March 7, 1974

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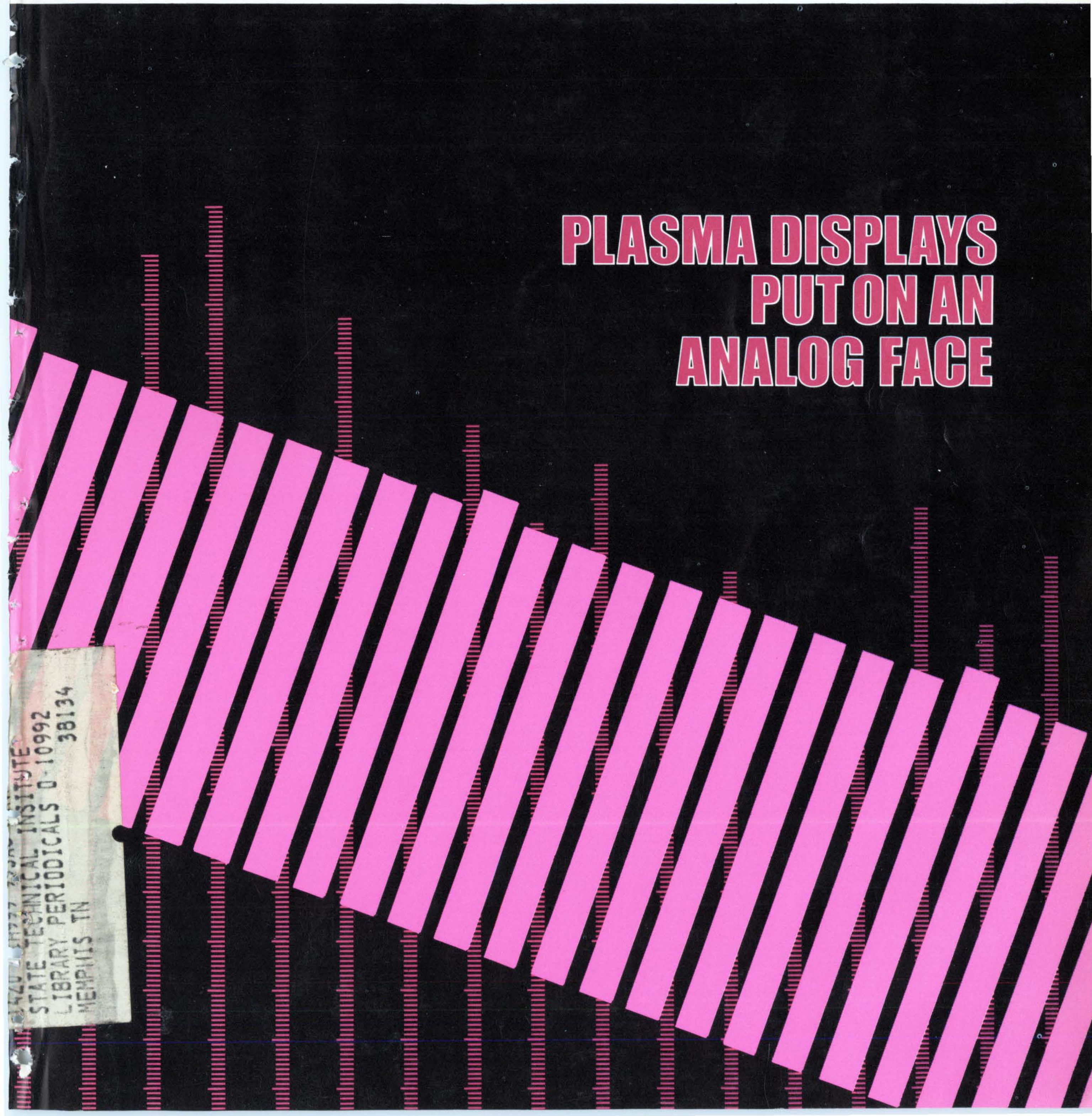
Electronics



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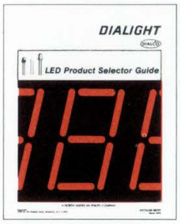

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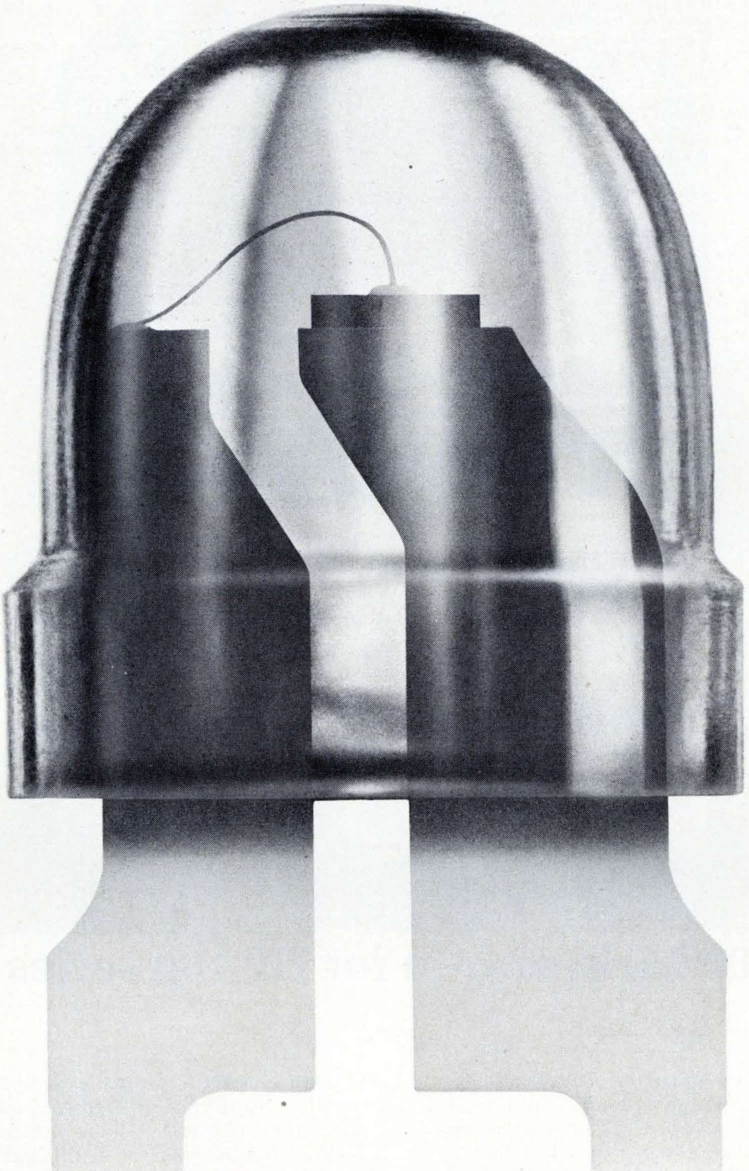

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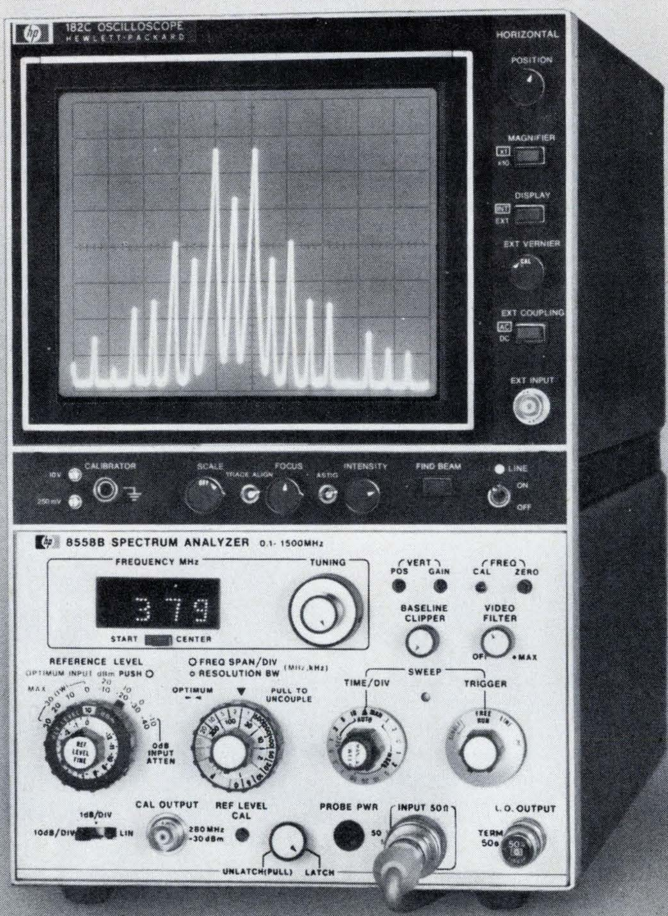

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Electronics

The International Magazine of Electronics Technology

Vol. 47, No. 5 • March 7, 1974

Highlights

The cover: Analog display takes on new glow, 89
Bar graphs driven by digital circuitry are the latest development in the fast-moving field of gas-discharge technology. Having no moving parts, a Burroughs panel is a strong challenger to existing electromechanical indicators.

Car makers need perfect devices for pennies, 74
Semiconductor manufacturers have yet to learn that automobile economics demands higher levels of quality control and reliability than even aerospace programs. This was the message from automotive company representatives at an ISSCC discussion and a panel sponsored by *Electronics*' magazine.

How companies evaluate EE performance, 107
Today's more thorough and more objective evaluations are improving communications between managers and EEs and often help the individual engineer plan his career more effectively. This Special Report surveys systems in use at firms across the country, and a questionnaire invites *Electronics*' readers to tell how they react to being evaluated.

Simpler n-channel process increases yields, 117
Higher yields mean lower costs, yet the resulting ion-implanted metal-gate MOS devices perform as well as silicon-gate LSI. They also operate off +5 volts and are fully TTL-compatible.

And in the next issue . . .
Optical waveguide moves into systems . . . a 12-bit microcomputer . . . designing with computer-generated Smith charts.

Electronics

Publisher's letter

As evaluation of an engineer's job performance has become more sophisticated, the process of evaluation itself is having increasingly more impact on the career of every engineer. What's more, evaluation has become an increasingly effective tool in helping supervisory personnel do their job.

Since evaluation used to be thought of as just a necessary chore, we were surprised at some of the changes in attitude that we found when we conducted a survey for our report on the dimensions of engineering evaluation today (see p. 99). For one, an unexpectedly large number of EEs not only approve of the concept, but, in fact, desire to be evaluated—and then informed of the results. Indeed, more and more companies are encouraging the engineer to comment on his rating by providing space for that purpose on the evaluation forms.

The most important byproduct of evaluation procedures is an increased communication between supervisor and engineer, which leads to higher productivity and greatly helps in career planning.

Our survey's cross-section, while representative, was necessarily a small one. So, to get a better handle on the pros and cons of evaluation—and find out how you readers react to your company's evaluation procedures—we've included two questionnaires in this issue (see p. 103 and p. 104). We urge you to take the time to fill one out. In an upcoming issue, we'll publish the results, as well as the most illuminating comments that we receive.

The automobile represents a relatively new and potentially lucrative market for electronic products. But there's a long journey between seeing the possibilities of the market and successfully entering it. In our Probing the News section this issue, we have two stories—both about automotive electronics—illustrating that long trip.

The first, by our Washington bureau chief, Ray Connolly, rounds up the current status of electric-vehicle research in the U.S., Europe, and Japan (see p. 70). The conclusion: there should be a strong market there for electronic controls. But there's still a lot of work to be done—on both cost and performance—and it's still at least three years before electric vehicles—most likely buses—come on strong.

Connolly, in reporting on the Third International Electric Vehicle Symposium, points out that "solid-state technology is still a newcomer in the EV marketplace." It's the potential of that technology that makes the market attractive and only time will tell if the potential can be realized.

In a way, the electric-vehicle market holds out the same kind of promise that Detroit did several years ago. On page 74, our Managing Editor-News, Larry Curran, has put together a report card on the first mass installations of electronic seat-belt interlock systems, electronic ignition, and electronic fuel injection. The score given by auto makers to electronics: A for effort. But as you'll see when you read the article, the reliability vs. cost problem, the key to the future of electronics in cars, is still a big question mark.

