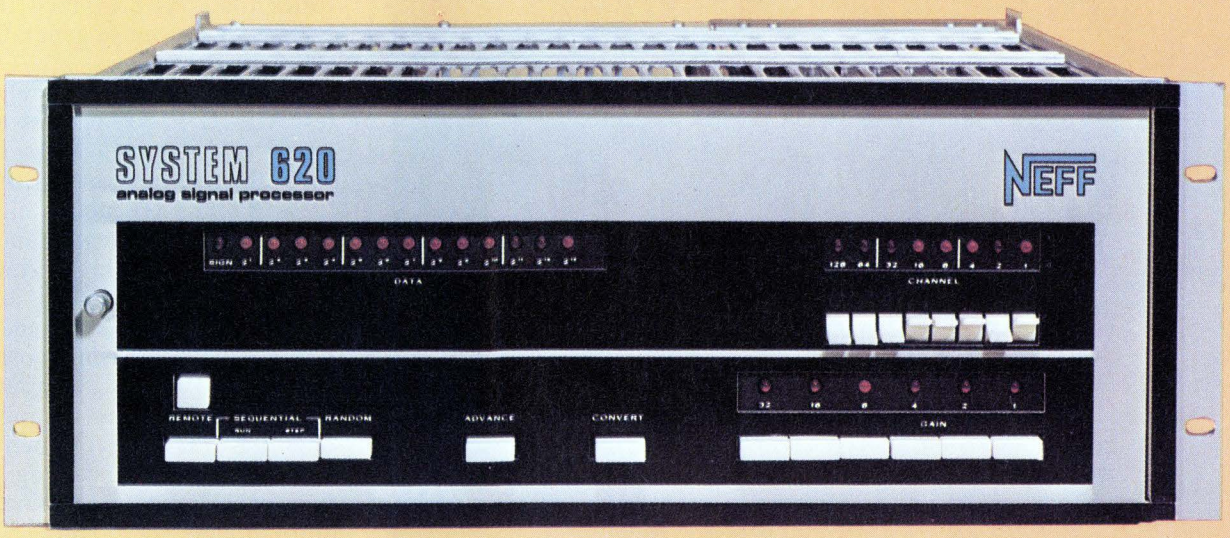
Dixon says that the machine can solve the production problem for small-to-medium-size companies. "It's tailored for relatively low volume per lot, and many different lots," in contrast to the huge systems that make millions of the same type of subassembly.

Dixon Automation, 22 Esteban Dr., Camarillo, Calif. 93010 [391]

Systems test switching of ECL, Schottky TTL

A small digital waveform analyzer is the heart of two low-cost systems that test the dynamic switching characteristics of emitter-coupled logic and Schottky TTL. Equivalent to a sampling oscilloscope integrated with digital control and readout subsystems, the analyzer was developed last year by Automatic

You supply the transducers and the computer...



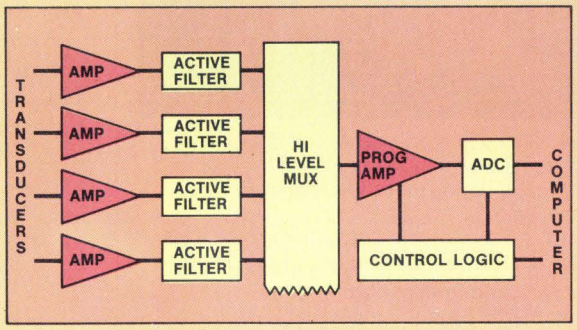
System 620 takes care of the rest

A WORD FROM OUR AMPLIFIER-PER-CHANNEL

There's one of us for each channel. We isolate transducer signals right at the source. This means lower noise, less crosstalk, higher CMR, high input impedance, and continuous analog outputs for each channel. If one of us gets zapped by a tidal wave input, the rest don't feel a thing. You can set our gain from 0.1 to 1,000 in the field with our plug-in gain modules.

OUR HIGH LEVEL MUX CHIMES IN

I'm FET & fast. I'm addressed sequentially or at random. Then I zip data to our programmable gain amplifier. It's your turn, amp.



OUR ADC SPEAKS HIS MIND

I'm responsible for the 50KHz throughput with 12 bit digital output while my slower brother can output 14 bits at 20KHz. And my sample & hold amplifier insures accuracy with dynamic signals.

OUR CONTROL LOGIC DEMANDS EQUAL TIME

Using DTL/TTL logic, I'm the one that makes it so easy to interface *your* computer with System 620.

IN UNISON !!!

Imagine, 64 amps & filters, a MUX, a programmable amp, an ADC & control logic in a 7-inch rack cabinet for less than $150/channel. And expandable to 256 *or* 2048 channels. No wonder we're multiplying like rabbits in installations everywhere.

OUR ACTIVE FILTER SPEAKS UP

Anyone in the know will tell you that the place to filter is *after* amplifying the signal. No wonder I'm so active. I limit the signal bandwidth, which reduces noise and eliminates signal components which produce aliasing errors. It's easy to set my bandwidth from 1Hz to 1KHz in the field with my little plug-in module. System 620 puts the cart (that's me) after the horse, where it belongs.

LETS HEAR FROM OUR PROGRAMMABLE AMP

I'm fast too. And my gain is also under computer control. I can increase the input sensitivity of System 620 by 1, 2, 4, 10, 20 or 40. This allows our input amplifiers to accommodate maximum signal levels, while your computer programs me for best signal to noise ratio.

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Circle 157 on reader service card

New products

Measurements Corp. The parent company, E-H Research Laboratories Inc., has combined the analyzer with fast pulse generators and test fixtures.

The results are the model 4850 to test MECL 10,000 circuits and the model 4875 to test Schottky TTL. E-H calls them Minisystems—the analyzer is only 8¾ inches high, and each of the pulse generators is little more than 5 in. high. And since each system is priced at less than $30,000, E-H says they should bridge the gap between bench-instrument testers and large, computer-controlled test systems costing about $200,000. E-H recommends the Minisystems for incoming inspection or assembly-line testing of medium volumes of circuits.

The model 4850 ECL tester is operated manually, the 4875 manually or with a tape control. In the first, the stimulant is an E-H model 120 pulse generator, which provides pulses with rise times of less than 500 picoseconds and repetition rates to 500 megahertz at ECL voltages. The TTL tester drives at rise times of less than 3 nanoseconds at up to 10 volts and at rates to 50 megahertz. Model 4875 contains two pulse generators, an E-H 135A for timing and an E-H 1501A programable generator for stimuli.

More than 30 measurements a second can be made with the model 1010 analyzer. Such functions as time range (0.2 ns to 100 milliseconds per scope division), delays, probe-selection, vertical sensitivity, and measurement modes are programed in ASCII code through a keyboard, tape reader, or computer. Among the measurement modes are time or voltage relationships in probe channels, full sweep or short sweep of the scope trace, measurement start and stop points, and reference-voltage selection.

The dual-trace cathode-ray tube displays both the waveform and eight lines of alphanumeric data. One line is the digital value of the measurement, making interpretation of the waveform unnecessary in production testing. The other seven show the program codes.

Two probes are provided with the

This minicomputer memory dropped 2 bits in 7 days... and failed.

Our final performance test is rugged, and sometimes it takes guts to stick to it. But we have found through experience that it is required to be sure that you get a working disc memory that will keep working.

The test is simple: The disc is run continuously for 7 days; each day during the test repetitive write, read, and check operations are performed to verify error free performance. If more than one bit is dropped, the unit goes back for rework—it's pass or fail with no compromises.

Every minicomputer disc memory we ship is factory certified to have successfully passed this final test; the memory you put into your system has been through it.

And we have a memory just right for your system—memories with capacities ranging from 32k to 4200k words for Data General, for DEC, for HP, for Varian, and for most other minicomputers.

To find out more about the disc memories with tested reliability, call your Data Disc representative or contact us at 686 West Maude Avenue, Sunnyvale, California 94086; 408/732-7330.

DATA DISC

Circle 159 on reader service card

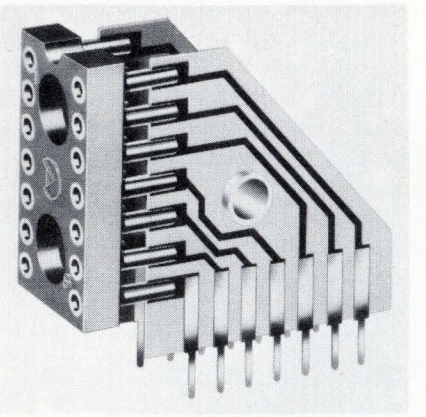
New products

basic system. An optional multiplexer allows up to 100 probes—enough for five two-probe test stations—to share the analyzer.

E-H Research Laboratories, 515 Eleventh St., Box 1289, Oakland, Calif. 94604 [392]

LED numeric socket accepts 14-, 16-pin packages

A vertical-mount LED numeric display socket accepts 14- and 16-pin packages with flat leads or leads 0.016 inch to 0.021 in. in diameter. The sockets consist of two-piece machined-contact assembly with inner contact and outer sleeve. They are designed for mounting components

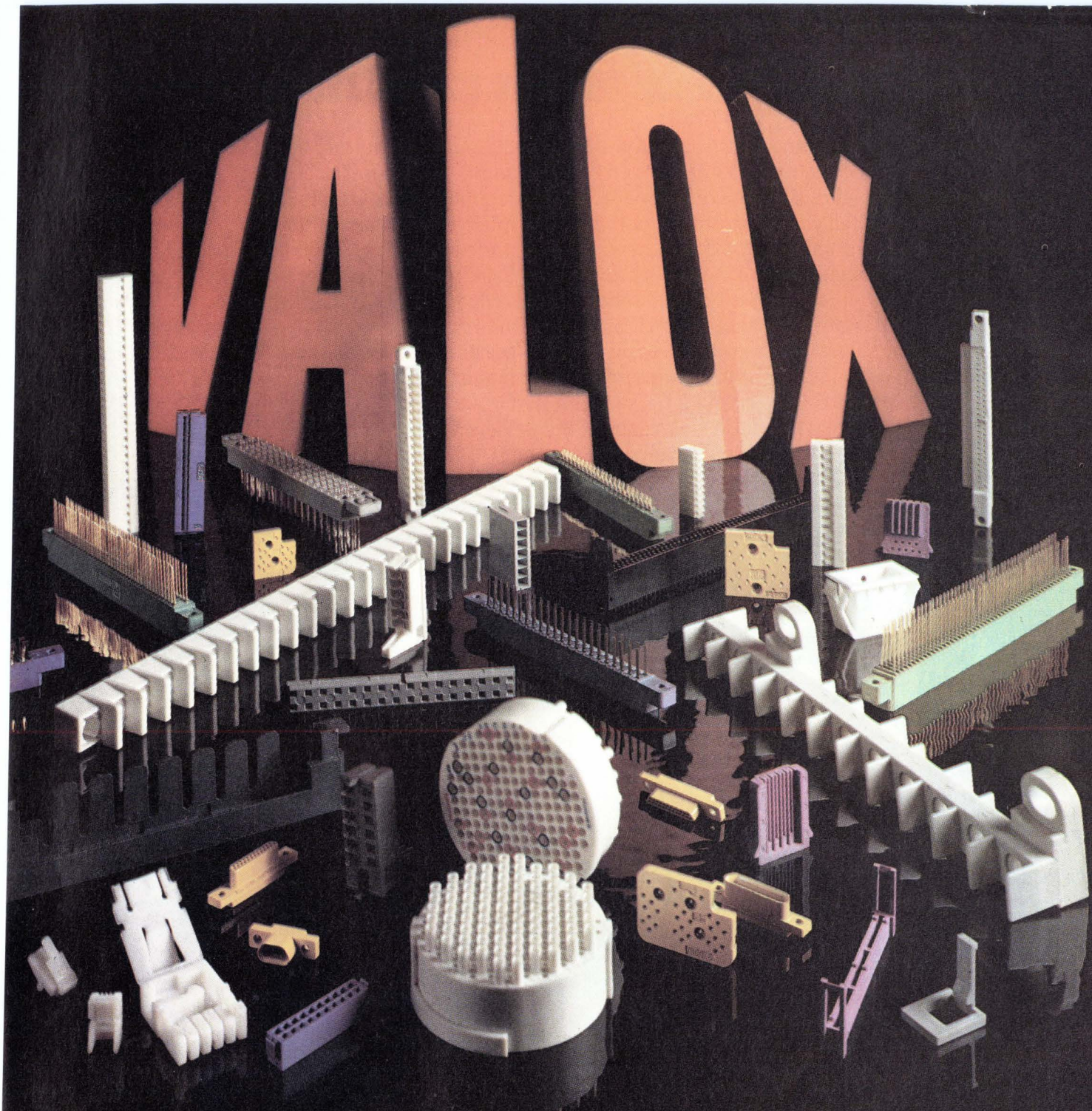


on 45°, 60°, and 90° angles, and the units may be gang-mounted on centers 0.400-in. or greater on printed-circuit boards or chassis. Price ranges from $1.50 to $3 per socket, depending on style and quantity. Delivery is from stock.