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Readers comment

Date-coding ICs

To the Editor: This is to supplement Fred U. Rosenberger's letter on the problems of date-coding ICs [*Electronics*, Dec. 20, 1973, p.6]. The confusion that Mr. Rosenberger mentions is, in fact, already with us because several manufacturers use a three-digit code. They must eliminate the initial seven, banking on the likelihood that the user won't mix parts made recently with parts made a decade ago or a decade hence. Thus it was that I was asked to determine if an op amp marked 316 was, in fact, LM316. It was not, but it certainly was date-coded for the 16th week of 1973.

I suggest that if manufacturers who use the four-digit code would substitute the letter D for the seven, and if manufacturers who use the three-digit code would prefix their codes with the letter D, it would cause less confusion.

Lawrence W. Johnson
Hewlett-Packard Laboratories
Palo Alto, Calif.

HP-35 statistical analysis

To the Editor: In "doing statistical analysis with a single data entry," [*Electronics*, Nov. 8, 1973, p.121], Walter Manka suggests a 10-step method for finding standard deviations. Here's a key sequence that eliminates one of the steps: DATA, ENTER, ENTER, ×, RCL, +, STO, ROLL DOWN, +. If you have a large number of data inputs, saving that single step can save a lot of time.

It is also possible to use the HP-35 calculator as a counter, taking advantage of the behavior noted by J. Snaper in another Engineer's Notebook, "Storing two constants instead of just one," [Nov. 8, 1973, p. 121]. Just load the increment, push ENTER three times, and you are ready to count. To set the display to zero, push CLX, and each press of the + key will then change the display by the desired increment.

The Rev. Walter L. Pragnell
Grace Church
Everett, Mass.

To the Editor: The Engineer's Notebook, "Doing statistical analysis with a single data entry," shows an equation that is not the generally accepted one for relatively small sample sizes, where N is less than or equal to 30. The correct equation is:

$$S.D. = [[\Sigma(D_i)^2/N - 1] - [(\Sigma D_i)^2/N(N-1)]]^{1/2}$$

With this equation, the mean, variance, and standard deviation can still be determined with a single data entry on the HP-35 calculator.

Paul Wahlstrom
Reserve Mining Co.
Silver Bay, Minn.

■ *The author replies: Where a rigorous analysis is required, your equation should be used. By increasing N, the two equations approach equality. The differences between the two equations with N = 5 is about 12%, with N = 10, it is about 5%, and with N = 30, it is about 1.7%. These differences usually are not large, compared with the indeterminate errors present. Therefore, it becomes a matter of convenience which equation to use.*

For example, with N = 31, there is still a difference of 1.02%. In some situations, this may still be significant, requiring that your equation be used with sample sizes greater than 30. The accuracy desired depends on the situation. The important point is that statistical analysis can be done on the HP-35 with a single data entry.

Cutting keystrokes

To the Editor: Some keystrokes can be trimmed from the method suggested by Philip Geffe in "Evaluating polynomials and finding their roots by means of the HP-35 [*Electronics*, Engineer's Notebook, Nov. 8, 1973, p.120].

The polynomial can be written as:

$$P(x) = a_n x^n + a_{n-1}x^{n-1} + \ldots + a_1 x + a_0$$

For evaluating $P(x_0)$, the key sequence becomes:

x_0, ROLL UP, ROLL UP, ROLL UP, a_n, ×, a_{n-1}, +, ×, a_{n-2}, +, ×, . . . , a_1, +. ×, a_0, +

The longer the polynomial is, the more keystrokes can be saved with this method.

John A. Ball
Harvard College Observatory
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40 years ago

From the pages of Electronics, March, 1934

Radio and the FCC

President Roosevelt has asked that a new Federal Communications Commission be set up to take over the functions of the Federal Radio Commission and the communication responsibilities of the Interstate Commerce Commission. Two bills accordingly have been introduced in Congress: Representative Rayburn's bill which would create the new Communications administration and set it in operation with the existing radio laws; and Senator Dill's bill which would repeal all present radio legislation and enact a wholly new law in its place.

The Federal Radio Commission has been purely a traffic-regulating body. The new Commission of seven will handle ether traffic and in addition take over rate-fixing and the supervision of all charges made for interstate and international communication. Excepted from this, however, will be broadcasting advertising rates—broadcasting being clearly defined by all parties as not a common carrier. Supervision of operating conditions by broadcasters will be continued by the new Communications Commission.

While there is always the hazard that a new group of seven political appointees will find work to keep themselves apparently busy and to build a vast bureaucracy as in the cases of other Washington commissions, it begins to be apparent that the force of the new communications administration will fall chiefly on the wire services where the vast bulk of the dollar volume lies. There is as yet little continental radio communicating service . . . When the new FCC comes to fixing upon international radio rates, the dilemma is presented as to how the American commission can fix rates, when it has no authority over the various foreign governments which cooperate in the interchange of radio messages! On the other hand the FCC can play a great future part in coordinating American communication services and putting the Government firmly behind American operating companies . . .

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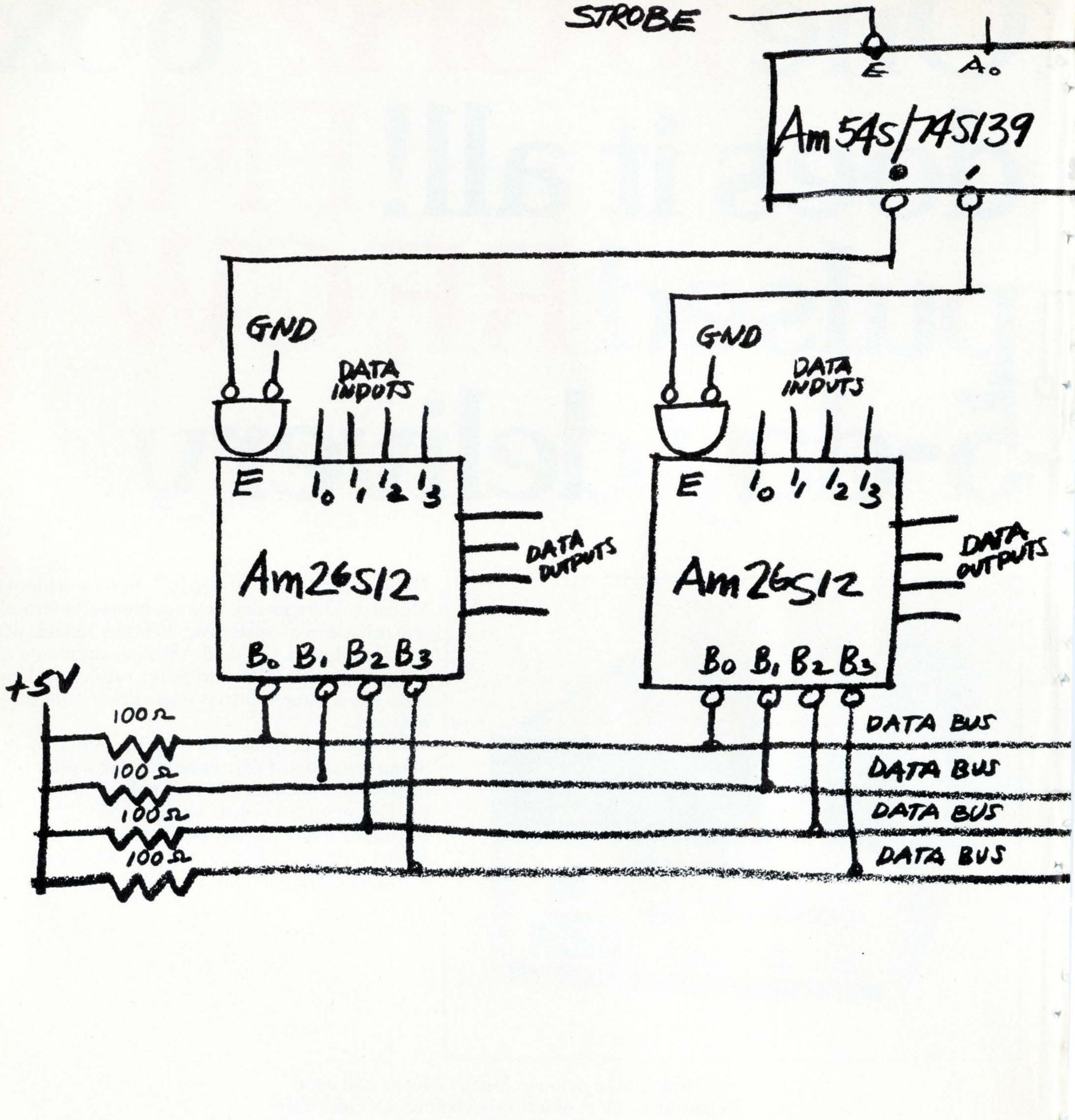
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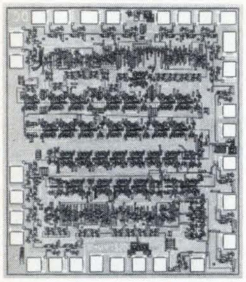
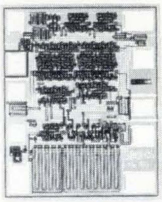
It's time for silicon gate





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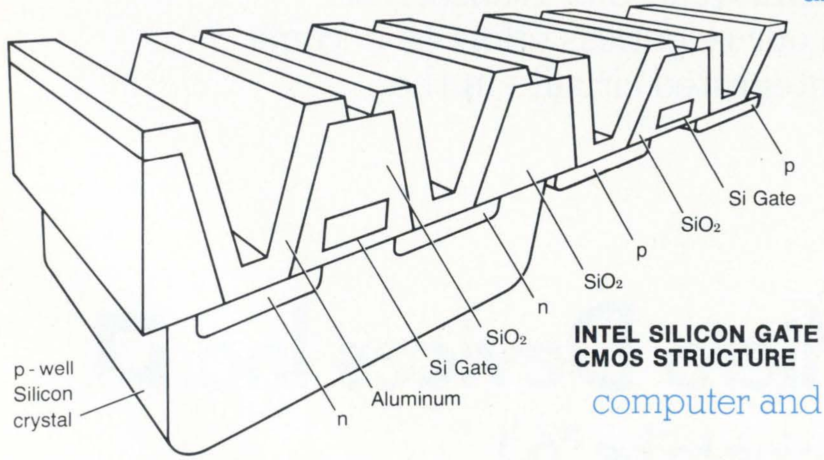
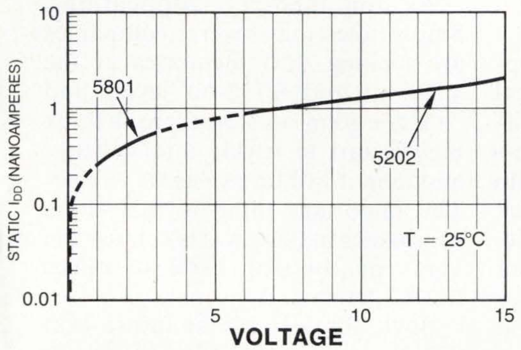
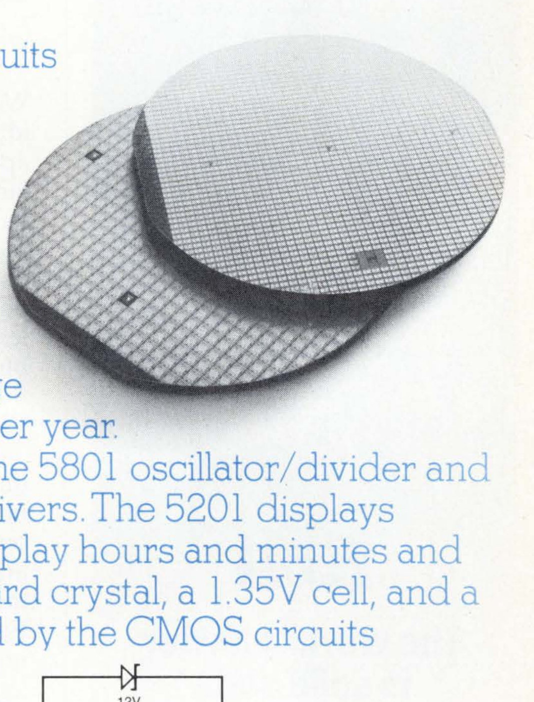
This advanced CMOS technology will move ultra-low-power designs ahead just as Intel's silicon gate p-channel and n-channel MOS technologies are moving microcomputer and memory designs ahead.



INTEL SILICON GATE CMOS STRUCTURE

Intel to talk CMOS.