Augat Inc., 33 Perry Ave., Attleboro, Mass. 02703 [395]

Connectors offer selection of contact terminations

A series of metal-to-printed-circuit connectors offers a selection of contact terminating techniques and polarity. Keying is built-in to the connector bodies to prevent mismating. Recessed pockets accept standard hardware for perpendicular or parallel mounting on printed-circuit boards. Low insertion forces result from a decreased spring rate and in-



WHEN WE SAID VALOX® FLAMES OUT IN ZERO SECONDS, A FEW PEOPLE MADE THE CONNECTION.

THERMOPLASTIC POLYESTER

Introduced only recently, VALOX thermoplastic polyester is already turning up in electrical connectors for everything from appliances and cars to oil drilling and tv sets.

Why? Because in tough UL flammability tests, VALOX resin flames out in zero seconds flat. So it surpasses UL SE-O and Group I self-extinguishing standards.

What's more, unlike nylon, VALOX resin offers better dimensional stability, much lower water absorption and better high-temperature electrical properties.

Unlike phenolic, it has better electricals and overall toughness.

And unlike DAP, it provides greater impact resistance and higher dielectric strength at lower finished-part cost.

VALOX resin has the rigidity and dimensional stability to prevent warpage, changing tolerances and loss of critical contacts. Plus heat resistance to over 400°F, built-in lubricity and unsurpassed chemical resistance. And it usually molds easier and injection cycles faster than any other engineering plastic.

For full details on VALOX thermoplastic polyester, The Connector Material, write Section 176, Plastics Dept., General Electric Co., One Plastics Ave., Pittsfield, Mass. 01201

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GENERAL ELECTRIC

Circle 161 on reader service card

Push-button promises.

Atmosphere. That intangible social, professional or creative influence that you have been a part of since you started your working career. We don't have to tell you how important the right working atmosphere is. Nor do we have to tell you how often it's maligned in recruitment propaganda through gross exaggeration. It's an important part of packaged promises designed to get you onto the payroll. We at Fairchild don't discount the importance of atmosphere. But, at the same time, we aren't going to make any false claims about the Fairchild atmosphere. Collectively, we are a multi-division company comprised of thousands of highly-skilled professionals. But, individually, we are people. And as people we react differently to different situations. Challenge to some may be frustration to others. Some need regimentation. Others won't tolerate it. Some must lead, others cannot. Some companies can't understand this. Fairchild can. That's the Fairchild atmosphere. A place for the highly-skilled. But still a place for people. If you're interested, we would like to talk to you. Call or send us your resume. Employment Opportunities, Fairchild Semiconductor Components Group, Dept. 25, 465 National Avenue, Mountain View, California 94040. (415) 962-3401.

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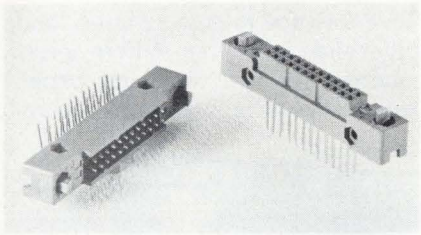
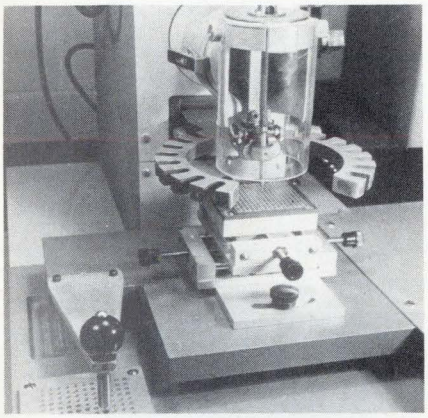


creased deflection capability. Series 8223 connectors are available in four sizes: 24, 48, 72, and 96 contacts.

Elco Corp., Willow Grove, Pa. 19090 [397]

Step, repeat table increases thick-film production rates

For manufacturers of small thick-film circuits or components that can be printed and fired in multiples on



a single substrate, a resistor-trimmer modification that is attached to the thick-film-trimming system can increase production rates. By eliminating the loading process, the step-and-repeat table can multiply production rates up to two and four times on snap substrates or ladder networks.

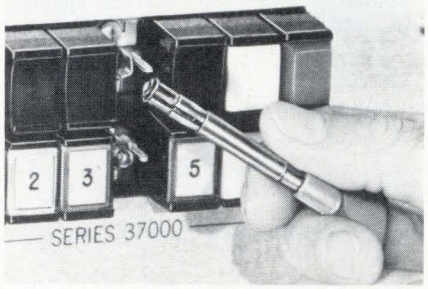
S.S. White Industrial Products, 155 Old Brunswick Rd., Piscataway, N.J. 08854 [398]

Special tool removes subminiature lamps

For removal of subminiature lamps in switches, pilot lights and other components using T-1¾ units, a tool called P-2460 features three operations: slip tool over lamp, slide

New products

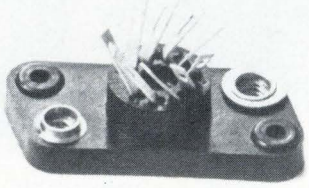
sleeve forward to engage lamp, and pull or slide lamp free. Where access is gained through the front panel, the tool is especially designed for re-

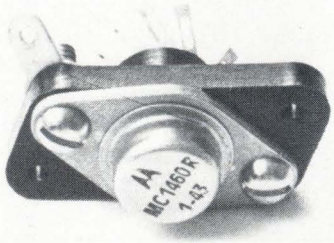


moving lamps from push-button and multiple-station switches and other components. Price is $1.50.
Switchcraft Inc., 5555 N. Elston Ave., Chicago, Ill. 60630 [399]

Socket accepts devices in 9-lead TO-66 case

The model A1369 socket accepts devices in the nine-lead TO-66 case, and enables devices to be mounted on, or removed from, heat sinks and





chassis without soldering leads. The device is plugged into the socket and secured with two screws that also connect the transistor case to the solder lug. Price in small quantities is $2, and for 250 pieces, it is 80 cents.
Jermyn, 712 Montgomery St. San Francisco, Calif. 94111 [400]

A new concept in packaged power circuits as convenient as the TV dinner.

The International Rectifier PACE/pak™ is the device behind this new concept.

They are power integrated circuits, made up of SCRs, diodes, triacs, etc. which give you a complete control circuit function in a single package. And like the TV dinner, they take most of the shopping and assembly times out of the job.

But that's just the beginning of the benefits they offer.

Smaller size. PACE/paks (Passivated Assembled Circuit Elements) are electrically isolated up to 2.5 kV. There's no need for a separate isolated heatsink, so you get up to 60% reduction in space requirements.

A better designed system. With the smaller size of these power hybrid control circuits you get more design and packaging flexibility. And since you don't have to spend time designing with discrete components, you have more time to make other improvements.

One-fifth the assembly time. No more do you have to assemble five to seven devices for single and 3-phase functions. With the PACE/pak there is just one part to mount, one part to interconnect with push-on or screw terminals. Your system reliability is higher, too.

Just think of the other savings you can make in testing, inspection and field servicing.

Lower inventory costs. We estimate a 7-to-1 reduction in inventory, plus savings in procurement time and costs. Standard PACE/pak circuits now cover 90% of single-phase power circuit requirements, with more in development for 3-phase applications.

They are available as standards with 25 or 42.5 Amp current ratings, in either 120 or 230 Volt RMS versions.

Find out how PACE/paks will revolutionize your designs like dc motor controls, inverters, chopper drives, generator exciters, solid-state circuit breakers, battery chargers and variable dc power supplies.

Call your local IR sales office for details or contact the factory: *International Rectifier • 233 Kansas Street, El Segundo, CA 90245 • (213) 678-6281 • TELEX: 67-4666.*

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Circle 165 on reader service card

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The 8 bit Model 4028 and the 10 bit Model 4029 feature an exceptional combination feedthrough (—60 db at 10kHz, guaranteed) and settling time (typically 3 μsec to ½ LSB). The external reference signal may vary in amplitude from +10V to —10V at frequencies up to 140kHz, and may be any waveform such as a square wave, ramp, etc.

Ask your local Philbrick representative for the details. Or write, Teledyne Philbrick, Allied Drive at Route 128, Dedham, Massachusetts 02026. For toll-free ready data, dial (800) 225-7883. In Massachusetts (617) 329-1600.

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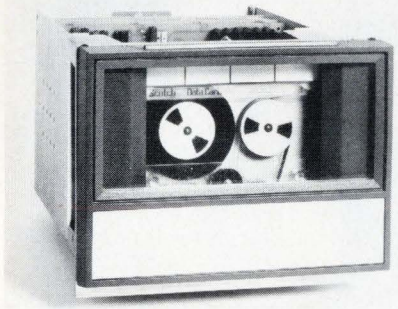
Data handling

Tape drive is simple

3M system using cartridge is aimed at OEMs, including small-computer market

The company that developed the ¼-inch digital tape cartridge now attracting the attention of the EDP business, Minnesota Mining & Manufacturing Co. [see p. 129] is also producing a tape drive. The



new DCD-3 drive, though offering performance much like ½-inch drives, is priced more like a cassette drive, says Ed Crosby, product marketing manager for the 3M Data Products division. The unit is priced at about $350 in OEM quantities, including heads, deck, and motor-speed control. He says the low price is possible because the cartridge permits a simple drive, requiring only a single motor. All tape tensioning and guiding is in the cartridge.

Crosby says that, in application, the drive fits between the ½-inch and cassette drives. In fact, he claims that his competition will be more likely to come from makers of traditional reel-to-reel ½-inch drives than from cassette makers. Users will include those in such classic computer applications as small systems, rather than in such low-cost areas as paper-tape replacements.

The 3M deck uses phase-encoded bit-serial recording at 1,600 bits per inch, proposed as standard to ANSI and ECMA. One, two, or four tracks can be used, and a tape recorded on one can be played on others. Record and playback speed is 30 inches per second with 15 in./s an option. The drive is bidirectional, with rewind/fast-forward speed 90 in./s, and the transfer rate is 48,000 bits per second. A dc tachometer circuit provides accurate speed control, and Crosby says that, while most tachometer circuits control only final speed, the DCD-3 also has controlled acceleration and deceleration ramps, so that it precisely controls inter-record gaps.

Two versions of the deck are made. One has a front door that opens for drop-in loading of the cartridge, and the other is lever-locked for mounting with the cartridge on top. The basic unit includes the servo control, end- and beginning-of-tape sensors, file-protect switch, and cartridge-loaded switch. The drive can be expanded by adding a prewired card cage, read/write amplifier card, encode-decode card, and direction-control card. These options can be supplied either by 3M or by the OEM. All levels are TTL-compatible. Power required is +5 volts at 0.9 ampere and ±18 V at 1.4 A, with 3.6 A surge for acceleration and deceleration.

The door load unit is 7 in. high, 8¾ in. wide, and 12 in. deep. The level-load unit is 6½ in. high by 8 in. wide by 8 in. deep. Weight is less than 11 pounds.

Data Products Division, Minnesota Mining & Manufacturing Co., 300 S. Lewis Rd., Camarillo, Calif. 93010 [361]

Computer offers 40,960 characters of main memory

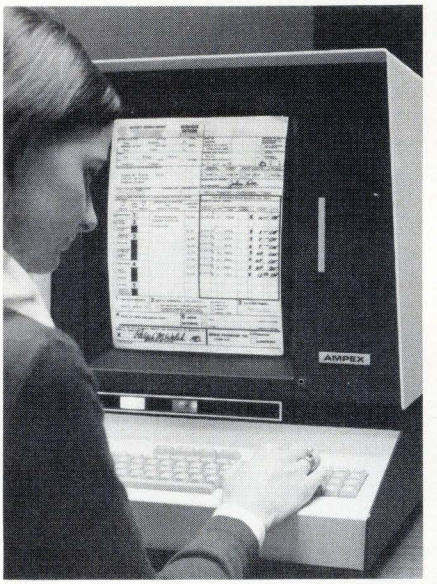
An addition to the series 2000 computer line is the model 2030A, which is a purchase-only unit at the low end of the Honeywell 2000 family. The computer offers 40,960 characters of main memory and multiprograming under the OS/2000 operating system, in addition to on-site modular capabilities. For users who wish to increase capacity of the system, the Datanet 2000 front-end network processor is

available. Purchase price ranges from $101,3000 for a basic central processor with a cycle time of 2.0 μs to $230,480 for a central processor with 196,608 characters. The basic model 2030A system with 40,960 characters, typewriter-like console, disk-drive subsystem to store and retrieve 18.4 million additional characters of information, card reader-punch, and 650 line-per-minute printer is priced at $209,110. The 2030A is the third purchase-only computer in the 2000 family.

Honeywell Inc. 200 Smith St., Waltham, Mass. 02154 [364]

Terminal accesses computer data or document images

A dual-purpose terminal accesses either computer data or document images from the same keyboard for display on the same cathode-ray-tube screen, eliminating the use of two different retrieval terminals. The new terminal can display the information a page at a time. Users may retrieve, display, enter, edit,



and obtain hard copies in this mode. The terminal is available in Videofile systems that combine videotape/disk recording and computer technology for automated television filing and handling of documents. Recorded and stored documents are immediately available as TV pictures, printed copies, or both.

Ampex Corp., 401 Broadway, Redwood City, Calif. 94063 [363]

Fast Fourier transform processor has own memory

A stand-alone unit operating asynchronously to external computers, the model 1040 fast Fourier transform processor contains its own memory and arithmetic processor unit. It is also designed to perform forward and reverse Fourier transforms and co-ordinate conversions on data arrays stored in memory. The algorithm for performing the

A flexcircuit for electronic pocket camera control.

We did it for Kodak.

The Kodak Pocket Instamatic, one of the major marketing successes of the decade.

Many of the pocket Instamatic® cameras, Model 50 and 60 pack the Schjeldahl flexcircuit you see above. One circuit containing two integrated circuits, all other electronics and flexed into 12 planes. That's using flexcircuitry as it should be used.

But there's more to the Schjeldahl circuit than that. It is only 8 mils thick yet it's fully insulated on both sides. Components mount directly to the flexcircuit and they can be hand or wave soldered. It replaces all wire and all circuit boards and provides the entire interconnection function.

To help make its great new camera possible, Kodak needed a compact, sophisticated flexible circuit that could be produced at the rate of thousands per week.

Schjeldahl did it for Kodak.

Schjeldahl Company
Electrical Products Division
Northfield, Minnesota 55057

The state of the art people in volume flexible circuits

And we can do it for you.

New products

transforms uses a nondestructive readout table of sine and cosine values, which enables 256 complex

point transforms in 3 ms and up to 4,096 in 64 ms. In addition, the unit allows real-time spectral analysis.
Spectra Data Co., 18758 6 Bryant St., Northridge, Calif. 91324 [365]

Portable TV terminal displays 40 characters by 16 lines

The model 209 Telecomputer TV terminal is a portable unit designed to be compatible with model 33 Teletypes. The desktop CRT can be acoustically coupled or hardwired to

30 MHz for only $225*?

Prove it to yourself with the Heath/Schlumberger 30-day trial offer

- ***Auto-ranging***
- ***5 Hz to 30 MHz range***
- ***10 mV input sensitivity***
- ***6-digit LED readout with leading zero blanking***

Heath/Schlumberger does it again...with the new SM-118A. Compare features and price against the competition. The new 118A provides 5 Hz to 30 MHz guaranteed range...2 Hz to 40 MHz typical...10 mV sensitivity guaranteed over the entire range ...5-8 mV typical. Plus features not found on other low cost counters: Autoranging with four automatically selected ranges of 10 sec., 1 sec., 100 ms or 10 ms., plus switch-selected time base ranges of 1 sec. and 10 msec. ...1 MHz time base provides stability of 1 part in 10^6/mo...plus a rear panel input to allow use of an external time base oscillator for extreme accuracy or frequency ratio measurements. Other features include 6-digit LED readout with leading zero blanking...combination carrying handle/tilt stand...small size and light weight...120/240 VAC operation.

A value? You decide. Check the details of our trial offer at right and put one to work for 30 days. We think you'll keep it.

Factory assembled & calibrated SM-118A, 7 lbs. **$225.00***

Send for our FREE 1973 Electronic Instruments catalog and get complete details on this and other high performance, low cost instruments. Use the coupon to receive your FREE copy now.

How we can sell high performance instrumentation at low cost. Heath/Schlumberger sells direct to you, through the mail. No salesmen, no distributors. Result? Lower selling costs...lower prices. Heath/Schlumberger is a division of the Heath Company, the world's largest manufacturer of electronic kits, one of the world's largest buyers of electronic components. That means real purchasing power for us, lower costs for you.

And we're not a small company struggling with high overhead, but a small division of a very large company, getting the benefit of sharing some other very important (and expensive) facilities. Again, this means lower costs for us...and for you.

Take advantage of our 30-day trial offer and prove it to yourself.

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We're so sure that our products can deliver on our claim of high performance and low cost that we make this offer: try this or any other Heath/Schlumberger product in your lab for 30 days. Just send us your purchase order with the statement below typed on it.

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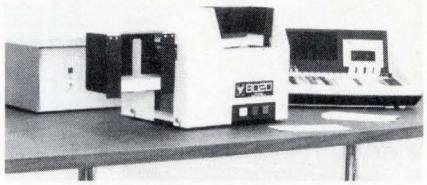
New products

any communications line and displays 40 characters by 16 lines or 640 characters in all. The terminal has a built-in acoustic coupler and operates with any ordinary TV set for display, without modifications, by clipping onto the TV's antenna terminals. The 209 may also be used with a video monitor, and a single 209 display on up to 10 monitors or TVs. Data rates are 110 baud and 300 baud with up to 9,600 baud optionally available. Price ranges from $1,295 to $1,095 depending on quantity and options.

Digi-Log Systems Inc., 666 Davisville Rd., Willow Grove, PA 19090 [366]

Punched card reader plugs into calculator

A fully automatic punched card reader that plugs into the I/O connector of a calculator, requiring no modification of the calculator, is



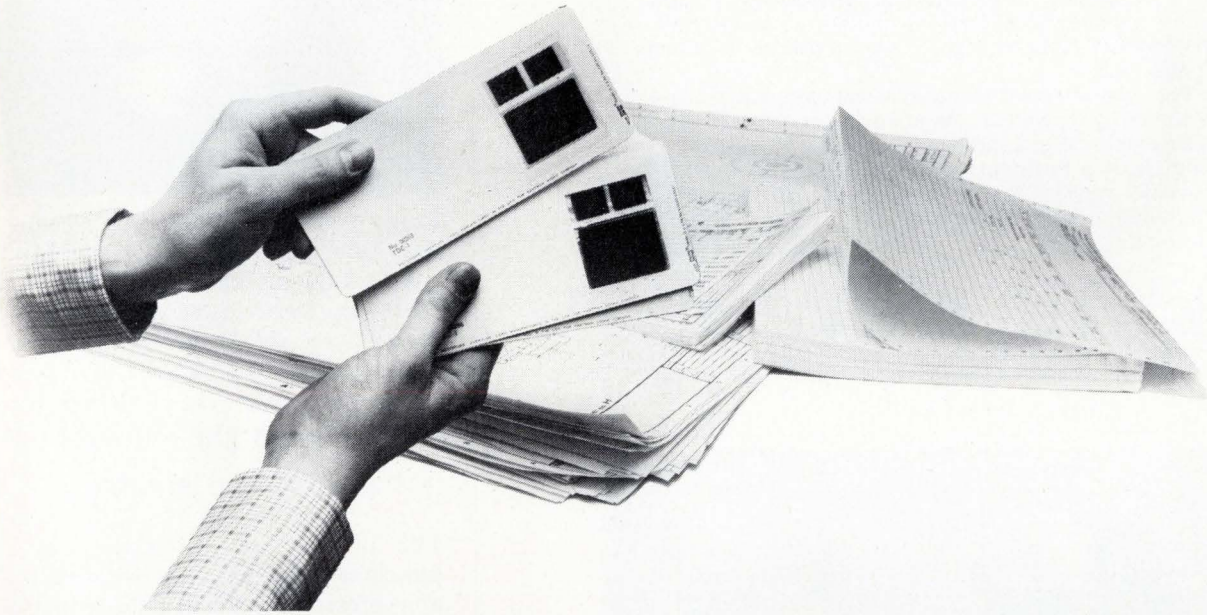
designated the model IW-770. The unit can handle jobs previously done by data processing systems. The reader mechanism can handle up to 200 cards per minute and allows stacks of up to 500 cards to be processed without operator intervention. Price is $3,850.

Digital Laboratories, 377 Putnam Ave., Cambridge, Mass. 02139 [368]

Multiprograming computer is aimed at on-line applications

Designed for on-line applications, the model 251 multiprograming computer is an addition to the Century series of processors. The unit is designed as an intermediate step between the model 200 and the model 300 of the series. Standard features include a CRT console and an input/output writer using thermal

How to get it all under control.



Looking for a better engineering document control program? Kodak can help you put the pieces together.

There's a new concept in engineering document control that uses microfilm as the key element in the filing, retrieval, and reproduction of engineering drawings.

You keep your engineering drawings as well as support data—change notices, specifications, parts lists, standards, etc—on microfilm, available for ready reference with microfilm readers.

Modern Kodak microfilming and photoreproduction techniques let you go from the original drawing to microfilm, and then back to a full-size photographic blowback for revisions or for the production of inexpensive diazo duplicates.

You'll save filing space, reduce retrieval time, and still have the capability of producing full- or reduced-size drawings of exceptional quality when desired. All it takes is the right equipment, materials, and know-how.

Kodak can help you with these. With microfilmers, film processors, readers, and reader-printers. With microfilm, and with drawing reproduction films and papers. And with the knowledge gained in more than 40 years' experience in microfilm.

Send for more information.

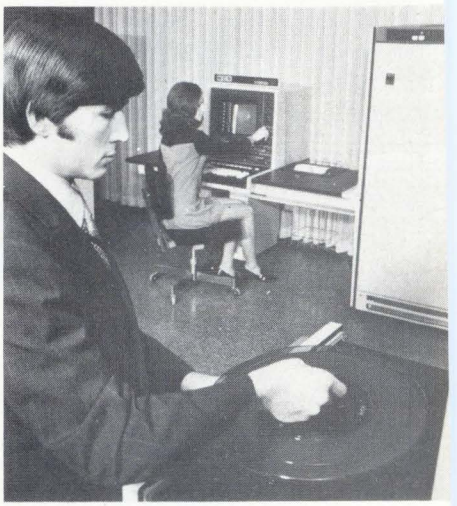
Just drop us a line for our brochure on the engineering document control concept, or request a sales representative to phone for an appointment. Eastman Kodak Company, Business Systems Markets Division, Dept. DP841, Rochester, N.Y. 14650.

Kodak products for engineering data systems

Kodak

New products

printing. Four memory sizes are available: 96,000 words, 128,000 words, 192,000 words, and 256,000

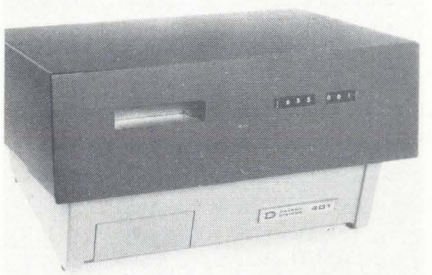


words. Cycle time is 1.2 μs for each four-byte access. Monthly rental for a typical system is about $10,000.

The National Cash Register Co., Main and K Streets, Dayton, Ohio 45409 [367]

Keypunching time recorder has variable field lengths

The model 401 automatic keypunching time recorder with variable preset transaction field lengths enables up to 14 separate transactions to be encoded on a single card. Insertion of prepunched standard 80-column tab cards generates a



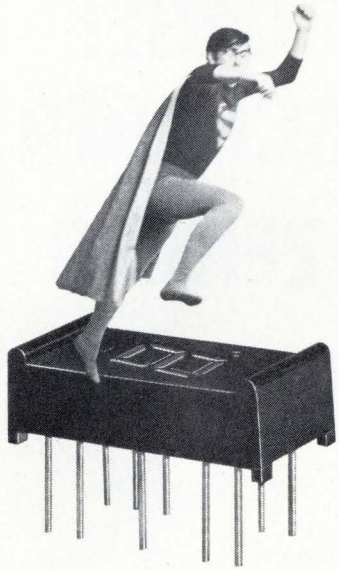
3-7-digit time and date record immediately ready for computer processing. The unit greatly eliminates keypunching, handwritten records, and manual calculations. Units can be rented on a 90-day trial basis or purchased for $1,850.