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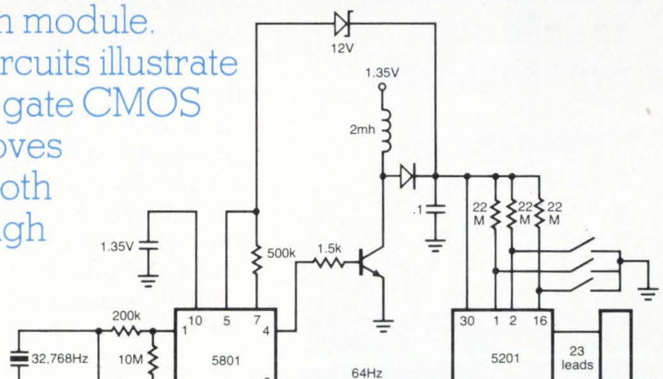
The watch circuits illustrate how Intel's silicon gate CMOS technology improves performance in both low voltage and high voltage operating ranges. They're a small sample of the exciting CMOS designs you'll be talking about with Intel. Don't wait—write now for more information on silicon gate CMOS. Intel Corporation, 3065 Bowers Avenue, Santa Clara, California 95051 (408) 246-7501.



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CCD inventors win Liebmann award

With the charge-coupled device rapidly finding its way into practical applications, its co-inventors—Willard S. Boyle and George E. Smith—have been honored by the IEEE with the Morris N. Liebman memorial award. Citing the two Bell Telephone Laboratories engineers for leadership in the field of MOS-device physics, the award was presented at the recent International Solid State Circuits Conference in Philadelphia.

The acceptance of CCDs was not unexpected by the two Bell Labs men. Both envisioned from the outset the three principal applications areas that are emerging: imaging, memories, and analog delay lines. For his part, though, Boyle has been mildly surprised at how fast imaging applications are moving. "We're now talking about some large arrays that work," he points out, such as the 256-by-220-bit one in Bell's experimental video camera [*Electronics*, Feb 21, p. 29]. (Smith and Boyle are shown on a video monitor through the lens of the experimental Bell Labs' camera.)

Boyle who is now executive director of Bell's Allentown and Reading, Pa. labs, believes that imaging has probably come on first because "there just wasn't anything that did the solid-state imaging job very well. It filled a vacuum."

Smith, a department head in the Unipolar Integrated Circuit Laboratory, remarked how easy it was to get good transfer efficiency into the devices: "That was our first bugaboo," he says, but it was quickly overcome.

As for memory applications, Smith notes that several companies are making CCD memories at the 4,096-bit and 8,192-bit levels and "it's not going to stop there. I think they'll start to trickle into systems, and then it will be like RAMs vs core. The important thing is that those companies making RAMs can use the same production lines to make CCDs," he says.

Boyle foresees use of future CCD imaging in a variety of consumer products, but he also looks for incorporation of CCDs into instrumentation. "If you have a good linear device with good resolution," he observes, "it should get into spectroscopy, for example, and maybe even astronomy."

Smith thinks astronomy is probably a rather esoteric field for CCDs, although he won't rule it out. However he expects "more mundane" uses to be found for the devices. "A big use," he says, "could be in machine-positioning functions, such as mechanical-assembly machines, because you'd get good positive feedback."

Heath makes assembled instruments, kits compatible

Deciding to home in on the industrial assembled-instrument market, the Heath Co. has started to phase out its more exotic scientific instruments, such as the spectrophotometer. The principal architect of the change for the Benton Har-

"Delivery In 42 Weeks?"

For some companies that's a death sentence.

Picture yourself waiting—42 weeks!—for a 10-cent part you desperately need to complete your product. That's typical of the leadtimes being quoted for all kinds of components and materials as industry after industry gets hit by shortages. And there you are with your overhead costs soaring, your unhappy customers demanding shipment, and your production line at a standstill. It's a chilling thought. But for a lot of people, it's real, and right now. And from the looks of things it's going to get worse.

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bor, Mich., firm, is Jimmy Lee, newly named engineering vice president. Lee, who has an MSEE from Georgia Tech, formerly was manager of the Heath/Schlumberger scientific instrument line.

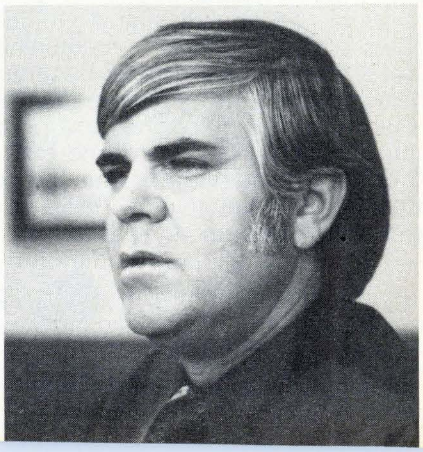
"We're concentrating on those instruments compatible with the rest of the Heath line–electronic test and measuring equipment and automotive-test equipment," he says. Besides consolidating Heath's two engineering staffs, the move will bring the marketing of the new line into closer compatibility with that of other Heath products. "A $6,000 instrument doesn't lend itself to mail-order," Lee comments.

While the industrial and the hobbyist lines aim at the medium- to low-cost instrumentation market, there are differences: "Sometimes it's only a styling change; sometimes the instrument's design is involved." Differences are dictated by the differing needs of the customers, and by economies of production. "Take frequency counters, for example," Lee says. "We go up to 600 megahertz for our industrial counters, and the hobbyist doesn't need that sensitivity."

But the biggest factor is the more price-conscious kit builder. "The kit product may have a switch with wires to the pc board–we can save him some money," he points out. "But in the assembled product, we'll have a switch that plugs into the pc board. It's a more expensive part, but it saves labor."

The new line will be marketed through Heath's retail stores and by mail–a growing trend for medium-priced instrumentation sold to industry and consumers alike.

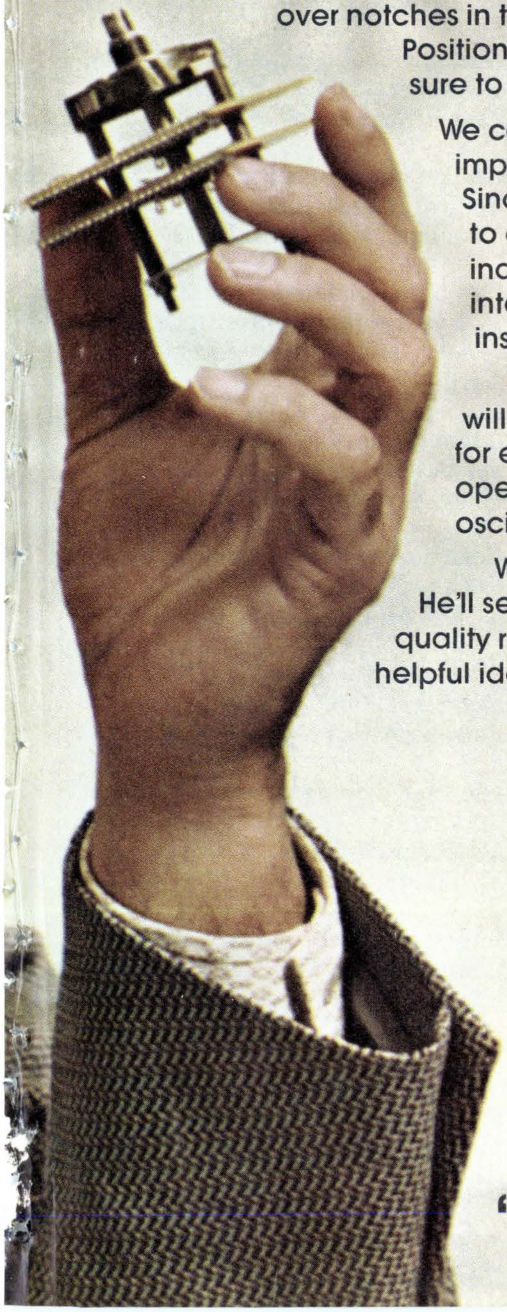
In phase. Jimmy Lee will phase out Heath's exotic instrument line.



Bern Golbeck's nifty idea gave a crisp new feel to rotary switches.

A few years back, Oak's Director of Engineering, Bern Golbeck, had a hunch. Use two ball bearings instead of one, and let them index a simple starwheel. This would give crisp detenting while greatly reducing the wear on any single moving part.

It worked. The two ball bearings, controlled by flat springs, travel independently over notches in the starwheel. Detenting is smooth, even and sure. Positioning is precise. And it gives a crisp, uniform feel that you're sure to recognize.



We call this fancy detent system Unidex,® and it's just one of many improvements Oak engineers like Bern have pioneered. Since Unidex, we've added molded rotors and molded sections to our rotaries—innovations that are now benchmarks of the industry. And today we're busy incorporating PC board mountings into almost all our switch designs for the quickest and simplest installation possible.

We think you and the people who use your products will notice the difference great ideas like Unidex make. Just try, for example, the storage select switch on an IBM System/370 Model 145 operator's console. Or the sweep selector on a new Hewlett-Packard 1220A oscilloscope. You'll feel it.

While you're at it, write Dave Clifton at Oak. He'll send you free literature detailing the broadest line of quality rotaries in the industry. And he'll pass along some of Bern's helpful ideas on how to choose the right rotary switch for your job.

OAK Industries Inc.
SWITCH DIVISION/CRYSTAL LAKE, ILLINOIS 60014
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"Nice going Bern"

Circle 19 on reader service card

Meetings

Aerospace and Electronics Systems Winter Convention (Wincon): IEEE, Marriott Hotel, Los Angeles, March 12–14.

Zurich Digital Communications International Seminar: IEEE, Swiss Federal Institute of Technology, Zurich, Switzerland, March 12–15.

International Convention (Intercon): IEEE, Coliseum and Statler Hilton Hotel, New York, March 26–29.

Salon des Composants Electroniques: SDSA, Porte de Versailles, Paris, France, April 1–6.

International Reliability Physics Symposium: IEEE, MGM Grand Hotel, Las Vegas, Nev., April 2–4.

International Optical Computing Conference. IEEE Computer Society, Zurich, Switzerland, April 9–11.

Optical and Acoustical Micro-Electronics: IEEE, Commodore Hotel, New York, N.Y., April 16–18.

Carnahan Conference on Electronic Crime Countermeasures: IEEE, University of Kentucky, Lexington, April 17–19.

International Circuits and Systems Symposium: IEEE, Sir Francis Drake Hotel, San Francisco, April 21–24.

Communications Satellite Systems Conference: IEEE, International Hotel, Los Angeles, Calif., April 22–24.

Pittsburgh Conference on Modeling and Simulation: ISA, University of Pittsburgh, Pa., April 24–26.

National Computer Conference, AFIPS/IEEE Computer Society, McCormick Place, Chicago, Ill., May 6–10.

International Magnetics Conference (Intermag) '74, IEEE, Four Seasons Sheraton Hotel, Toronto, Canada, May 14–17.

Semicon/West '74, SEMI, San Mateo Fairgrounds, San Mateo, Calif., May 21–23.

A flexcircuit for the new Mustang II

We did it for Ford.

Ford Motor Company hopes for big things for the 1974 Mustang II, with consumer acceptance equal to or better than the original Mustang.

It's a quality engineered, totally new automobile. And part of its quality, though unseen, lies in the Schjeldahl flexible circuit used behind its attractive and functional instrument cluster.

This new flexcircuit was engineered to accommodate multi-plane design with errorless connections. At the same time, possible future circuitry needs for safety standard items such as ignition interlock systems and additional warning lights were provided.

Flexcircuitry may be the answer to your electronic design problem too. It's now six years old with Ford Motor Company. And they've proven that it will do the job like nothing else could, along with reducing manufacturing costs.

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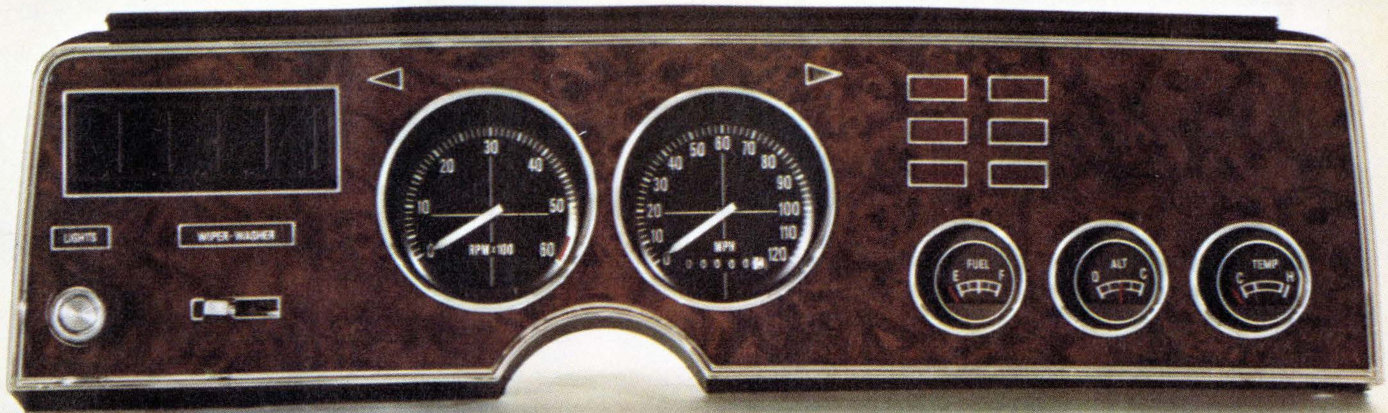
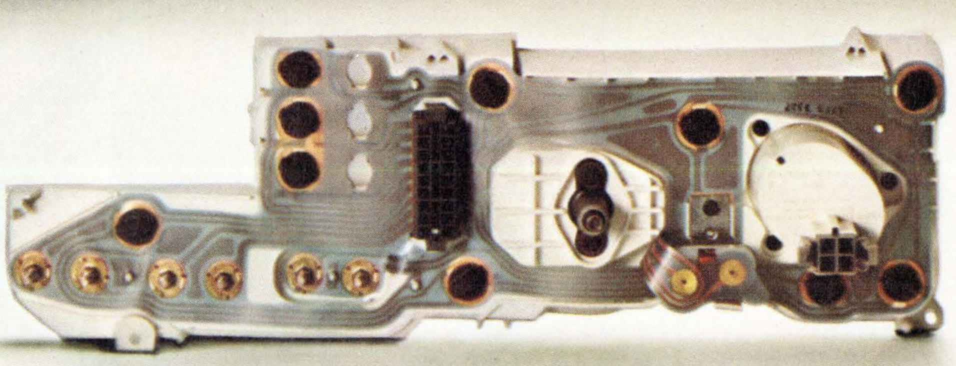


MUSTANG II

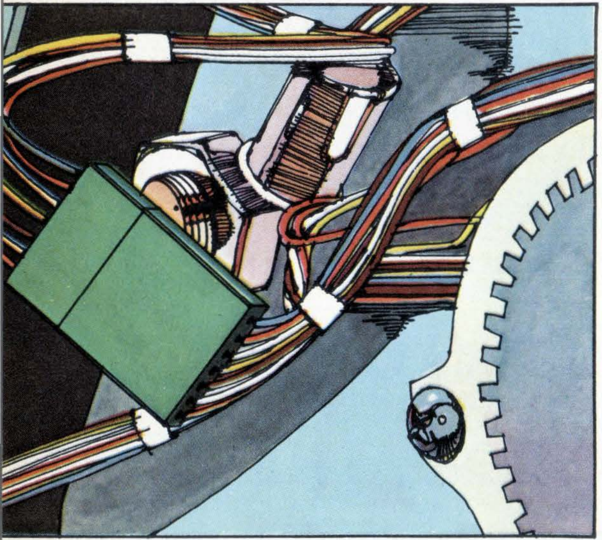


And we can do it for you.

Circle 21 on reader service card

Growing with the

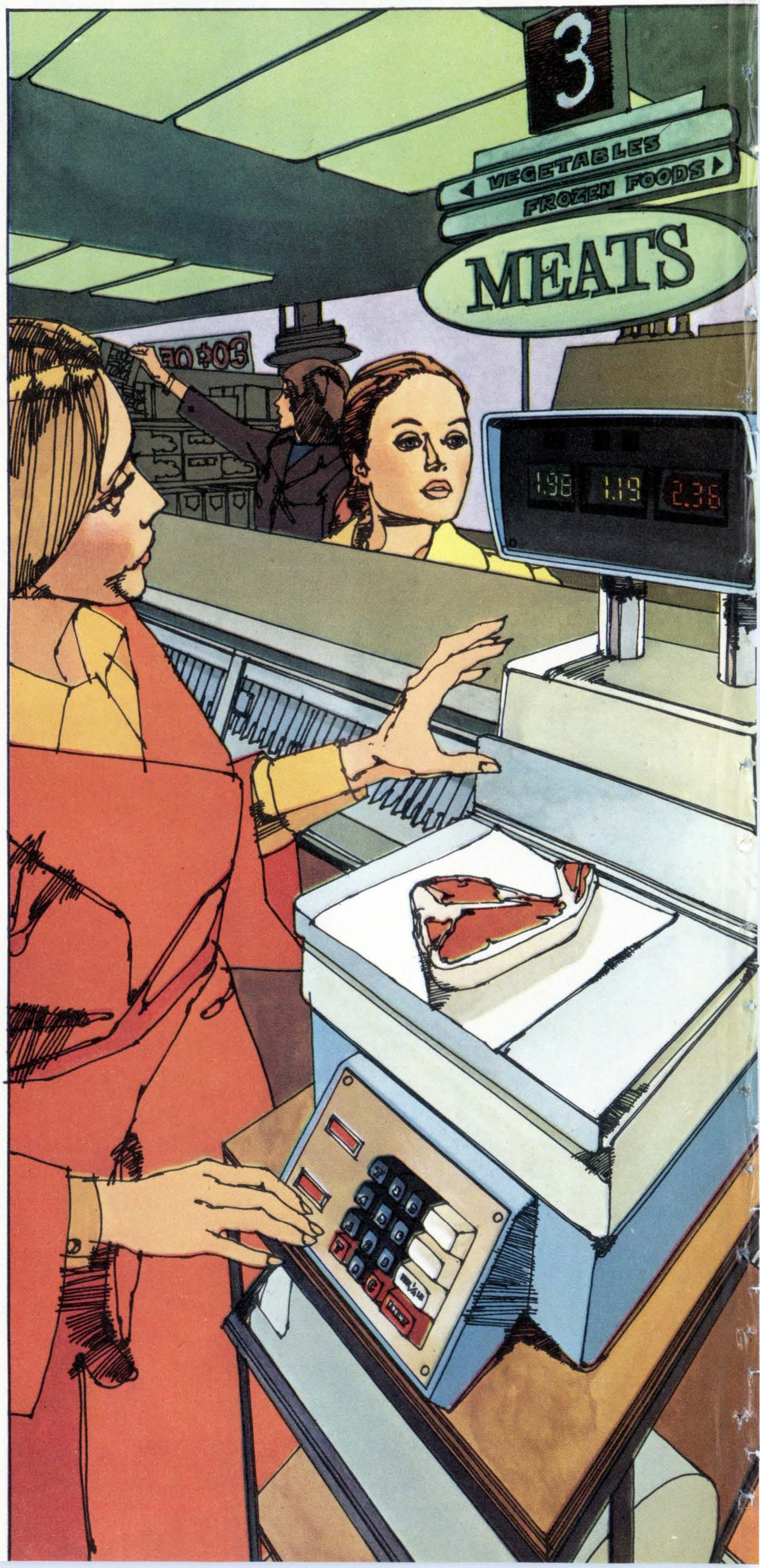
Amphenol connectors help assure correct weight in new automatic weighing system.



Meat merchandising has taken a big step forward with advanced solid state circuitry. The system includes a scale, mini-computer, and a printer in an integrated modular package that can weigh and price meat in seconds.

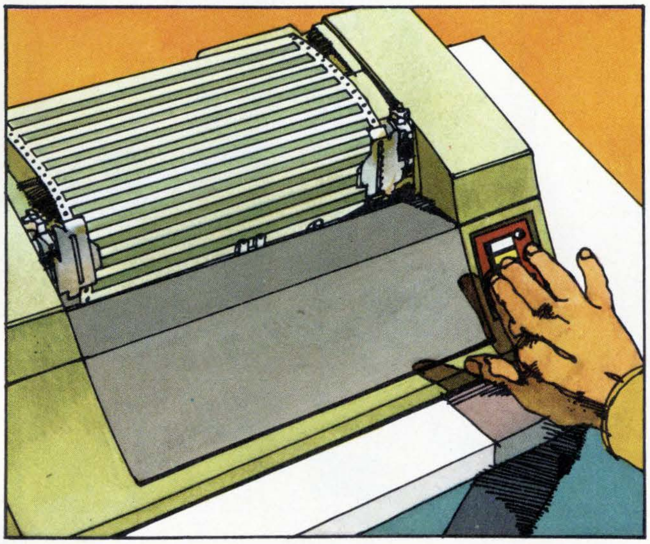
Amphenol 221 Series micro-miniature connectors share the responsibility for transmitting weight and price data to the mini-computer. Their low cost, sturdy design, and high-reliability contact configuration make them ideal for this application.

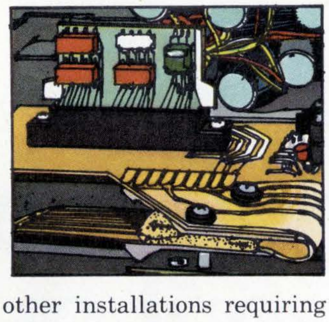
The 221 Series does the same kind of reliable work in a variety of equipment in the electronic data processing, telecommunications and home entertainment industries.



new electronics

Amphenol connectors help transmit computer data in new high speed printer.

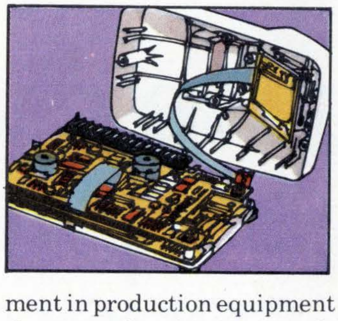




A unique modular matrix printer was recently developed to interface with mini-computers, medium-speed batch terminals, and other installations requiring high speed data output. Data is received at up to 75,000 characters per second. The data is then carried through PC cards to a printing head with an output of up to 165 characters per second.

Precise signal input and data output depend on consistent and accurate information flow. That's why this peripheral systems manufacturer specifies Amphenol 225 Series PC connectors and 6034 Series trimmers. They also rely on Amphenol connectors as an important link to the power supply portion of the printer.

Amphenol assembly services help produce new credit card verifier.



A major computer corporation recently developed a new computerized credit system. To eliminate a costly investment in production equipment and inventories, they turned to the Amphenol Cadre Division.

All assembly and material supply is now handled by Amphenol people including component preparation, stuffing and wave soldering of printed circuit boards, hand wiring, and mechanical assembly. In addition, unique quality control tests are carried out.

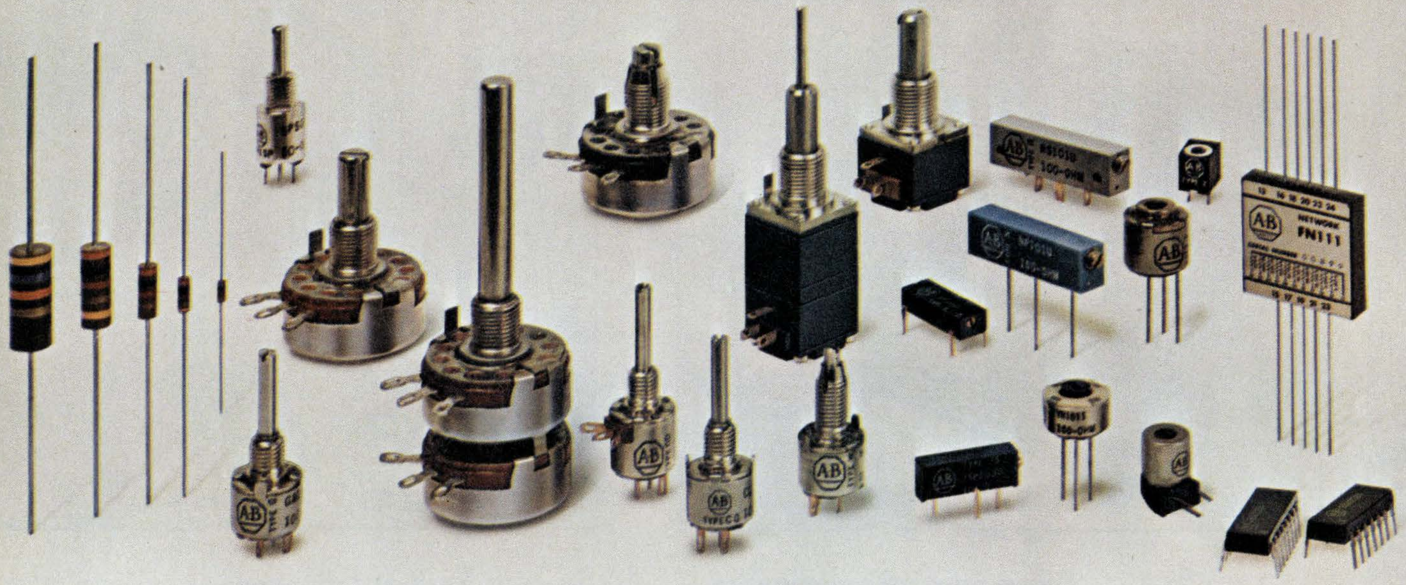
Over 500 units have already been produced with excellent turnaround time and high product quality. They are now in use by a nationwide resort and restaurant chain for added customer convenience and man-hour savings.