Datron Equipment, a Division of Data Access Systems Inc., 100 Rte. 46, Mountain Lakes, N.J. 07046 [369]

THIS IS NO ORDINARY DISGUISED MAN,

IT'S THE SUPERMAN DIGIT.

Replaces everything else. The Data-Lit 707 is designed in the standard 14-pin dual in-line package. It's pin-for-pin identical with the MAN-1 and DL-10. The Data-Lit 704 is pin-for-pin identical to the MAN-4 and DL-4. And while it isn't pin-for-pin identical with tubes, the total system cost will beat them penny-for-penny.

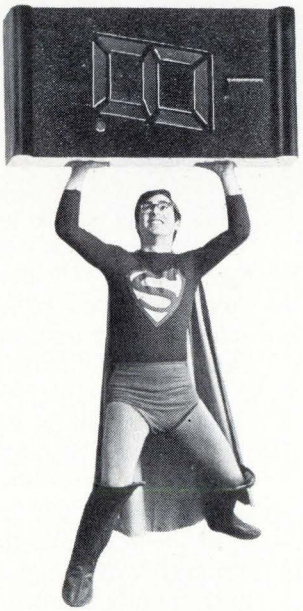


the bright guys litronix

The Data-Lit 707 second generation LED display has all the qualities you would like to see in a Superman digit. Low cost, low power, full solid segments with minimum gaps, low cost, availability, standard pins, high reliability, low cost.

It's Cheap. Everyone wanted us to say economical. But the DL-707 is cheap compared to what you've been used to for LED displays and tube displays. The total system cost of power supplies, drivers, digits and mounting hardware is now less in the 2 to 8 digit range using LED's *than any other* display technology.

ELD makes it all happen. Encapsulated Light Diffusion (ELD) was developed in our Krypton lab. We've produced a high quality diffusing light channel in a single encapsulating step. This allows us to use 85% less GaAsP material without sacrificing brightness. The only thing it cuts is cost.



This looks like a job for Superman DL-707. If you're anywhere in the thriving metropolis of desk top calculators, POS equipment, digital panel meters, small instrumentation and so on, you have to see the Data-Lit 707 and get our volume prices.

Here's the first of our Superman Data-Lit 700 Series:

DL-707	Common anode, left decimal
DL-707R	Common anode, right decimal
DL-701	Common anode, polarity and overflow
DL-704	Common cathode, right decimal

So step into a phone booth and call one of our distributors. The Data-Lit 700 Series is going at $3.25 in 100-999 quantities.

No surprises, the Bright Guys did it again.

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Tritech, DeWitt (315) 446-2881
Ohio: EMA, Inc., Centerville (Dayton)
(513) 433-2800
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Pennsylvania: G. C. M., Ambler
(215) 646-7535
Texas: Semiconductor Sales,
Richardson (214) 231-6181
Houston (713) 461-4197

Washington: Compar,
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Circle 175 on reader service card 175

New products/materials

A glass-free gold conductor paste, designated EMCA Gold 210, is used for silk-screen printing of thick-film microcircuits. Its fired composition of 99% pure gold permits applications at microwave frequencies, even above 10 GHz. Resistance is less than 2 milliohms/square at 0.5-mil fired thickness. The material is insensitive to firing temperatures and may be fired at 950°C ±50°C for five to 15 minutes in air.

Electro Materials Corp. of America, 605 Center Ave., Mamaroneck, N.Y. [476]

A one-component silver epoxy adhesive is designed for all types of chip bonding, including gallium arsenide phosphide and gallium arsenide light-emitting-diode chips to substrates. Material K01001 is curable in one hour at 120°C, and it has the viscosity of light thrixotropic paste. In addition, the material gels in one to two seconds at 260°C.

Hysol Division, The Dexter Corp., 211 Franklin St., Olean, N.Y. 14760 [477]

A two-part epoxy adhesive for fastening transistors, diodes, integrated circuits, and other heat-sensitive electronic components to printed-circuit boards, radiators, and heat sinks is called material 2153. It mixes into a putty-like paste and cures overnight at room temperature or in a few hours at 65°C into a hard rigid finish.

Tra-Con Inc., 55 North St., Medford, Mass. 02155 [478]

A line of high-purity powders include 223 different materials, designated the 539 series. Included are metal powders, oxides, salts, special alloys, cermets, rare earths, and special blends. The materials include copper, glass, silica, tantalum, and nickel. Many of the materials can be used in spraying applications for flame and plasma processes. Typical prices are $6 per pound for 325 mesh, 99.8% pure aluminum powder and $2.50 per gram for 99.999% pure gallium powder.

Aremco Products Inc., Box 145, Briarcliff Manor, N.Y. 10510 [479]

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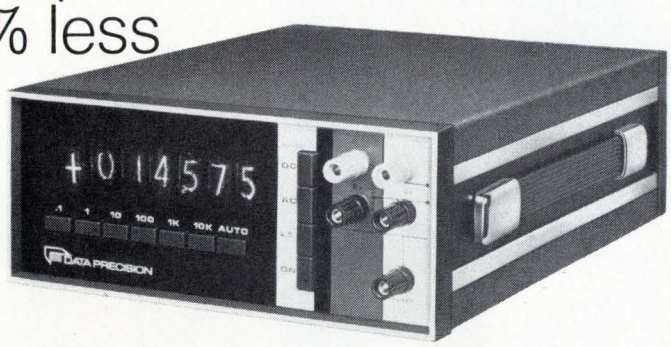

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New products/materials

finishes of 4 microinches or better as fired. The substrates are thus suitable for thin-film applications. Designated Micro Surface, the material provides substrate thicknesses ranging from 0.010 to 0.030 inch. A variety of substrate sizes are available.
Comco Inc., 9421 Telfair Ave., Sun Valley, Calif. 91352 [480]

An asbestos felt, phenolic resin laminate is designed to make circuitboard carriers that can withstand high temperatures without blistering, warping or deteriorating. The material is molded in rectangles measuring 11 by 7½ inches and ¾-in. thick. They are machine-finished so that the user needs only to place the pc board on top of the carrier to transport the boards through solder baths. The carrier withstands temperatures to 450°C during the process.
Geonautics Inc., Newburyport, Mass. [401]

Material 26-2 is an electrically conductive room-temperature-curing adhesive designed especially for structural bonding where rf attenuation is required. The silver-filled brushable paste has a three-hour work life and produces strong bonds to a variety of materials. Volume resistivity is 0.005 ohm-cm with no change after 100 hours at 85°C/85% rH. It is available in one-pound and four-ounce two-component kits, as well as premixed or frozen in containers ranging upward from 1 cc.
Ablestik Laboratories, 833 W. 182nd St., Gardena, Calif. 90248 [405]

A line of solder pastes, designated Blend-Ohm-Solder-All is designed for thick- and thin-film applications. The pastes are available with three flux activities and in 200 and 325 mesh. The screen-printable materials cover a range of alloys, and besides screening, the paste may be applied by brushing, syringe, dipping, or mechanical dispensing. Reflow is possible in an infrared oven, hot-plate, or soldering oven. The material can be used to hold components into place prior to fusing. Delivery is from stock.
Methode Development Corp., 7447 W. Wilson Ave., Chicago, Ill. 60656 [403]

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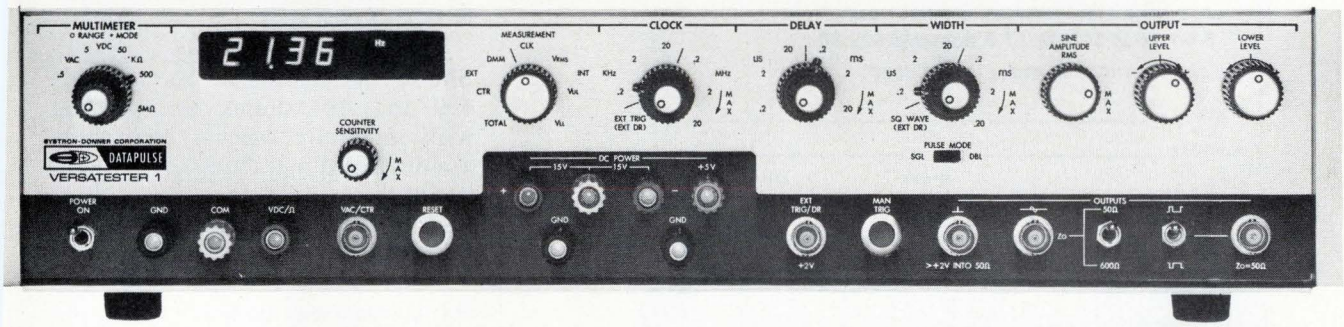

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New literature

Spectrum analyzers. Quan-Tech Division, KMS Industries Inc., 43 S. Jefferson Rd., Whippany, N.J. 07981, has published a brochure entitled "Applications of Modern Tracking Wave and Spectrum Analyzers." Circle 421 on reader service card.

Alphanumeric terminal. Computek Inc., 143 Albany St., Cambridge, Mass. 02139, has available a users' manual for the company's series 200 line of programable alphanumeric terminals that use nondestructible ROM program storage. [422]

DIP sockets. Specification sheet 5000 provides information on 14 and 18-pin DIP sockets made by Aries Electronics Inc., Box 231, Frenchtown, N.J. 08825 [423]

Sliding terminations. The models 450 and 480 sliding terminations with miniature coaxial connectors are described in a data sheet offered by Maury Microwave Corp., 8610 Helms Ave., Cucamonga, Calif. 91730. [424]

Random-access memory. An application note from Advanced Memory Systems Inc., 1276 Hammerwood Ave., Sunnyvale, Calif., describes the configuration, design, and operation of memory systems using the 6003 model 2,000-word MOS RAM. [425]

Voltage regulator. Tele-Dynamics/Wanless Division of Ambac Industries Inc., 525 Virginia Dr., Fort Washington, Pa. 19034. The Varax C474 ac line-voltage regulator is detailed in a two-page data sheet. [426]

Cell applications. Codi Semiconductor, Division of Computer Diode Corp., Pollitt Dr. South, Fairlawn, N.J. 07410. A 12-page applications bulletin compares the accuracy of the company's Certa-Cell against unsaturated standard cells of the mercury-cadmium type. [427]

Solderless interconnect. Robinson-Nugent Inc., 800 E. 8th St., P.O. Box 470, New Albany, Ind. An eight-

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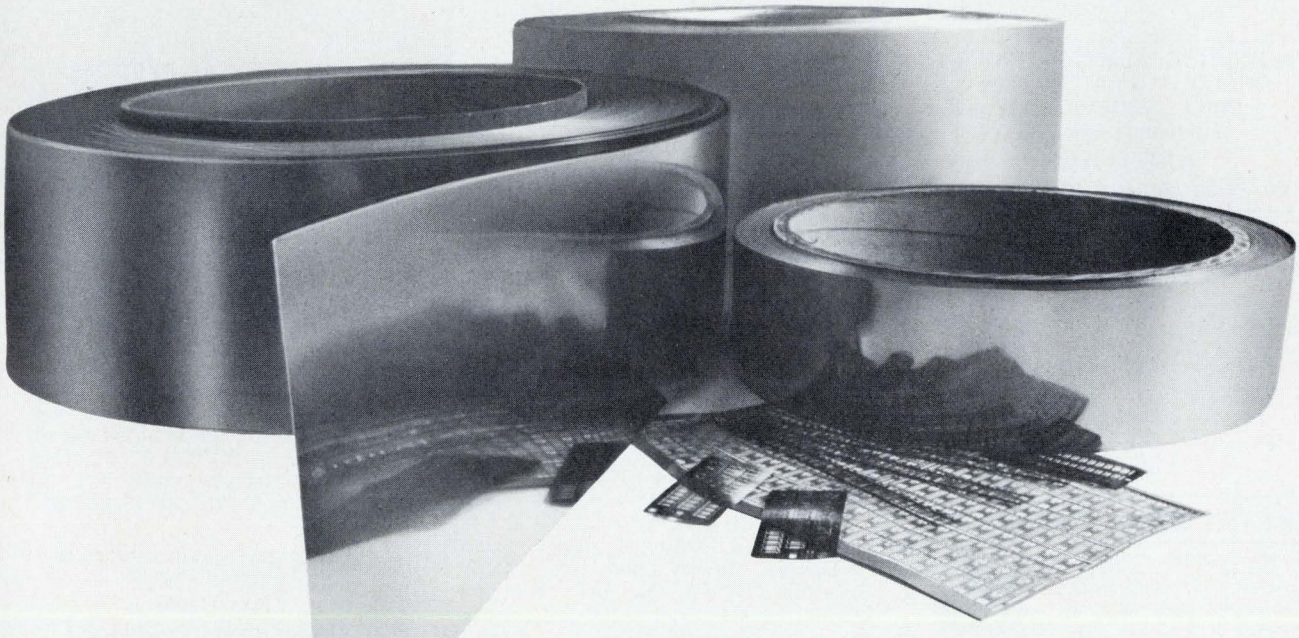

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page catalog describes the concept and components of the Allochiral solderless interconnect system. Technical details and test data are provided. [428]

Integrated circuits. Signetics, 811 East Arques Ave., Sunnyvale, Calif. 94086, has published a handbook and catalog on integrated circuits. The manual covers digital, linear, and MOS circuits.