BUNKER RAMO AMPHENOL

For more information, contact these manufacturing/sales facilities. United States: Amphenol Components Group, 1830 S. 54th Av., Cicero, IL 60650 **Canada:** Amphenol Canada Ltd., 44 Metropolitan Rd., Scarborough, Ont. **Great Britain:** Amphenol Ltd., Thanet Way, Tankerton, Whitsable, Kent, England **West Germany:** Amphenol-Tuchel Electronics Gmbh, 8024 Deisenhofen bei Munchen, West Germany **France:** Usine Metallurgique Doloise, 92a98 Avenue de Gray, 39100—Dole, France **Australia:** Amphenol Tyree Pty. Ltd., 10-16 Charles St., Redfern, N.S.W. 2016, Australia **India:** Amphetronix Ltd., 105 Bhosari Industrial Area, Box 1, Poona 26, India **Japan:** Daiichi Denshi Kogyo K.K., 20, 3-Chome, Yoyogi, Shibuya-ku, Tokyo, Japan 151

Circle 23 on reader service card

There's more to resistors than resistance



If you're really serious about cost, be serious about quality.

If you think all resistive components are the same, listen to what these users have to say about Allen-Bradley fixed composition resistors:
Buyer—"A-B has shipped nearly four million parts without a single reject or problem. The quality is superb. I've spent 12 years in production control and purchasing. I've seen the amount of down-time, rework and field retrofit caused by others."
President—"We have used many millions of Allen-Bradley hot-molded resistors. The uniformity of quality from one shipment to the next is truly outstanding."
Engineer—"When we use A-B resistors instead of some other make, it's one less component we have to worry about."
"We learned the hard way. The subtle things make the difference. They all add up to the top quality we want in our products."
Purchasing Agent—"We wish we had more Allen-Bradleys."
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A-B QUALITY

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Milwaukee, Wisconsin 53204

Circle 24 on reader service card

Electronics newsletter

TI's 4,096-bit RAM hit by yield problems

Texas Instruments is having yield problems with its much-heralded 4,096-bit RAM, the TMS4030. The result is that at least one customer is using an additional supplier while a second has contingency plans for a 1,024-bit part, **threatening TI's lead in the 4k memory market.** Hewlett-Packard, which has gone to Mostek to satisfy its needs, says that those TMS4030 memories it has on hand are "excellent," but that it isn't getting enough. And Datapoint, a San Antonio, Tex., terminal and peripheral maker, says it isn't alarmed because it can switch to a 1k memory.

Meanwhile, TI, which is working to increase yields and volume, says, **"We are convinced that the 4k RAM will be producible in large volumes this year"** but won't commit to definite delivery dates now.

United challenges instrument makers with test lines

United Systems Corp., Dayton, Ohio, is mounting a well-financed drive designed to take over a larger share of the test and measurement market. **The company has developed more than 20 new products for introduction during the first quarter of 1974** in a design effort that has cost more than half a million dollars thus far.

Included are new housings and proprietary circuitry, some of which is in the form of custom LSI chips. The objective is to make the company's new products more attractive, both physically and economically. **For example, United's 4½-digit panel meter sells for $219. The nearest competitor is priced at $250.**

The HT (for high-technology) series makes its formal debut at IEEE's Intercon 74 March 25 (see p. 147) where 22 members of the family are being shown.

Motorola invading data market

Motorola Semiconductor will soon launch a major invasion of the MOS data-communications market. Following the announcement of its 8-bit n-channel silicon-gate microprocessor chip set (see p. 29), **Motorola will introduce a number of MOS parts intended for data communications.** The microprocessor set itself includes a sophisticated asynchronous communications adapter that directly interfaces to a modem, and a synchronous adapter is to follow.

Some of the other new parts are designed for use with the microprocessor; others stand alone. All are n-channel or complementary-MOS. Next is a single-chip 300-bits-per-second modem designed to replace the Bell 103, to be followed by a 2,400 b/s, 201-type modem; a European CCITT modem; a bit-rate generator; a subscriber dialer; a first-in, first-out register for changing data rates; Touch Tone encoders and decoders, and a 1,200 b/s modem.

AMI, Standard develop 1-chip print calculators

Taking technology to its logical extreme, both American Microsystems Inc. and Standard Microsystems Inc. have developed single-chip printing calculators. The AMI device, developed with Sweden's Facit-Odhner, **is on a 214-by-218-mil chip, making the circuit one of the biggest ever developed at AMI.** It contains all the control logic, arithmetic unit, memory, timers, and clocks and hammer drivers, all running off the same +6 volt (operating mode) and −13 V (standby) supplies. The Facit calculator, a 10-digit machine called the 1145, sells for $349. It prints on the familiar roll of 2-inch paper tape and operates from house current or a 9 V battery. AMI plans more calculator circuits with built-in display functions—though not printers.

Standard has three printing calculator chips and three more to be in production late this year. They're for 12-digit machines, and have memories, floating-point, and several kinds of fixed-point arithmetic, and automatic accumulation. One of Standard's customers is Ataka of Japan.

Signetics to offer CCD shift register

Signetics will announce in the last quarter of this year a 16,384-bit CCD dynamic shift register, **becoming the first major American semiconductor maker to announce a CCD memory product.** The device is intended to replace disk and drum memories, and the company aims **to eliminate medium-size disks by 1975.** In addition to a cost of 0.1 cent a bit, the part runs at 20 megahertz, compared to the 3 to 5 MHz of today's MOS shift registers.

International Rectifier to offer LEDs

Power semiconductor specialist International Rectifier is about to enter the market for light-emitting diodes. First products will be discrete infrared LED's with wide frequency response and spectral response closely matched to fiber-optic transmission lines. **These products can transmit a TV signal and are also useful for high-voltage optical couplers,** which will be introduced later. The company does not plan to enter the visible LED arena.

CML Satellite faces shakeup

Industry sources see a shakeup brewing at CML Satellite Corp. among cash rich Comsat and its domsat partners, MCI and Lockheed. **The likely outcome will be one or more partners dropping its share of the operation.** A reason: Comsat, barred from dominating CML, is said to feel hamstrung by the company's financial pinch, especially since its partners came in with only $1 million each.

Fueling the rumors are serious talks between CML and American Satellite Corp. about some form of merger, a latchup both acknowledge they would like as they admit they're seeking partners. One official close to the discussions rates it "better than 50-50." CML, MCI, and Lockheed officially refuse any comment but a CML officer assures that the company will continue its newly planned program (see p. 42).

Ceramic package costs less and seals cooler

Diacon Inc. is marketing a new ceramic IC package **that not only seals at a lower temperature, but costs less than side-brazed or co-fired packages that typically seal at 310°C.** "MOS and linear devices with close-spaced metalizations, shallow-diffusion, and surface sensitivity suffer when subjected to high-temperature assembly," says Bryant (Buck) Rogers, president of the San Diego package company. "Consequently, lowering the sealing temperature to 265°C by using our lead-tin-indium seal should boost IC manufacturing yields." The package, a member of the cerdip family, is priced at 24 cents each in the 14- and 16-lead versions in million-lot quantities.

ULTRA-MATCHED INSTRUMENTATION OP AMPS... *made easy!*

ΔVos - 70μV

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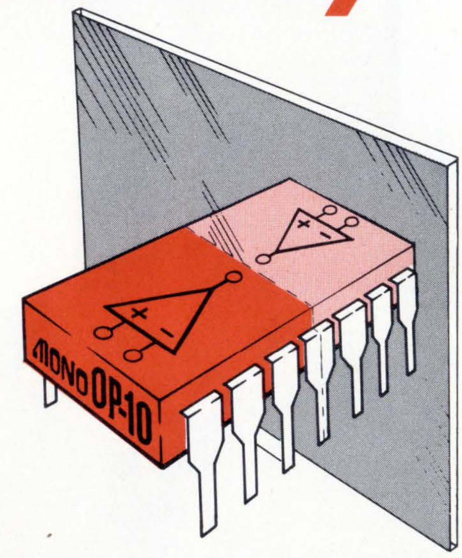
14 Pin DIP Package



AT LAST—MATCHED DUAL OPERATIONAL AMPLIFIERS!

New monoOP-10 makes matched amplifier designs easy — two low noise, low drift, low bias current monoOP-05 Instrumentation OP Amps in a 14 pin DIP! Of course, they're fully compensated and completely protected so there's nothing to add but your ingenuity. And the tight matching makes possible a new generation of applications including high input impedance instrumentation amplifiers with no chopper noise, low drift multistage active filters, matched channel amplifiers, tracking dual voltage references and . . . No more costly hand selection of individual op amps — monoOP-10 saves time, space and cost while boosting performance! Try one — they're off-the-shelf at your PMI distributor now!

GUARANTEED MIN/MAX SPECIFICATIONS

	monoOP-10AY	monoOP-10Y	monoOP-10EY	monoOP-10CY	
Operating Temp. Range	−55/+125	−55/+125	0/+70	0/+70	°C
Δ Vos (Vos_1-Vos_2)	180	500	500	—	μV
TC Δ Vos	0.8	1.2	0.9	—	μV/°C
Δ CMRR	114	106	106	—	dB
Input Bias Current	3.0	3.0	4.0	7.0	nA
Noise (0.1 Hz to 10 Hz)	0.6	0.6	0.6	0.65	μV, pk-to-pk
Long Term Drift*	0.2	0.2	0.2	0.3	μV/Month
Price @ 100 pcs.	\$60.00	\$40.00	\$25.00	\$16.00	

* Typical long term drift trend, averaged over a 12 month period (per amplifier)

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Motorola joins microprocessor race with 8-bit entry

Motorola will supply all the 5-volt components for its microprocessor, assuring compatibility with TTL

The microprocessor race appears to be heating up with Motorola's development of its eight-bit, n-channel microprocessor family. The five-chip set, which includes a central processor, the 6800, along with random-access and read-only memories, and peripheral and communications interfaces, is expected to give Intel's n-channel, eight-bit systems, built around the new 8080 CPU, a run for their money.

Although all the details of the Intel chips have not yet been revealed, both microprocessors offer about the same number of instructions—78 for the 8080 and 72 for the 6800—with roughly comparable performance. The Motorola microprocessor, however, may result in system savings for certain applications by requiring fewer interface circuits and power supplies.