Graphics system. A four-page brochure describes an interactive graphics system for preparation and verification of NC tape. Systems Science and Software, La Jolla, Calif. 92037 [430]

FETs. Siliconix Inc., 2201 Laurelwood Rd., Santa Clara, Calif. 95054, has published an applications note that deals with techniques to use field-effect transistors as voltage-controlled resistors. The 16-page brochure discusses the characteristics of junction-FETs as VCRs and makes performance comparisons between J-FET VCRs and conventional fixed-value resistors. [431]

Pc-board relays. A line of relays that allows spacing of 0.5 inch center-to-center on rack-mounted pc cards is described and illustrated in a two-page product bulletin from Siemens Corp., 186 Wood Ave. S., Iselin, N.J. [433]

Power supplies. Sola Electric, 1717 Busse Rd., Elk Grove Village, Ill. 60007. Catalog 617 is a six-page foldout brochure featuring four dc power supplies. [434]

Evaporation sources. Materials Research Corp., Rte. 303, Orangeburg, N.Y., has issued a 24-page brochure on vacuum-evaporation sources, and it includes information on electronic thin-film vacuum coating. Illustrations are provided in the brochure. [435]

Digital lock. A four-page data and applications note from Telesis Laboratory, Box 387, Chillicothe, Ohio 45601, describes a digital lock system and operating modes. Also, pin

New literature

plug programing of single and multiple codes is also described in the publication. [436]

Power supplies. A 110-page catalog from the Sorenson Co., 676 Island Pond Rd., Manchester, N.H. 03103, contains detailed information on the company's line of power supplies. Catalog 72 A includes dc modular supplies, laboratory units, and high voltage supplies. [437]

Power controllers. Vectrol Inc., 1010 Westmore Ave., Rockville, Md. 20850. An eight-page bulletin describes the VPAC 500 series of SCR phase proportioning power controllers. [438]

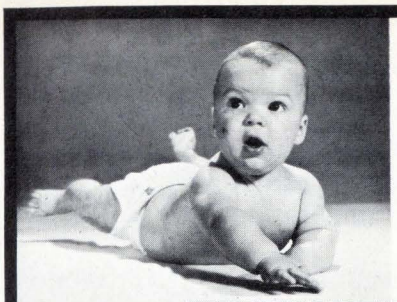
Data systems. A two-page bulletin briefly describes data systems and signal-conditioning equipment manufactured by B & F Instruments Inc., Cornwells Heights, Pa. 19020 [439]

Crystal oscillator. Data sheet VCX0103 provides information on a voltage-controlled crystal oscillator, giving a general description and specifications. Ferwalt Inc., Webb Rd., Lapwai, Idaho 83540 [440]

D-a converter. A data sheet is available from Sitek Inc., 1078 W. Evelyn Ave., Sunnyvale, Calif. 94086, describing a digital-to-analog converter option for the company's model 1420 linear IC tester. The two-page publication contains a description and specifications for the program board. [371]

Message display. Advanced Digital Systems Inc., 146 W. Main St., Mohawk, N.Y. 13407. Bulletin ADS 721006 describes how alphanumeric display VSN-1, a tape-mount message display of tape commands, may be used. [372]

Digital controller. A technical bulletin from Brooks Instrument Division, Emerson Electric Co., Hartfield, Pa., provides information on an electronic digital controller that is BCD-programable. Specification, applications and design notes are included. [373]



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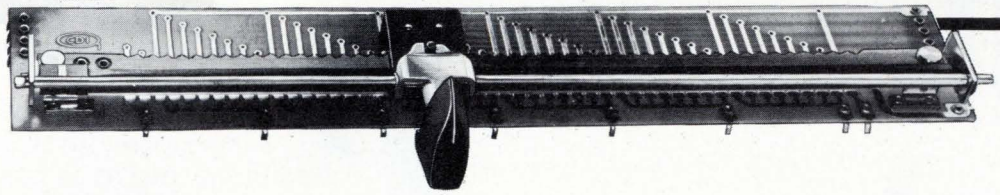

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"Let's kill all the lawyers!"

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There is a new and different kind of rebellion in America today. An angry revolt against the pollution and despoilment of our environment.

And some people, again seeking a scapegoat, have also hit upon a popular idea.

Put the blame, and the burden, on business.

Indict U.S. industry as "The perpetrator of an irresponsible assault on the environment."

Demand that industry immediately stop all pollution, end all depletion, and forthwith "restore our natural heritage."

And enforce these demands with new, harsh and punitive, laws and regulations. Impose criminal penalties on the owners and officers of offending companies. Launch an onslaught of "Citizens' and workers' suits for environmental damages." Attack, harass, threaten, punish and compel.

The idea has its appeal. It focuses on a convenient, conspicuous and vulnerable target. It offers immediate action and immediate release for accumulated frustration and anger. Most temptingly, it promises a quick, easy and painless solution to the whole environmental problem.

Against this attack, and in the face of this appeal, industry is at a crippling disadvantage. It has, to put it bluntly, been hit with charges that cannot be denied—demands that cannot be satisfied. And, backed into its corner, it is in an awkward position.

A position in which anything it says is likely to be taken as defensive or evasive, anything it does is questioned in advance as inadequate.

Nevertheless, some things *need* to be said.

First, that industry *is* guilty of an assault upon the environment, and *is* responsible for the consequences.

But, second, that the guilt has long since been acknowledged, the responsibility long since accepted. Today, however belatedly, U.S. industry stands firmly and fully committed to the environmental cause.

The commitment is sincere. It is also specific and binding. The U.S. Commission on Environmental Quality has designed a massive pro-

gram to cleanse and restore the American environment in the 1970's, at a total cost of $287-billion. Industry's share of this cost is set at $195-billion.

Clearly, this assigned task and this imposed burden will strain the financial, and test the technical and managerial, capacities of U.S. industry to the utmost. It adds an enormous responsibility and a formidable challenge to all of the other responsibilities and challenges that industry must continue to confront in a competitive and demanding world.

The responsibility has been accepted, the job will be done. But beyond this assigned task, beyond this designated goal, beyond these outer limits of the possible, industry probably cannot go. It is not a question of will, but of capacity. The issue is not what industry *ought* to do, but what industry *can* do.

To the extremists' premise that industry can be threatened, harassed and driven to exceed its utmost capacities—that it can somehow be *made* to do what it manifestly cannot do—a frank and unequivocal response must be made.

Industry cannot immediately stop all pollution, end all depletion, and overnight restore our natural heritage. It is impossible. It is financially impossible, technically impossible, economically impossible, morally impossible, and physically impossible.

It is financially impossible for industry to immediately allocate and spend $195-billion. There is not that much money to be had, from any source, by any means, using any device.

It is technically impossible, at any price, to totally eliminate all forms of pollution.

It is economically impossible to bring all of U.S. industry to a complete halt while pollution control is given absolute priority over production.

It is morally impossible to close every offending plant, shut down every faulty operation, and throw thousands of people out of jobs, whole communities into bankruptcy.

And it is physically impossible, even if everything else could be done, to compress the work of a decade into a day, a month, or a year.

To these obvious impossibilities, one more must be added. It is impossible to separate industry from the society to which it belongs —and which it serves and reflects.

The environmental crisis is not an isolated, but a total, national crisis. The result of universal neglect and unanimous irresponsibility. And of a prolonged, overwhelming, devastating *mass* assault on the environment, made by millions of American citizens and consumers, in ignorance or blithe disregard of the consequences.

We are no longer ignorant. We are no longer quite so blithe. But the assault continues. Because the insistent, unrelenting pressure of consumer needs, wants, desires and demands continues.

And this, ultimately, is the problem. Not for industry alone, but for the whole of a truly interdependent society. Any major solution to the environmental crisis requires a profound change in the personal expectations, habits, attitudes and actions of millions of individual Americans.

But the point, with regard to industry's responsibility, is simple. Industry cannot dictate change. It can control its own actions and reform its own habits. But it cannot refuse to meet needs, ignore wants, desires and demands, and reform the habits, attitudes and actions of 200-million Americans.

Killing lawyers does not further the cause of justice. Persecuting and punishing industry will not advance the cause of a better environment. The sacrifice of a scapegoat solves nothing and gets us nowhere.

Except off the track. A common, national problem demands a common, united, national effort. The job belongs to us all.

It is time to forget the diversion and get on, *together*, with the job.

We at McGraw-Hill believe in the interdependence of American society. We believe that, particularly among the major groups—business, professions, labor and government—there is too little recognition of our mutual dependence, and of our respective contributions. And we believe that it is the responsibility of the media to improve this recognition.

This is the sixth of a series of editorial messages on a variety of significant subjects that we hope will contribute to a broader understanding.

John R Emery

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IN THIS SECTION:

MONEY MANAGEMENT

The pay-later binge, and how to live with it

Returning from one of his frequent business trips abroad,a 38-year-old executive of a large international company recently tried to straighten out his household bills. He made a shocking discovery. "I found we were carrying an average monthly balance of $4,000 on credit cards and charge accounts," he says. "You know what that means? It means we were paying 18% annual interest on a $4,000 'loan' we didn't need and never meant to make."

While his revolving balance of $4,000 may seem uncommon, his experience is not. American consumers, like it or not, are a nation of borrowers. They are some $150-billion in hock for automobiles, appliances, personal loans and whatever they can charge on credit cards, and are going about $2-billion deeper into the hole every month.

For the home-owning, steady-working breadwinner in his mid-30s earning $10,000 to $30,000 the question is not *who* will lend him money or *how much*. The problem is *how to handle all the credit that's thrust upon him*. If he's had his job, say, seven years, owned his house for five, and is firmly saddled with two or three children, he's enough to make mouths water in credit and personal loan offices across the U.S. In fact, in Chicago, Los Angeles or Detroit, he would almost precisely fit the profile lenders welcome most.

Ironically, his greater disposable income is making him more of a borrower than ever—primarily because it's coupled with greater leisure time for recreation vehicles, boats, new cars, travel and other time-payment expenditures. In fact, James Ford, a personal banking officer with Chicago's Continental Bank, predicts, "By 1985 personal loans will probably overtake commercial ones."

Ford and some other bankers feel that they detect a growing sophistication about borrowing among their clients. It comes from increasing practice, they say, augmented by truth-in-lending laws and consumerist movements. "The American consumer," says Dallas banker Homer L. Stewart, senior vice-president of Republic National Bank, "is the most disclosed-to, most protected individual in the world right now."

Nevertheless, plenty get into trouble. At least 30,000 will end up in personal (Chapter 13) bankruptcy this year. The primary causes will be over-borrowing and/or careless use of credit cards and revolving accounts. A Chicago family counseling service, for instance, sees a marked rise lately in middle-income-and-up families sinking into the fiscal morass. "And," says a spokesman, "many of them can't even answer the question: 'How much do you owe?' "

A major contributor to the confusion is revolving credit. The debtor is encouraged to pay a modest monthly amount

This PERSONAL BUSINESS section is written by McGraw-Hill editors to give you helpful information on the better management of your leisure time and money. Personal Business covers everything from taxes and investments to education and travel. We feel that today, more than ever, personal-business planning is of prime concern to businessmen and professionals.

"If you don't know the value of money, go and borrow some."
—Benjamin Franklin

toward his account, and is charged up to 1½% per month (18% per year) on the balance. A typical holder of an interbank *MasterCharge* card in New York, for instance, recently received a monthly bill asking him to make a "combined minimum payment" of only $26.01, although he actually owed a balance of $445.84. It is easy to see how he might feel that all he "owed" was the $26.01, particularly if he had in mind charging a weekend in Miami to his account with Diners' Club (which now, incidentally, also offers members in good standing the opportunity to borrow up to $25,000 through a South Bend, Ind., financial service).

Bankers across the country say that "wipe-up" loans—to consolidate a confusion of term payments into one monthly bite—now rank third or fourth among reasons people seek personal loans. And the Chicago family counselor lists failure to keep credit within bounds an increasingly major cause of family financial trouble.

What are fair limits? A *Personal Business* survey shows that bankers generally draw the red-line on applicants when their monthly payments reach 50% of their monthly disposable income. The rule, however, is often relaxed upward as an applicant's income rises. In his recently published *The Money Book* (Scribner's) W.J. Reddin, a teacher of personal finance, offers a common-sense control system: Compute total monthly payment obligations as a percentage of income at quarterly or semi-annual intervals. If the percentage markedly rises, retrench on charging things until it subsides.

The convenience of credit cards, bank cards and revolving charge accounts cannot be beat, but the interest users pay can be. "Almost invariably," says Assoc. Dean William J. Pierce of the University of Michigan Law School, who helped write the consumer credit code which served as a model for the Truth in Lending Act, "credit unions and banks will be cheaper than the consumer finance industry. A credit union is your best bet for almost everything—if you happen to belong to one."

Credit unions generally charge 1% per month on the outstanding balance, or 12% a year, but some charge as little as .5% per month, or 6% annually. "Not many consumers are aware, either," says Dean Pierce, "that there are two windows in most banks—the consumer-credit window where a loan may cost 12% or more, and the commercial-loan window where you can get a one-payment deal for perhaps 7%." The rates vary from state to state, says Pierce, bu it generally pays to shop around.

Passbook loans, in which a borrowe uses a savings-account passbook a collateral, are by far the least expensive A major Atlanta savings and loan assoc ation, for instance, will lend up to 90% c the cash value of a passbook at 6% while the money in the passbook sti goes on earning 5% for its owner. Ne cost of the loan: 1%.

Why borrowers don't make more us of such bargains puzzles Pierce. "Ther are people," he says, "who will walk int a personal loan company and pay, say 22% on a $1,000 loan for their daugh ter's wedding, even though they hav $20,000 sitting in bank accounts. The won't touch their nestegg, even thougl economically it's foolish not to. I gues it's human nature."

Ready cash at low rates is also avail able to people who carry cash-value life insurance (not term or group). A policy holder can always borrow against his current cash value at 5%-6%, and is un der no pressure to pay anything but the annual interest. But personal finance ad visors suggest this source be tapped only for the most important reasons—i puts one's insurance plan out of whack as long as the loan is outstanding.

For credit-worthy borrowers, counselors rank small loan companies far down the list. "Try a commercial bank first," says Chase Manhattan's consumer affairs specialist Judy A. Gorman, "and, if at first you don't succeed, try another . . . and another." Small loan companies, because they assume risks banks would reject, charge higher interest rates. They can range sky-high in somes states (Mississippi permits over 41%), and the least is 18% to 20%.

The oft-maligned pawn shop has its own fans, but for reasons other than economy (although rates in most states compare with other personal lenders). The attraction is *privacy*. Since goods are pledged as collateral, there's no searching credit check. The idea appeals as much to the very rich as it does to the fly-by-night. Indeed, some upper-crust pawn shops, such as Paul Kaskel & Sons, Inc., on Manhattan's fashionable 57th Street, do a rousing business with jet-setters caught short between trust-fund or alimony checks. They usually have grade-A collateral—minks, jewels, and fine art—and an aversion to having their private finances examined.

For most consumers today, a certain amount of borrowing is almost essential. Without a credit rating, they are lepers in the market place. A $60,000-a-year executive in Los Angeles found that out recently when he was turned down flat for a home loan. "He paid cash for everything," the local credit bureau manager recalls. "There simply was no record on him anywhere." He ultimately got the loan, but it took special handling.

The cozy shelter: a fly-by-night for little birds

"The big push behind tax sheltering," notes Sheldon Cohen, Washington lawyer and former Commissioner of Internal Revenue, "is simply high tax-vulnerable income that needs protecting. Sheltering is for the birds—the rich ones—and the middle-income man shouldn't let himself get lured into the game."

Cohen, whose own clients would mostly qualify for sheltering with ease, has dispensed his share of advice on oil, cattle, and all the rest. But he adds: "Lately the whole shelter picture has been marred by too many fast-dollar promoters."

The fast-dollar people, according to the ex-Commissioner and other top-rank advisers, are invaders of the shelter scene who have done two things, essentially, that have given the business a black eye:

- Too often they have pushed shelter plans (or "programs") on small investors who needed ordinary income, not the array of tax deductions upon which the shelter concept mainly rests.
- Too often they have treated themselves to oversized, ironclad profits scooped "off the top" of risky deals, and justified by neither the real prospects of the business at hand, nor their own limited expertise as managers.

Thus, tax-sheltered investments have begun to lose some of their luster, especially since U. S. Internal Revenue has lately erased some of the flukier paperwork moves invented by the promoters. "As long as the tax cost attached to ordinary income can go as high as 70%, sheltering will stick," says Bernard Greisman, New York lawyer and leading tax writer. "But people have learned that 'tax shelter' does not guarantee success, far from it."

Some shelter deals not only are highly speculative, but amount to just opportunities to "buy" tax deductions in one year, with an uncertain hope of a return of the money in another year. Says Greisman: "You mix this with the fact that some offerings are further burdened by management fees as high as 50% of every dollar put in—and you quietly stop to investigate."

The theme in comments from ranking advisers in the field is beginning to dent the ironclad attitudes of the shelter sellers. It is, in two words: caveat emptor. It makes good sense. One of the most successful shelter consultants is D. Bruce Trainor of Tax Shelter Advisory Service, Narberth, Pa. "If anybody is thinking tax shelter in order to make money, somebody is going to have to do a lot of hard work," he says. "You have to have an independent expert—a mining engineer, geologist, or cattleman—check the procedure used. Then you have to study the structure of the particular deal, because you could have the best oil well in the world, for example, and not make money if the deal has not been structured to benefit the limited partners." The limited partners are, of course, the outside investors who put up the cash.

Among the many and varied types of shelters on the market today, some of the best deals are private ones, put together by an accountant, lawyer, brokerage house, or consultant for a small group of high-income clients. But since 1969, an increasing volume of public deals have appeared, and their A-to-Z quality spread has made it doubly hard to spot a winner.

Brokerage houses now account for 80% of all publicly-held tax shelters, and unhappily they aren't known for their skill in handling real estate, oil and gas, and cattle feeding—the three biggest areas for sheltering. The sales-minded brokers have tended to draw investors into deals that have frequently been too risky as well as lacking tax-bracket practicality.

In commenting on shelter deals offered to the public, Earl A. Samson, Jr., of Samson & Monier, a shelter advisory service, notes: "The things the general public is seeing are the things that private individuals don't want to do." And consultant Trainor, in pointing out that oil and gas are the best shelters around, notes that fewer than 10% of them amount to "reasonable" offerings.

Whether an investor wants to buy tax savings often depends on how much he is willing to gamble. A high-bracket man may willingly take the risk. But as the tax bracket drops, and the leverage provided by tax deductions decreases, the allure of such a gamble should dim and disappear. Many of the more reliable ventures offered today will specifically provide in the prospectus that the offering is solely for people in 50%-plus tax brackets whose net worth is at least $50,000, or, in some cases, as much as $200,000.

What tax shelter does—for the man who can use it

In an oil deal, as much as 80% of the investment may be tied up in "intangible" drilling costs which are fully deductible from ordinary income. Thus, on every $1,000 invested, $800 is deductible. For an investor in the 50% tax bracket, this cuts taxes by $400—and actual investment cost is $600. If the venture is a failure ("dry hole"), the taxpayer can then deduct the remaining cost in full against his other income. If it hits, percentage depletion rules take over—and 22% of *gross* income from the venture is tax-free (up to 50% of taxable income). Finally, if the taxpayer sells out at a later date, he gets taxed at the lower capital gains rate.

In a real estate deal, the same basic shelter mechanism—deductions-and-capital gains—applies. Lately the syndicators have turned their sights to apartments and other residential properties because there they still can take depreciation deductions at the 200% declining balance rate, and this facilitates the creation of high deductions, in excess of cash returns. Not only are the deductions used, but they provide the investor with tax losses which can be offset against "other" income. (Two drawbacks: The building must be held for over 16 years and eight months for the investor to fully realize capital gains on any appreciation. Also, the initial advantage of early loss deductions may be at the price of having to report more substantial ordinary income in later years—one of many points to check out.)

In a cattle feeding deal, a short-term tax shelter is provided, and may be attractive to a person who is presently in a high bracket but who expects to be in a lower bracket at the time he will realize income from the venture. A man approaching retirement may fit the bill. Similar deals are available in hogs (riskier), eggs, and pullets.

In a vineyard deal, an investor seeks tax benefits similar to those available from citrus groves before the law revision in 1969. The investor deducts planting and "development" costs to rework raw land, but some experts warn that vineyard tax windfalls may be limited by Congress in the future.

The pros' advice is to the point: "Don't distort your investment decisions for pure tax reasons—don't let gimmickry hurt your portfolio," warns Sheldon Cohen, the former Commissioner of Internal Revenue. And John Jones, tax lawyer with the Washington firm, Covington and Burling, comments: "People don't ask the same clear questions when going into a tax shelter as they do when making a normal investment."

Young marrieds and middle-agers tap the cash box

The retirement planners agree that last year was *the* year for Social Security changes, with both benefits and costs jacked up to proportions that would have choked even New Dealers of the Roosevelt era. Indeed, some businessmen choke up over the 1973 tax tab they must meet for employees.

A benefit bonanza is going on, and it's one that taps new-found resources for infants-in-arms as well as 65-plus retirees. "What some businessmen fail to realize," says compensation specialist Mario Leo of Towers, Perrin, Forster & Crosby, the consulting firm, "—is the extent to which Social Security embraces young families and middle-aged people, including the businessmen themselves." Today, 25% of all beneficiaries are *under* age 60.

Disabled workers of all ages and income levels *and* their families may now reap benefits that are widely misunderstood or simply not known. This holds, too, for widows, widowers and their children, who get some amazingly liberal benefits upon the death of the family breadwinner. Even a surviving *divorced* wife may pick up monthly checks.

A typical example of the new Social Security at work might be this: A young father dies in an accident this year, leaving a widow and two children under age five. His average earnings covered by Social Security amount to, say, $450 a month. In such case, his family gets $468 a month, or $5,616 a year—or well over $75,000 by the time the eldest child is 18, the usual cutoff date for such benefits. If the children attend college, the coverage continues to age 22. *And* in later years, the mother gets widow's benefits.

When a father dies in 1973 at, say, age 40, the maximum family benefit—assuming maximum coverage under Social Security—comes to $530 a month. And since the average monthly earnings covered will be as high as $1,000, starting in 1975, the top family benefit for death or disability in the years following goes up to $707 a month.

Disability payments gain importance when it is considered that the income—which is tax-free—will continue as long as the individual is unable to work. Here there is *no* cutoff date. Moreover, under revised law, the purchasing power of this income will be maintained by cost-of-living increases.

Disability benefits can be paid to "disabled" workers *under* age 65; to young people and children who become disabled before age 22 if a parent insured under Social Security is entitled to benefits or dies; and to disabled widows and widowers age 50 or older, if their disability began no later than seven years after the death of the insured spouse.

But though the definition of *who* may receive benefits is liberal, the spelling out of *when* is somewhat restrictive. As a general rule, a person is considered "disabled" if he cannot work because of a severe physical or mental impairment that has lasted—or is expected to last—12 months or more.

There is a waiting period of five full months following the last work day before benefits can begin, though there should be no delay in making application. It is important, in fact, to apply promptly when it becomes apparent that the disability will last a year or more—a delay in some cases will cause the loss of some benefits.