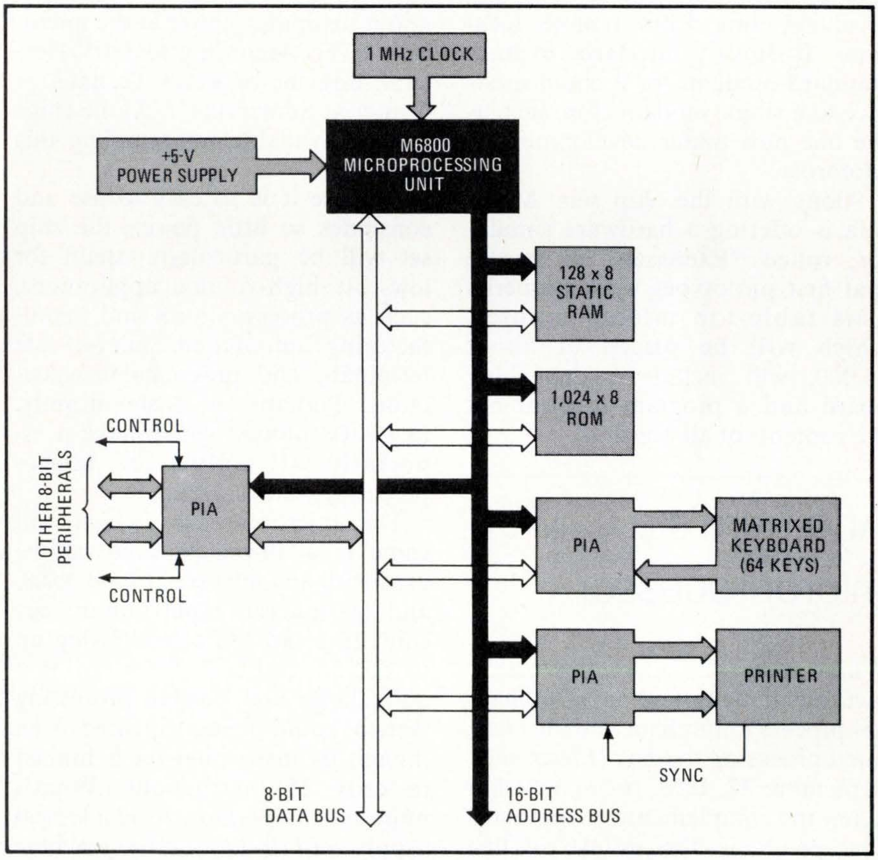
Significantly, the Motorola microprocessor set forms a complete microcomputer that needs only a single 5-volt supply and one external clock—no multiplex, multiple supplies, or interface packages are required. The chips, built with an ion-implanted n-channel silicon-gate process, will enter production in November.

Motorola's Semiconductor Products division has put extensive effort into developing the microprocessor because it feels this device is the key to getting the MOS business it hasn't enjoyed so far.

The single microprocessor chip (MC6800) is equivalent to about 120 MSI TTL packages. It has 72 self-contained basic instructions with decimal and binary arithmetic capability, variable-length instructions, double-byte operations, two accumulators, and seven addressing modes. The typical instruction time is under 5 microseconds, and since up to 64,000 bytes can be addressed in any combination of RAM, ROM, or peripheral registers, peripheral capacity is almost unlimited.

Another key component in the family is the MC6810, a static, 500-nanosecond 128-by-8-bit static RAM designed for use with the MPU, but other RAMs, including the 4,096-bit MCM6605, or other types and speeds of memory can be used. The MC6816 ROM is a static 1,024-by-8-bit memory for use with the system, but other ROMs are also usable.

The microprocessor set is organized around the popular parallel data-bus concept introduced by Digital Equipment Co., Maynard,



Bussed. Motorola's microprocessor is organized around the parallel data-bus concept. Up to 10 LSI chips can be directly attached to the bus—ROMs, RAMs, peripheral interface adapters (PIA), and communication interface adapters (CIA).

Mass., with its PDP-11 minicomputer. All memory and peripheral/interface chips simply hang on the eight bidirectional data lines (16 address lines are provided). Chip interfaces are tri-state, and up to 10 LSI chips can be directly attached to the bus for operation to 1 megahertz– ROM, RAM, the peripheral interface adapters (PIA), and communications interface adapters (CIA). A bipolar bus extender can be added to drive still more peripherals, but a significant system can be assembled from the 10 chips.

For this operation, a peripheral adaptor, the MC6820, is provided. It is a bidirectional unit with two parallel eight-bit outputs that can drive two peripherals, or its two outputs can be used together for higher throughput.

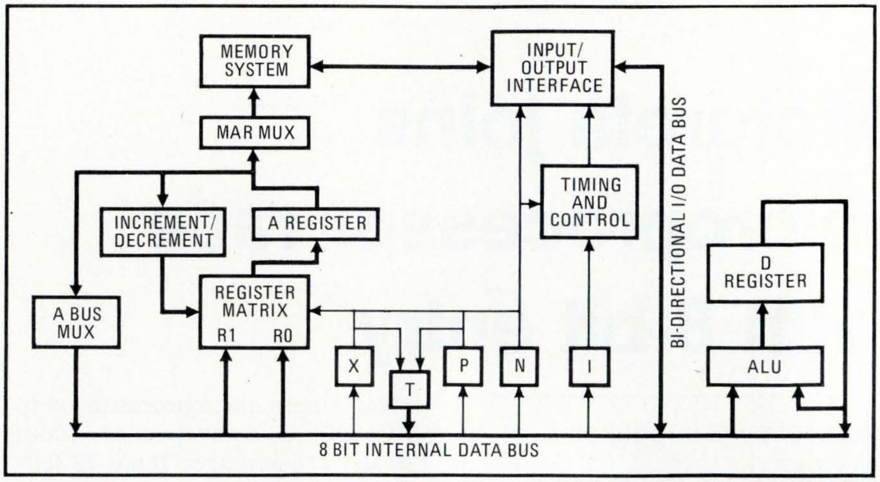
The final member of the family is the MC6850 asynchronous communications interface adapter–a synchronous version will be announced later. This bidirectional device takes a load off the MPU for sending and receiving data from remote locations. It directly interfaces to most standard modems, or it could interface to a single modem chip, such as the one now under development at Motorola.

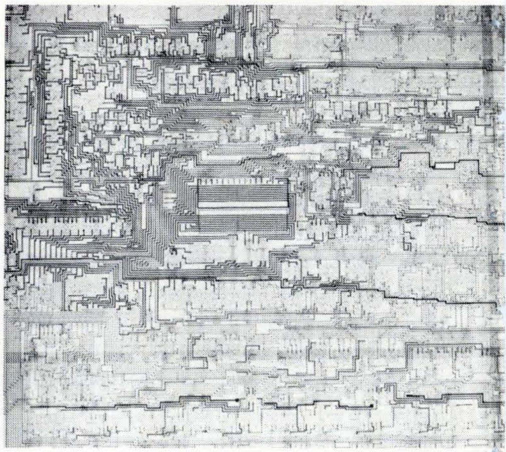
Along with the chip sets, Motorola is offering a hardware simulator, called "Exerciser," to ensure that first prototypes work properly. This table-top microcomputer, which will be priced at about $5,000, will include a debugging board and a program to print out the contents of all registers. □

And here's a C-MOS microprocessor

While many semiconductor manufacturers have settled on an n-channel process to implement their latest microprocessor designs [*Electronics*, September 27, 1973, p. 33], RCA has taken the complementary approach. The result is the industry's first C-MOS microprocessor.

With its standard 4000 series COS/MOS technology, RCA's 2-chip 8-bit microprocessor set–a single-chip design is under way–has all the advantages that C-MOS circuits offer. It can operate off power supplies providing anywhere from 5 to 15 volts, it has 40% noise immunity, and it dissipates power at the microwatt level. According to Jerry Hertzon, director of RCA's Technology Center at Somerville, N.J., the chips will be available for sampling this year.





Complementary. RCA's C-MOS memory system shares the microprocessor input/output interface with system peripheral devices. C-MOS chip is at right.

Because it is so easy to use and consumes so little power, the chip set will be particularly useful for low-cost high-volume applications, such as process control and manufacturing automation, point-of-sale terminals, and programable calculators. Perhaps more significantly, its C-MOS process could make it especially attractive for microprocessor control in cars.

The microprocessor, which will come in a 40-pin package can be used with any mixture of RAM, ROM, and peripheral input/output circuits. It is capable of addressing up to 65,536 eight-bit bytes, so that quite large and flexible processing systems could be implemented, even though its instruction set is limited to only 25 instructions. What's more, when operating from a typical supply of 10–12 V, the machine cycle time is a respectable 3 microseconds. And using a standard 1-μs RAM, the microprocessor chip set has a maximum 6-μs fetch-execute time for any instruction.

The CPU has a unique hierarchy. At its heart is a 16-by-16-bit scratchpad memory, which serves to reference the accompanying RAMs and ROMs. These 16 registers, called the register matrix, are addressed by any one of three P, X, or N registers, which are all four bits wide.

With these registers, fetch and execute is done in two steps. The N register and another I register are used to hold the instruction fetched from the main memory. The contents of the I register determine the instruction type to be executed. Depending on the reading, the contents of the N register are used to select one of the scratch-pad matrix registers that control the input/output devices.

The P register is used to determine which one of the 16 scratchpads is to be used as the program counter, while the X register is used to address the scratch-pad matrix for additional reference instructions. In this way, all 25 instruction cycles can be accommodated quickly. □

Government electronics

Richard E. Wiley named FCC chief

The appointment of Richard E. Wiley to become chairman of the Federal Communications Commission has drawn good notices from industry observers who used phrases like "bright," "hardworking," and "looks at both sides of the issues" to describe the 39-year-old lawyer. Wiley, who has been an FCC commissioner for more than two years and was previously the body's general counsel for one year, will succeed Dean Burch, who will leave shortly to become a counsellor to the President with cabinet rank.

Observers watching his performance as commissioner, don't expect any drastic departures from the commission policies established under Burch's stewardship. It is expected that Wiley will continue Burch's emphasis on fostering competition with AT&T monopoly services, while perhaps adding some new touches of his own—such as clearing up obsolete regulations. And while Burch was considered to be a friend of the cable-television industry, Wiley is seen as being "pro-broadcasting industry," but fair-minded about it.

New FCC chief. Richard E. Wiley, new FCC chairman, is considered likely to foster competition with AT&T and be pro-broadcasting.

Wiley is likely to preside over "the second Nixon phase of the FCC"—the Administration will have appointed all seven members by the time Wiley's term is up in three years. After Burch's departure, the commission will shrink to four members when another member's term expires this summer.

Although the President can only appoint four from his party, the Democratic seats will be filled by persons sympathetic to the administration. Nominal Democrat James H. Quello may soon be confirmed for one seat, since opposition melted away during Senate confirmation hearings. Widely mentioned for the two other slots are Ward White, minority Republican communications staffer with the Senate Commerce committee, and Luther Holcomb, vice chairman of the Equal Employment Opportunities Commission.

Industry executives generally approved of Wiley's appointment. "Dean Burch worked hard to make the FCC a dynamic organization, and it looks like he'll carry on in that tradition," comments William G. McGowan, board chairman of MCI Communications Corp. Another industry official, who declined to be named, uses words like "hardworking, knowledgeable" in saying that Wiley "understands the many complex and broad issues that confront the commission. That's not true of all commissioners."

Wiley has campaigned for the chairmanship almost from the moment he came aboard. Helping, too, was the 1968 campaigning he did for President Nixon before he joined the commission. He is reputed to have political aspirations beyond his new post. Born in Peoria, Ill., he received his BS degree from Northwestern University and his JD degree from Northwestern School of Law in 1958. After three years as an Army legal officer, Wiley joined a Chicago law firm, was assistant general counsel for Bell & Howell Co., and was a partner in another law firm before he joined the FCC as general counsel in 1970. □

Commercial electronics

Electronic cure for VTR's mechanical ills

Some of the hottest items under development are solid-state analog delay circuits for communications, radar, and audio and TV equipment. Although the approach making the headlines is the charge-coupled-device delay line, Reticon Corp, Mountain View, Calif., has applied its self-scan MOS image technology to come up with a circuit that corrects time-base errors caused by variations in video recorder tape drives.

The mechanical problems of driving the video tape at an even speed past the tape head have been expensive to solve. One way to correct for image-degrading time-base errors is to digitize the signal and regenerate it with a precise digital/analog converter. But this is expensive; a videotape recorder maker can't afford that kind of signal control, and so far no maker has managed to cut costs or dared to cut performance to the point where home VTRs can sell below the \$300–\$500 range.

With the Reticon device, which is called a serial analog memory (SAM), a pair of shift registers clock the video signal independently into and out of an array of MOS capacitors. With 64 capacitors and a clock rate of up to 10 megahertz, the SAM provides a maximum delay of 6.4 microseconds. The TV raster scans one line in about 63 μsec, so a single SAM can correct time-base errors of up to 10% of the line width. The cost is \$1 a bit in OEM quantities.

Load and charge. The input shift register samples the analog signal by operating a set of switches that allow the signal to charge the bank of capacitors serially. When a start pulse loads the first bit of the register, the first switch closes and the first capacitor is charged. When the register shifts the bit to the next cell, the first switch opens, isolating the capacitor, and the next switch closes, charging the second capacitor. The start pulse thus has a maximum repetition rate of 1.8 times the clock frequency, where N equals the number of capacitors.

The output shift register reverses the process. The start pulse loads the register's first bit and connects the first capacitor to the output line, so that it discharges. As the bit travels down the register, it successively discharges each capacitor and reconstructs the waveform, with a new time base determined by the clock rate. A capacitor can take a new input signal as soon as it is discharged.

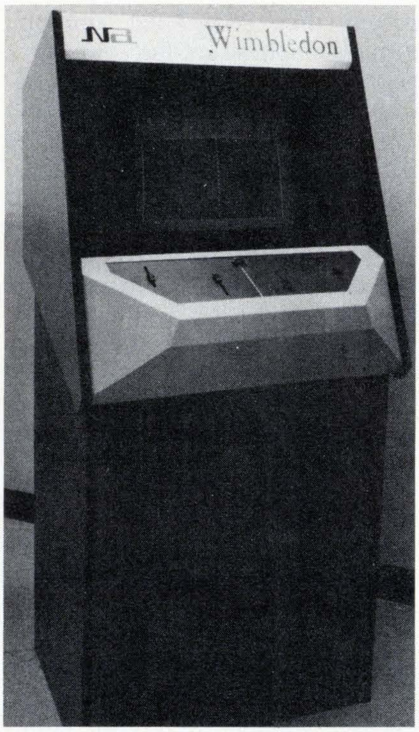
All of the circuitry for the SAM is fabricated on Intel's standard 67-by-300-mil silicon-gate MOS chip. To build it, Reticon uses the process and production facilities of the Intel Corp., its part owner, which are right across the street from its plant. Reticon has provided sample circuits to several manufacturers, and the SAM has already been installed in equipment.

John J. Rado, Reticon's president, says the circuit is also suitable for digital filtering, including fast-fourier transforms, time and frequency expansion and compression, pattern recognition, bandwidth compression for multichannel transmission, and other applications. □

Anyone for tennis —via color TV?

The contenders may not be Billy Jean King or Bobby Riggs, and the site of the match may not be the Astrodome, but the basic game is tennis—now in a coin-operated color-video version.

Called "Wimbledon," the new game uses a TTL processor and a television set to simulate a tennis match—complete with the sounds of play, a grass-green field, white border lines, white ball, tennis rackets in four different colors, and scores displayed on a bright yellow background. The first coin-operated color game, it is being marketed by Nutting Associates, Inc., Mountain View, Calif., which was among the originators of black-and-white video games two years ago.



Love it. Wimbledon is new coin-operated tennis game played on color-TV set.

Color, says William G. Nutting, president of the firm, is an important advance because black-and-white games are rather dull in appearance. He expects Wimbledon to recapture the market in "sophisticated locations, whose clientele won't tolerate the clanging of pinball machines." The generic name "pong" refers to the sounds of play the video games produce. In the past two years, some 22 game manufacturers have come out with black-and-white pong games, Nutting says.

The TTL processor, reports Miel Domis, Nutting's project engineer, controls the three guns of the color tube to simulate the motion of the rackets and ball on the colored field. The image of the field is generated by a solid-state memory, while the processor itself produces the other movements by generating digital vectors.

The players move sliding resistance controls, one for each racket. Control positions are stored in registers while the controls change the trigger settings of timing circuits, Domis explains. The timing changes vary the rate at which the electron guns are gated by the data words representing the rackets and ball, making them appear to move as the guns sweep across the field. If the ball hits the racket, a rebound vector is started by a flip-flop output. If not, or if the ball goes out of bounds, a point is scored and displayed.

No endless volleys. A 14.318-megahertz crystal output is counted down to time the motions and generate the TV gating, synchronization signals, and also the sounds of play for Wimbledon. The composite signals are fed to the set's antenna terminals. And there is another new feature for those who have learned to lock a pong game into a stable state where the paddles or rackets are placed so that the ball oscillates endlessly back and forth. Now, after eight volleys, a counter triggers a change in the ball's vector.

Having created color control, Domis is now considering other games, such as billiards or pool, where color would create a more realistic game. □

Solid state

Low-power Schottky gets second sources

Texas Instruments will shortly get its first competition in low-power Schottky TTL. Both Signetics and Fairchild will begin introducing the hard-to-make devices, which so far offer the best performance/power tradeoffs to military OEMs.

Signetics is entering the 54LS market with a few simple circuits—the 54/74LS/0 and 05 hex inverters in March, and some dual JK flip-flops—the 54/74LS 112, 113, and

the 30Hz Resolution Revolution

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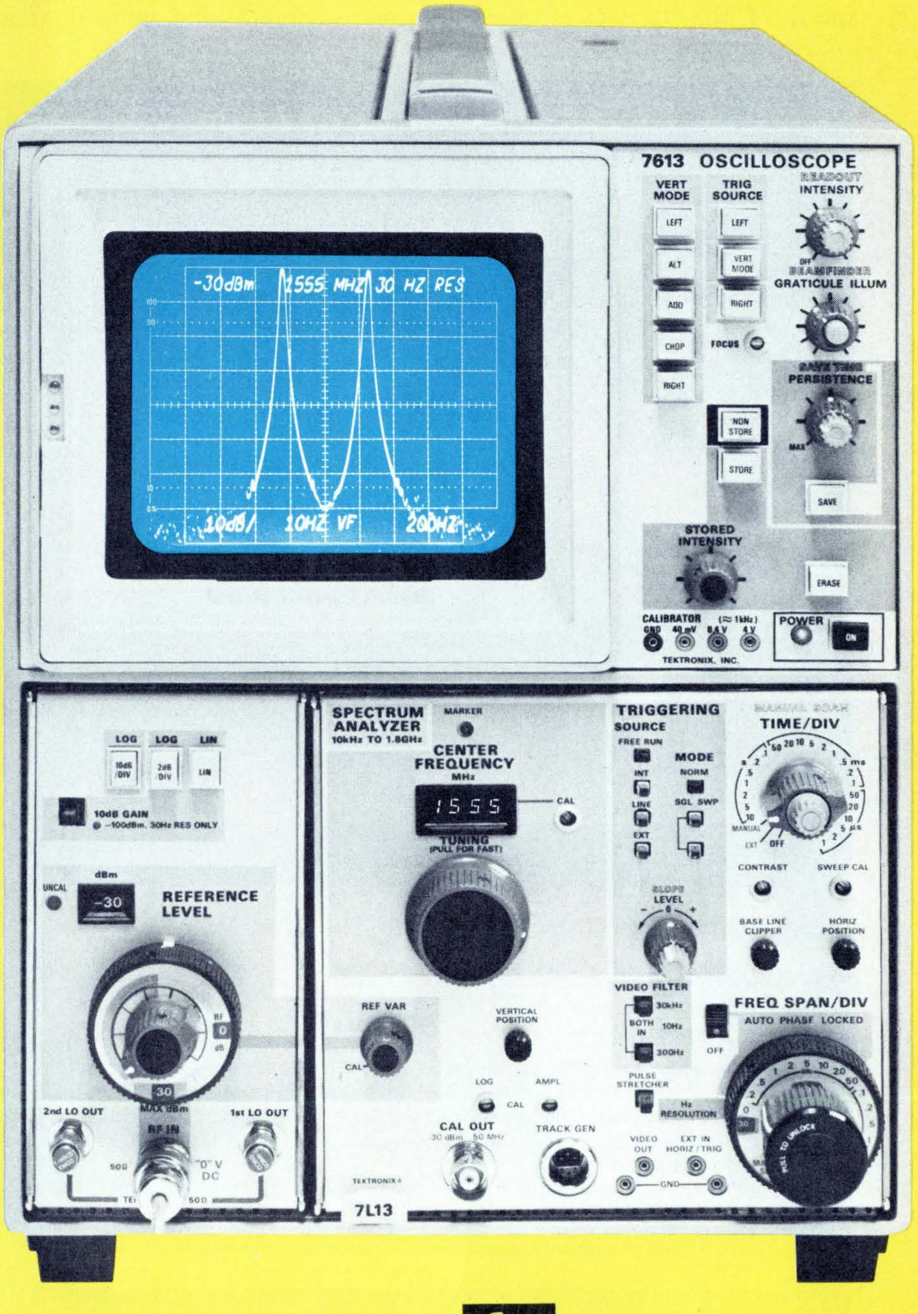

It is generally understood that High resolution means the ability to distinguish between signals differing little in frequency. Actually, the design that makes 30 Hz resolution possible results in more than just the ability to distinguish between close together signals. The design of the 7L13 means better sensitivity, −128 dBm; less drift, under 2kHz per hour; less FM, under 10 Hz phase locked; it means less noise . . . it means the revolutionary analyzer performance that is available from Tektronix, Inc. in the 7L13.

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114—in May and June. Product manager Stan Bruederle says the company will introduce 20 products this year, including the 54/74LS 181, a 4-bit arithmetic unit, and some other medium-scale-integration items.

Fairchild's first low-power Schottky parts, to be available in late March, will be small-scale-integration products. According to Rob Walker, product planning manager in the Digital Products division, "they are specified at twice the speed of the TI devices—5 nanoseconds typical and 10 ns maximum. Walker expects the Fairchild products, catalogued the 9LS, to serve "as a replacement to all H series and a lot of S circuits, as well as standard TTL."

TI presently offers about 60 circuits in the 54LS family. Signetics does not expect to compete across the board for some time, and is introducing the line now in the expectation of participating in some projects later this year. Low-power Schottky devices are presently going into avionics and ground transportable equipment operating at over 5 megahertz.

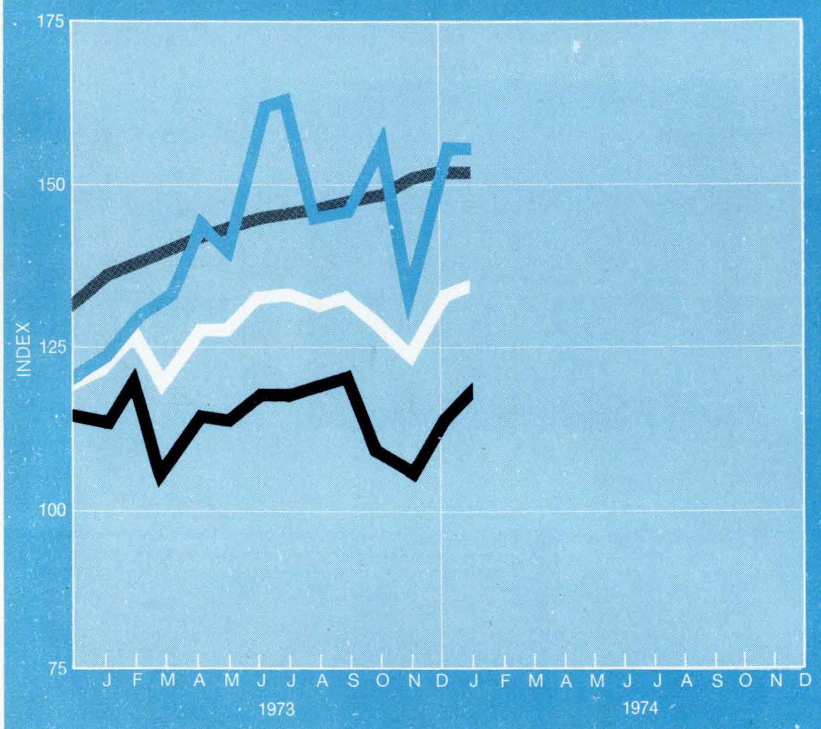
Low-power Schottky offers typical power dissipation of 2 milliwatts per gate while operating at 10 ns gate delay and 35 MHz flip-flop toggle rate. The regular 54/74 series has five times the power dissipation at comparable performance. The low-power series 54L, which dissipates only 1 mW/gate, operates at 33-ns gate delay and a 10-MHz flip-flop rate.

The C-MOS circuits match low-power Schottky at low frequencies, but C-MOS power dissipation goes up exponentially and crosses that of low-power Schottky at around 2 MHz. Low power dissipation is a must for military suppliers, and avionics contracts conventionally specify bonuses for undercutting power requirements and penalties for exceeding them. Signetics believes that low-power Schottky capability is essential for companies that wish to continue to supply the military. Within five years, Bruederle says, 54LS will be the standard military-design tool.

Military pressure for a second-source to TI induced Signetics to spend the money raised during last fall's $20 million stock sale for the ion-implantation and thin-film equipment necessary to build 54/74L. Signetics already uses ion implantation in every product line and has a thin-film process comparable to Fairchild's Isoplanar.

The first key to building the 54LS line is a technique, derived from LSI processing, for fabricating resistors no bigger than conventional Schottky resistors. □

Electronics Index of Activity



Segment of Industry	Jan. '74	Dec. '73*	Jan. '73
Industrial-commercial electronics	156.3	156.5	142.3
Consumer electronics	119.7	114.9	114.5
Defense electronics	152.5	152.5	137.8
Total industry	135.8	133.3	126.3

The index rose for the second straight month, reaching a level that is the highest since October 1969, and 7.5% above last year's level. The defense sector was the largest gainer, rising 4.2% above the previous month. The only drop occured in consumer electronics, which fell 0.1% from December's figure.