A new twist in the law is a boon to those whose ailments have been long and costly. For the first time, Medicare hospital and medical insurance becomes available to some people under 65. Starting next July, disabled persons who will then have received Social Security disability checks for two years or longer will come under Medicare's protection—*regardless of age.*

"Coverage" tests, too, are generally far more liberal than most people realize. To get full disability benefits, a worker age 31 or older must be "fully insured" (nearly all business and professional people are), and must be credited with five years of work in the previous 10-year period. If a man becomes disabled from age 24 to 31, he needs work credit for only one-half the time between age 21 and the date of his disablement. If the disability starts *before* age 24, he mus show 1½ years of work in the previou three years.

The formula for estimating possibl benefits is slightly arcane, at best though a bit of pencil work should tur up some accurate forecasting. First, t compute your "average earnings" fo disability or survivors' benefits—assum ing the disabling event occurs in 1973:

- Count the number of years to be averaged—begin with 1956 if you were born before 1930, and with the year you reached age 27 if you were born in 193C or later. To get the 1973 estimate, coun through 1972 only.
- List your earnings for all years beginning with 1951, and *include* 1973. Count no more than $3,600 for 1951 through 1954; $4,200 for 1955 through 1958; $4,800 for 1959 through 1965; $6,600 for 1966 and 1967; $7,800 for 1968 through 1971; $9,000 for 1972, and $10,800 for 1973. (Wage base for 1974 is $12,000.)
- Cross off your list the years of lowest earnings until the number remaining is the same as in the answer to step 1, above.
- Add up the earnings for the years left on your list and divide by the number of years used.

The result is your *average yearly earnings* covered by Social Security up to and including 1973. Turn to the table on this page—it should enable you to measure your possible benefits.

Paying the piper is part of Social Security, and living with the cost will become more onerous year by year. The 1973 tax is 5.85% of earnings up to a "base" of $10,800, and this figures to a maximum tax of $631.80 to be paid by both employer and employee. In 1974, the tax will go to a maximum $702 to be paid by each, on a $12,000 wage base. In later years the wage base will increase automatically with increases in "average" wages. ■

MONTHLY CASH BENEFIT PAYMENTS

Average yearly earnings* under Social Security	$3,000	$4,200	$5,400	$6,600	$7,800	$9,000	$10,800	$12,000
Disabled worker	$174.80	$213.30	$250.60	$288.40	$331.00	$354.50	$384.50	$404.50
Wife under 65 and child (added to above)	92.50	157.40	217.30	233.90	248.30	265.90	288.40	303.40
Widowed mother and 1 child	262.20	320.00	376.00	432.60	496.60	531.80	576.80	606.80
Widowed mother and 2 children	267.30	370.70	467.90	522.30	579.30	620.40	672.90	707.90
Child of disabled worker	87.40	106.70	125.30	144.20	165.50	177.30	192.30	202.30
Surviving child	131.10	160.00	188.00	216.30	248.30	265.90	288.40	303.40
Maximum family payment	267.30	370.70	467.90	522.30	579.30	620.40	672.90	707.90

*"Average earnings" today reflect lower wage bases back to 1951. Thus present benefits reflect lower taxes withheld in past years. Maximum family benefit paid in 1973 is about $650 per month; the $707.90 maximum begins for some workers in 1977 (*see formula*).

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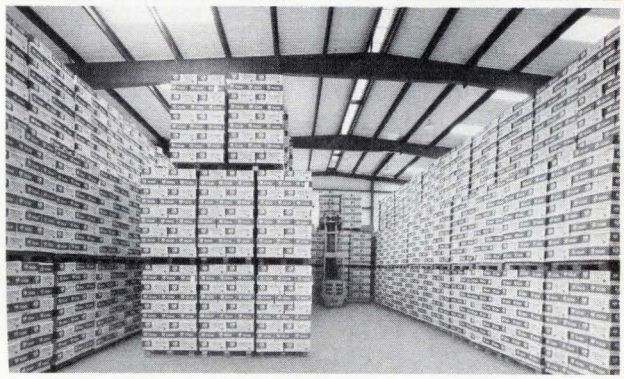

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"Dear Folks: Here at camp in Nigeria . . ."

The good old back-to-school essay on "My Summer at Camp" is no longer guaranteed to put the teacher and everybody else to sleep. This year, more than ever before, the kids will be cramming in travel, adventure and education that Dad never dreamed of in the days when "summer camp" meant bathing suits, baseball, sunburns and bugs.

Today's forward thinking camps might better be described as oases of escapism, intellectual pursuit and psychological fulfillment for affluent young people. They're that varied and fancy. For instance, the youngsters at Minnesota's Kooch-i-ching camp will paddle their canoes on streams as far north as the Arctic Circle; groups of Campfire Girls will investigate the archeology of New Mexico; "Y" campers will cross the U. S. from New York to Disneyland, while high schoolers go on work projects in places as farflung as Nigeria and Israel.

Thus, a parent tackles a real problem in picking one of the nation's 8,000 summer camps to suit both his youngster *and* his pocketbook. One place to start is the American Camping Assn.'s directory. It lists hundreds of quality camps, and points out basics such as activities, length of season, and costs (write to ACA, Martinsdale, Ind. 46151, $3). The directory assures a certain amount of screening has been done beforehand; ACA says that fully 15% of the camps it inspects are rejected.

Parents should do some screening of their own, and look over several camps. They should especially eye the camp directors who set the tone. "If you want just a babysitter, you'll find him," says Ernest Schmidt, ACA's executive director. "But look further—remember that kids get three times the exposure, twenty-four hours a day, to the camp than they get to school."

To match today's more sophisticated youth, many camps now offer mind-stretching, specialized programs. ACA's listing covers some 30 different types of learning camps—everything from science to farming. Besides camps offering academic improvement (reading skill is big on the list), there are those that will do such things as add charm (girls), reduce weight, improve the hitting of a Little Leaguer, and refine the talents of budding musicians.

But probably the most popular camps today are those that concentrate on travel and living in the rough outdoors. Outward Bound Schools (in a chip off a similar program for executives) offer an abundance of personal challenge and physical stress, culminating in a "solo" which amounts to three days alone in the wilderness with the barest minimal equipment. Standard 24- to 26-day courses cost $450 to $550, depending on whether the youngster is rafting down the Rio Grande, backpacking in North Carolina, or undergoing various tests for himself at one of four other OB Schools in the U. S.

Among travel-camp programs, those run by the Experiment in International Living (Putney, Vt.) are hard to beat. Here teenagers fan out to foreign countries all over the globe (mostly Europe), live with private families, and travel with their foreign counterparts, sharing canoes and tents. Idea is to spend six or seven weeks soaking up an overseas culture ($575 to $1,425).

Scholastic International (New York) combines the study of such things as ecology or archeology with travel overseas, mostly in Europe ($850 to $1,390).

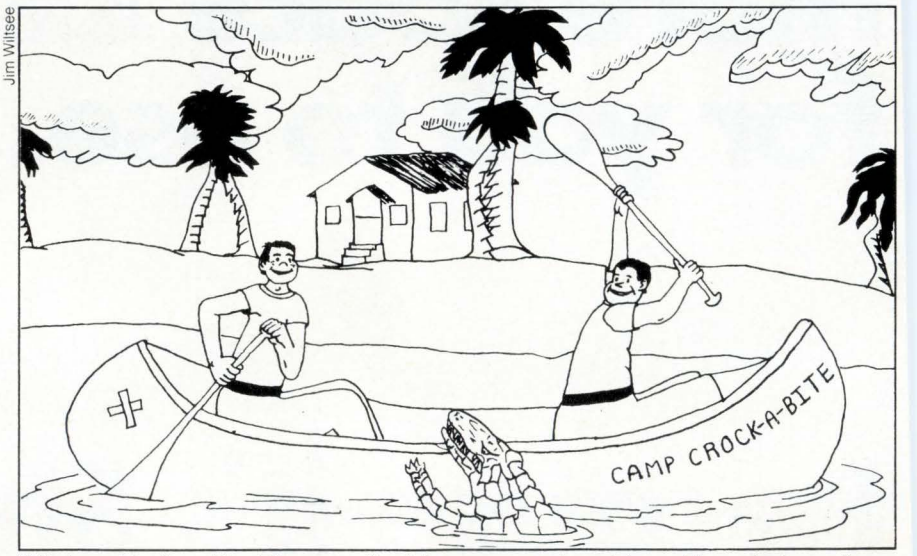
To keep camp costs down, shun the frills, cut the season—or take a look at the Scouts.

mountain rivers. About 100 Girl Scou camps, too, are today putting more em phasis on living in what one camp direc tor calls "the untouched environment."

Agency camp costs are generall much lower than private camp fees. Boy Scout camps run under $25 a week Campfire Girls about $50, and Gir Scounts from $40 to $75. YMCA anc YWCA camps are a bit more—$75 tc $150 a week.

Unhappily, there is no short-cut to foreign travel camp charges. The best be probably lies in roughing it with such groups as those sponsored by the American Yough Hostels. AYH has a wide range of programs, from, say, 22 days of cycling through France ($535) to a seven-country, 30-day tour ($765). Cycling in the U. S. is cheaper; for instance, 42 days in New England costs a modest $385.

As in most other things, private camp costs will vary a good deal, depending



"We tossed for it, and I got the crocodiles this summer and my sister got the polar bears."

If the prices seem stiff, consider that general-type private camps—those offering water sports and the usual campfire routines—are charging $700 to $800 and more for eight weeks. Says school and camp consultant Francine Foley of New York: "There are just two ways to cut the cost of a camp—pick an 'agency' camp, or go for less than full season."

Luckily the agency camps—run by the Scouts, 'Y' groups and churches—often have standout programs in wilderness camping, the very thing many campers want most. For instance, many of the 645 Boy Scout camps are loaded with what National Camping Director Russ Turner calls "high adventure" in the outdoors. Campfire Girls, with some 200 camps, often take on rough terrain and

on quality and content. Some parents wind up buying things that aren't really needed. Paying for a camp that has horses, for example, is a blunder if it's for a teenager who would rather spend the summer swimming.

Sending a child to camp for fewer than the usual eight weeks is another way to economize. For example, while Outward Bound Schools aren't cheap, their $450 to $550 charge for just under a month away from home is considerably below most private full-season fees.

Many private camp directors prefer the eight-week applicant, but frequently—as in 1972 when the economy was soft—they will make allowances toward summer's end. Says one: "If we have empty bunks, we'll fill 'em." ■

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It's hard to hate Chicago, a city that loves itself

The story goes that although Irving Berlin wrote *Alexander's Ragtime Band* in New York in 1910, Chicago made it famous. The story is rarely questioned by Chicagoans. Unlike most contemporary U. S. big-city dwellers, they unfailingly want to believe the best about their city—and some of their affection usually rubs off on those who visit.

Despite the critics of Mayor Richard J. Daley, few ever attack Chicago as poorly run. Strikes are rare, the streets are clean, and the vagaries attendant to every city government seem to have had at least some positive influence in the Windy City.

While the "neighborhood" quality for which Chicago has gained some fame and no little infamy still exists, the city—like most others—is changing. The traditional heart of the city is the "Loop," the downtown area so called after the elevated "L" Metro tracks that more or less encircle it. While the "L" is considered a landmark, Chicago has plans to tear down that early 1900s structure and put the trains underground. In fact, much of the glamor, glitter, and activity that once typified the "Loop" has all but disappeared.

But Chicago's heartbeat hasn't stopped. It's merely relocated to the North Side of town where the "Near North," "New Town," and "Old Town" neighborhoods have collectively, if not simultaneously, taken up where the old "Loop" left off.

For the visitor, a hotel in the "Loop" normally affords the most central location. However, it also means that he'll be taking taxis almost everywhere—by day to convention sites and by night to the North Side. A hotel on the North Side solves the evening problems by putting him within walking distance of the restaurants and clubs, but by day the taxi fares are likely to run a dollar or two higher—to get to the LaSalle Street financial section, for instance.

Among North Side hotels that are both conveniently located and well reputed are the Drake ($30-$41 for a double; $22-$39 single), situated on a tree-lined walkway along East Lake Shore Drive, and further north the Ambassadors East and West ($35-$44; $28-$37 single).

For something a little different—and with more space—a visitor might try the Hampshire House ($45-$60 double; $35-$50 single) on East Delaware, near Lake Michigan. The hotel has only 133 rooms, and all are suites. While the price is high, the hotel has made its name on service that covers the amenities up to and including a friendly concierge.

If circumstances dictate a "Loop" hotel selection, two of Chicago's best known establishments there are the Palmer House ($30-$41, double; $26.50-$34.50, single) on State Street, only a block away from the North-South dividing line of the city, and the Sheraton-Blackstone hotel ($31 to 45, double; $28-$36 single), adjoining the Blackstone Theater, which is the unofficial house of Neil Simon and company in Chicago. In plush if not posh surroundings, the hotel offers proximity to the "Loop" theater district.

Before settling for walking distance to the theaters, however, there's something that should be noted about Chicago theatrical productions. Since Chicago is a convention town, show operators often bring their Broadway offerings to it last. Often as not, two years on the road can take some of the bloom off the best of Broadway. Anyone who saw the New York smash musical *1776* in Milwaukee, and thought it was lackluster, should have seen it in Chicago, where it was worse. As a rule of thumb, if you like Broadway, see it there, not in Chicago.

That's not to say, however, that there isn't any good theater. There is, but, once again, it gravitates toward the North Side, where cabarets like the Happy Medium on Rush Street and the Second City on North Wells Street offer good improvisational and review entertainment. Best seats in the house can set you back $10 or $11 each, but you'll get more for the money than in the "Loop" houses.

Other theaters on the North Side that have a reputation include the Candlelight, offering *Man of La Mancha* in the round while you dine, and the more conventional proscenium stage at The Forum (next door, on South Harlem).

As for wining and dining, Chicago offers both the bland and the brilliant. *The Chicago Guide*, a monthly available at newstands, is a usually reliable source on where to go.

The "Loop" in general is a good place to lunch. Perhaps the most famous lunch spot in town is Miller's Pub on East Adams. Chicago's answer to Sardi's, it is often visited by show-folk, where, at modest prices ($17 dollars for an average dinner for two) they dine in busy but comfortable surroundings. Or there is the Palmer Steak House, in the Palmer House.

If cuisine in the provincial style of the south of France is your dish, try either of two North-Side restaurants, Le Bastille or La Cheminee.

"If you like Broadway theater, see it there, —not in Chicago . . .

For 1940s nostalgia, a drink at the Pump Room in the lobby of the Ambassador East Hotel on N. State Parkway is the ticket. An in-place to be seen, the Pump Room is primarily a restaurant, but has a small bar area where drinks are $1.70 and where a visitor can watch the "celebs" dine, and take in some of the elegance of a bygone era.

Chicago is also key-club country, the home of Playboy and several of its cousins. Playboy keyholders, of course, can dine or be entertained in the Playboy Towers, where dinner in the VIP Room can cost $50 dollars for two. Chicago's other famous key club is the Gaslight Club on East Huron. Located in a prestigious brownstone, it offers good food in a number of different rooms. But, unlike the Playboy, the Gaslight occasionally shows its years. For anyone who has to *buy* a key, best bet is probably Playboy.

Chicago, of course, has other attractions. The Chicago Lyric Opera is the only U. S. opera company outside of New York and San Francisco to offer a full, September-December, season.

Both art and architecture are also big in Chicago. The Art Institute on Michigan Avenue is reputed to have one of the finest French Impressionist collections, and the city's architectural heritage boasts the work of Frank Lloyd Wright, William Le Baron Jenney, the inventor of the skyscraper, and Mies Van Der Rohe. Walking tours of the various architectural attractions can be arranged through the hotels.

For more neighborhood roaming, Chicago's Old Town still merits a casual inspection. A number of years ago some enterprising people began to refurbish a dingy section bordering on North Wells Street. The places were quaint, the clientele young, the mood lively, and Old Town became boom town. Over the years, though, the mood turned gawdy (then tawdry), prices skyrocketed, and the place was nearly killed by its own success.

Many of its original shops have migrated to New Town, an area bounded by the Lake on the east and Halsted Street on the west. New Town is also singles country, evidenced by a plethora of friendly bars.

If all else fails, a visitor to Chicago can grab a fishing rod and take a bus down to the lake front, Within the shadows of the downtown area good coho salmon, steelhead, and chinook salmon fishing can be had. Even the most Thoreauesque will have to admit there's something right about a city where a man can still go fishing by bus. ■

On high finance and some other alien territories

DOING YOUR HOMEWORK: Right at the outset in *Understanding Financial Statements and Corporate Annual Reports* (Chilton, $5.95), author Louis O. Foster lays it on the line. "At no time is the road to this sort of learning presented as an easy one," he writes in the preface, ". . . it takes a bit of doing." Dr. Foster is emeritus professor of accounting and finance at Dartmouth's Amos Tuck School of Business Administration. He writes with authority, if not for easy reading, and his book focuses the beam of scholarship on high finance for the individual investor and stockholder. His effort might easily have been subtitled, *Understanding Capital.* Using the actual financial statements of major U. S. corporations, he introduces the investor to the accounting tools to analyze a company's sources and uses of its capital, and thereby draw the corporation's true financial profile. This new edition also covers mutual funds in clinical detail. *Understanding Financial Statements* is for the serious investor who wants to comprehend the fine points of corporate finance and accounting—and is willing to do his homework.

AT HOME ABROAD: It happens a little less frequently than it used to, but U. S. corporations still shove their people around the globe. For the family suddenly shifted abroad, Alison Raymond Lanier has written *Living in Europe* (Scribner's, $8.95). Mrs. Lanier, working for the U. S. State Department and several large overseas companies, has long taught Americans how to thrive on alien soil. Her advice ranges nearly everywhere, from dining room etiquette to shopping, schooling, health,, housing, easing one's way through customs and immigration, and some of the way-of-living quirks that distinguish one country from another. For those who find themselves Europe-bound, it could be as comforting a guide as Dr. Spock was for a generation of new parents.

WHEREWITHAL: For those to whom personal finance is an untracked wilderness, there is now *The Money Book* (Scribner's, $8.95). With A-B-C care, author W.J. Reddin covers the ground from budgeting to borrowing, saving, investing, and writing your will. ■

Deductions that save you money

Now and again the Internal Revenue people show a touch of compassion for the weary taxpayer, and in some areas—such as *medical and casualty deductions*—IRS seems to lean almost toward indulgence.

Although even the American Medical Assn. has failed to take a solid position yet on acupuncture, IRS's stand is positive. Fees and related charges paid for acupuncture are now fully deductible. This is not so astounding when one considers how broadly IRS defines "medical." Such items as fees paid to Christian Science practitioners, the cost of wigs—if MD-prescribed for mental health reasons—and clarinet lessons advised by a dentist for treatment of tooth defects, are deductible.

Generally, any cost of diagnosis, treatment or prevention of disease, is subject to tax write-off. A rough rule of thumb: If your doctor prescribes it, deduct it.

The casualty-loss deduction picks up some liberal IRS treatment with the declaration that purely *accidental* losses can now sometimes be fitted into the definition of "casualty," and written off.

IRS bends its back and—after a lapse of several years—"acquiesces" to the outcome of a case it lost in court. In that case, an auto door slammed on a woman's hand, crushing a diamond ring. Clearly, the ring itself became a deduction—it was damaged in a "sudden" event and thus fell within the definition of a casualty. Now, in a change of stance, IRS agrees that the diamond in the ring—*lost* in the aftermath of the accident—is deductible, too. The diamond's loss, after all, was the direct result of a "sudden" event, the slamming of the ring finger in the car door.

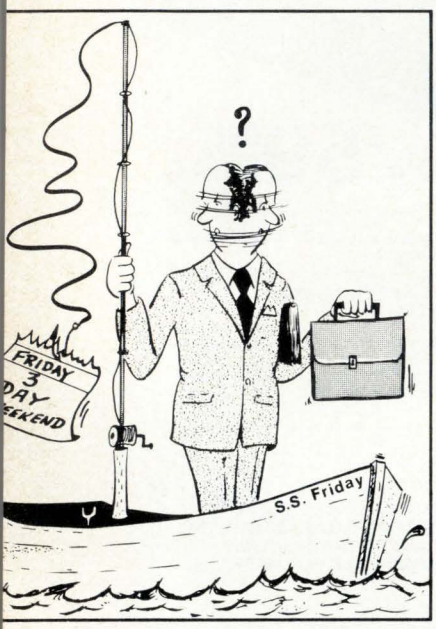
The case points to a sizable list of possible new deductions—personal items lost in the confusion of auto accidents.

On the job front, anybody who is switching companies may find himself in line for a modest tax-deduction break. Clearly you can deduct any charge paid to an agency or counselor that helps you locate a new employer. Now, because of a string of favorable court cases, it appears that a deduction may soon be possible to cover such a fee even though the agency *failed* to find a new job.

Healthy, wealthy and wise

by Joseph Wiltsee

Are you "loose" enough to swing with a 4-day week?



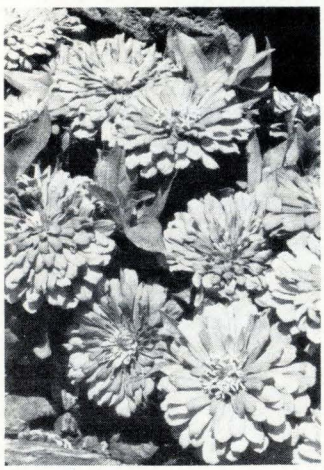
Robert McAuley

You may have to shake up your *work-week timing,* and *leisure planning,* as we The 4-day week is no joke—it may be just around the corner. . . . Hard eviden comes from Opinion Research Corp., the Princeton, N.J., consultants whose e perts personally interviewed 511 top and middle management executives in all i dustries. Over 70% think the 4-day week will soon become the *modus operandi* business, and believe that this will have taken place by 1980. The ORC repo shows the executives feeling strongly that the 4-day week will do a lot more goo than harm. . . . Besides creating vast new demand for leisure goods and service it will lead to closer family ties, more adult education, more traveling—and with r foreseen decline in the commitment to work.

Executives, though, have a considerable amount of adjusting to do, according the psychologists. The one who fails personally to gear up for the 4-day week ma face some troubles at the office and some life-style shocks at home. . . . For e ample, Arnold Judson, a psychologist with Arthur D. Little, Inc., the consultant notes that "This may be the businessman's last chance to feel 'undriven' by h work—if he's smart he'll plan on doing more of the things he's been promising hir self for 20 years." . . . The younger manager will fare best, in the view of Bill M yer, consultant with Chicago-based Roher, Hibler & Replogle. "He's flexible. B the 50-plus executive may have trouble—he'll need to force himself to round h life. If he's the type who's overly concerned with 'proving his value,' he's apt view the long weekend away from the office as a threat." . . . Consensus: For mo executives, the 4-day week poses an opportunity, not a threat. But it won't g away, and can't be ignored.

Changing jobs? There's a right way to use search firms

For the businessman changing jobs, it's a case of handholders galore. A new *D rectory of Executive Recruiters* has been compiled by Consultants News, Temple ton Road, Fitzwilliam, N.H. ($5). It lists some 560 firms across the country, includin the recruiting offices of the major CPA firms (an added feature that should interes mainly financial executives). The listing makes no effort to rate the recruiters (weakness), but it does flag their operations in terms of job catagories and minimu salaries. Some go as low as $10,000; others—such as the nationally known War Howell, Heidrick & Struggles, Boyden, and Spencer Stuart—are listed at $25,00(plus. . . . But the listing of 560 outfits is, in itself, part of the problem faced by any body who wants to use the professional search firms as an aid in relocating. Ho does one pick a workable eight or 10 firms to which to mail resumes? It isn't easy.


Peter Pan Scarlet Zinnia

Some recruiters are solid with track records to show for it; others are apt t prove fruitless, at best. One approach—maybe the only sensible one—is to scree local and regional firms by means of some careful inquiry, and then add to your lis the names of a few established national outfits. . . . *Some tips:* Bona fide recruit ers are paid by management, never by the individual. They interview only with spe cific jobs in mind, and for the most part they do not even acknowledge resumes However, if you happen to have the specific qualifications for a specific job, the ac tion can come fast. . . . *Don't* attempt to fool a recruiter as to your age or earning or, indeed, anything on your resume. Frankness and straightforwardness are *must.* The recruiter, if he's a real pro, will respect the confidence of your situation– and if you have any doubts on this score, then you've picked the wrong recruiter.

Breath of spring

Two 1973 All-America garden winners are Peter Pan Scarlet Zinnia (new color) and Happy Face Marigold (deep golden yellow). The Peter Pan combines large, wel doubled flowers with dwarf plant size, a combination currently in vogue. Happy face is an excellent "hedging" variety. Both grow easily from seed.