Indexes chart pace of production volume for total industry and each segment. The base period, equal to 100, is the average of 1965 monthly output for each of the three parts of the industry. Index numbers are expressed as a percentage of the base period. Data is seasonally adjusted.
*Revised.

Thermoplastic used between IC layers

Multichip LSIs with thermoplastic insulation between the layers of wiring interconnecting the chips has been developed in a joint Japanese-U.S. research program. Tokyo Shibaura Electric Co.'s Research and Development Center and the General Electric Co.'s Electronics Labo-

ratory, Syracuse, N.Y., have conducted the engineering research.

The advantages of the process, called semiconductor thermoplastic dielectric by GE, include reduction in circuit size and weight, elimination of labor-intensive processes, including wire bonding, and improved heat-sinking and reliability. A variation of the approach has been developed for microwave applications.

In the basic process, standard IC chips with conventional aluminum bonding pads are positioned precisely on an aluminum substrate, covered with a sheet of FEP, a fluorocarbon plastic, and then subjected to heat and pressure. The chips are pressed slightly into the substrate. The plastic at the top of the chip is extruded to produce a thin plastic layer covering the chips and a thicker plastic layer filling in spaces between the chips.

Holes are etched in the plastic layer for interconnections, which are copper, with a titanium barrier layer between copper and aluminum pads to prevent undesirable solid alloys. The insulation for the second and subsequent interconnection layers is also plastic, but the companies won't disclose its composition.

How big? An experimental circuit includes 11 TTL chips on a 25-millimeter square, 2-mm-thick, substrate. The two layers of wiring form 312 interconnections. The power dissipation is 2 watts, and temperature rise is 25°C. Thus, the completed product functionally replaces an equivalent number of integrated circuits mounted on a multilayer printed circuit. What's more, the unit insulated with thermoplastic is smaller and can be fabricated by batch processes that yield improved performance and reliability.

Microwave integrated circuits are built on a beryllia substrate with deposited connections to the reverse side of the chips, but the insulation system is similar. An experimental circuit on a 7-mm-square substrate has a power output of 14 W at 1.5 gigahertz and a bandwidth of 250 megahertz. Multichip circuits, therefore, have been shown to be suitable for micropower to high-power devices from dc to microwave frequencies. GE managed the design and evaluation, and Toshiba has handled the fabrication. □

Consumer electronics

Depthmeter's sonar put on a chip

With ICs turning up in more and more products, it's not surprising to find one in a product for the angler or yachtsman. Now, National Semiconductor Corp., Santa Clara, Calif., is producing a single-chip sonar system for an under-$100 fishfinder/depthmeter.

The bipolar integrated circuit, which measures only about 80 by 90 mils, includes a complete 12-watt transmitter—perhaps the first practical monolithic transmitter—and a receiver that drives a neon bulb with 10 W of power. The part was developed as a custom product for a large depthmeter manufacturer by National development engineers Thomas A. Frederiksen and William M. Howard.

Echoes. The system consists of a piezoelectric transducer mounted on the hull under the water, the receiver and transmitter, the IC, and a rotating-disk display. The transmitter feeds 12 W at 200 kilohertz to the transducer for approximately 800 microseconds. The transducer both converts this signal to a sonic wave, which is sent toward the bottom, and picks up echoes from fish or the bottom.

If the received signal is large enough to trigger a threshold detector and get through a special impulse-noise limiter, a neon bulb mounted on a rotating disk flashes. The angle at which the bulb flashes indicates the depth. Multiple flashes can occur—showing, for example, both a school of fish and the bottom. The system timing is derived from the rotating disk, which is driven by a small battery-operated motor.

Benefits offered. A single inductor is used to set both receive and transmit frequencies, eliminating the need for tuning the system in production, as is necessary with discrete units. What's more, frequency drift does not affect operation. And, in contrast to current gear, any transducer can be used. Present depthmeters require that the equipment be tuned to the transducer, a problem when a transducer or finder must be replaced.

No external transistors are required because the 18-pin package contains all semiconductors other than a swamping diode on an output transformer. But the transducer and the neon bulb require voltage transformation, since the transducer impedance is a high 600 ohms. And triggering the neon bulb requires substantially more than the 12-volt operating supply. Large Darlington power transistors on the chip drive the bulb and transducer, a piezoelectric crystal. □

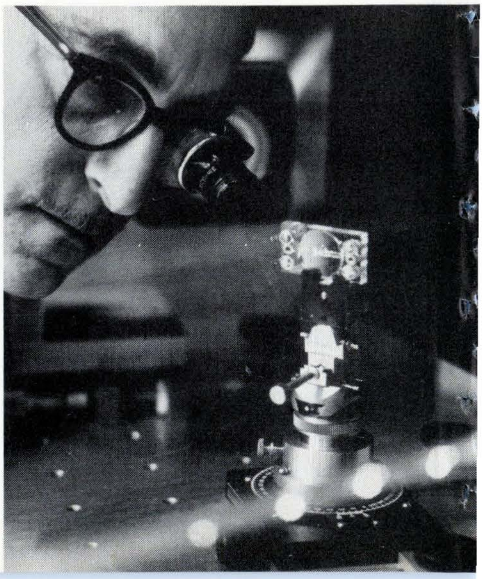
Communications

Optical waveguide has own modulator

Electro-optical modulators built right into tiny monolithic waveguides for laser light are the latest links in the chain of development leading toward practical fiber-optic communication systems [*Electronics,* May 24, 1973, p. 33].

RCA's David Sarnoff Research Center, Princeton, N.J., and Bell Laboratories, Holmdel, N.J., have

Eyeing an electro-optic modulator. RCA's device is built into a light waveguide.



fabricated low-loss optical waveguides and used them to modulate light at rates that could exceed 1 gigahertz. Once developed, such devices could be used to modulate signals for thousands of telephone channels in one waveguide.

The RCA modulator is made by depositing a film of niobium on a crystal of lithium tantalate, which is then placed in a furnace. Niobium atoms diffuse in to replace the tantalum and form a tiny waveguide of lithium-niobate tantalate. Because that compound has a higher refractive index than lithium tantalate, light coupled into the guide remains inside.

In a typical layer, about 30% of the tantalum in the substrate is replaced by niobium near the surface. This fraction falls to zero at a depth of about 2 micrometers. One device fabricated in a single-mode guide required 6.5 volts for 80% modulation at a wavelength of 6,328 angstroms and 3.5 V at 4,495 angstroms.

Modulation is performed by varying the voltage applied to the waveguide. As the electric field varies, the crystal's refractive index changes, and this change is used to produce amplitude modulation or beam diffraction.

The RCA device will operate—at 0.1 mW per megahertz—"as fast as it can be driven," according to Brown F. Williams, head of quantum electronic research at the center. The limit on frequency is the capacitance of the electrodes connected to the waveguide. Single-mode losses are of the order of 1 decibel per centimeter. The device has an active volume of 0.12 by 0.02 by 0.02 inches.

The Bell single-mode waveguide modulator is fabricated using an out-diffusion technique in which lithium atoms are removed from a lithium niobate crystal. What's left is a lithium-deficient waveguide at the surface of the crystal. Power requirements for the unit—0.4 milliwatt per megahertz—are somewhat more than for the RCA device. Thus, at 0.4 W, the modulator will operate at 1 GHz. The active region of the modulator measures 0.24 by 0.002 by 0.002 in.

The RCA unit is an amplitude modulator, whereas the Bell Labs device modulates phase. Both modulators operate at wavelengths from the visible to the near-infrared. □

Energy

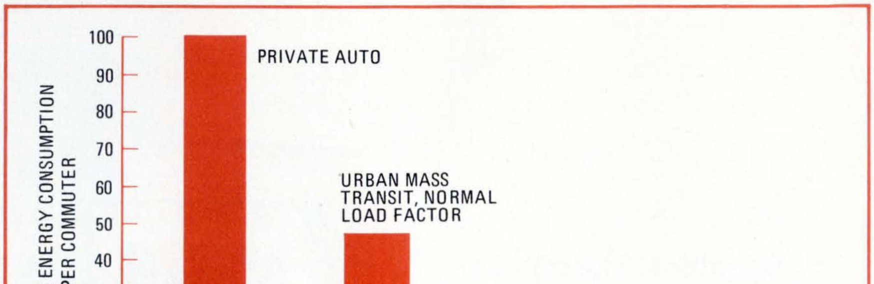
Communicating may replace commuting

The energy crisis may well accelerate the adoption of a far-reaching change in life style: communicating instead of commuting to work. The change has long been touted by futurologists, but research in computer and telecommunications technology indicates that it may be economically practical, even now—at least for some businesses. The University of Southern California, working under a grant from the National Science Foundation, is studying the subject, which could be a vital one for car-oriented Los Angeles, where USC is located.

The study, being coordinated by Jack M. Nilles, director of interdisciplinary program development, is concentrating on near-term practical results. A major part of the study is investigating those companies that Nilles classifies as "people huddled around a computer"—banks and insurance companies, for example.

Nilles points out that the workers in such companies could be dispersed to work centers near their homes. The additional costs involved would be for terminals plus communication lines to the central organization. These costs would be about the same as the present costs of commuting, he adds, suggesting that employees would walk or bicycle, rather than drive, to work centers near their homes, and they would pay at least part of the terminal costs in lieu of commuting expenses. The estimated energy consumption for a car in a typical Los Angeles round-trip commute of 22 miles is 50 kilowatt-hours, compared to only 2 kilowatt-hours for computer and telephone lines.

Among the technical problems being investigated is the man-machine interface. Nilles suggests that the traditional typewriter keyboard plus CRT terminals may not be optimum. Serious investigation must also be devoted to the communications lines. Present 3-kilohertz telephone lines could become inadequate if many companies adopt remote operations, and coaxial-cable or even fiber-optic communications lines might be needed □



Microwaves

Baritt diodes find new applications

Barrier injection transit-time diodes—Baritts, for short—have been little more than laboratory curiosities. But their status may be

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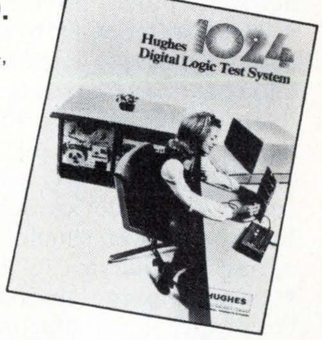

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changing as the Baritt finds applications in self-mixed doppler radars, X-band microwave generators in intruder-alarm doppler radars and in anti-skid braking systems.

Baritts have two serious disadvantages. They require 60 to 100 volts bias—while Gunn diodes use 6 or 12 V. What's more, their power output has been limited to about 10 milliwatts at 11 gigahertz—at least an order of magnitude less than Gunn devices.

However, a Swedish company, IMA Microwave Products, believes that the Baritt has enough going for it to give it the edge in certain applications. IMA has developed a complete intruder-alarm doppler-radar module using a Baritt, and is offering Baritt samples rated at 30 mW cw at 7 GHz, 20 mW at 9 GHz and 10 mW at 10 GHz. The worldwide doppler-alarm industry, which uses thousands of Gunn diodes every week, is the market IMA is aiming at.

IMA, a joint venture between the Microwave Institute in Stockholm, a government-sponsored research establishment, which does the R&D; ASEA, an electrical equipment manufacturer, which makes most of the semiconductor products; and Incentive AB, which provides financial backing.

Pros. Peter Weissglas, a professor at the Microwave Institute and consultant to IMA, lists the pros of Baritts in doppler alarms:

- The 10-GHz radar has an output of 5 mW, the same as many similar Gunn radars.
- The IMA module has a much longer effective range than Gunn modules because Baritt module noise is some 20 to 30 decibels better than Gunn module noise. That means fewer Baritt radars are needed to protect the same area.
- The Baritt is easier to set up in an alarm, because it is made of silicon, and so is more frequency stable with temperature changes than a gallium-arsenide Gunn unit.
- Accidental surges that will destroy a Gunn device don't affect a Baritt, so fewer should be wasted during installation.
- In the long run, the Baritt should be cheaper to manufacture, because

News briefs

IBM and Owens-Illinois agree on cross-license

IBM and Owens-Illinois have hammered out a non-exclusive cross-license for the manufacture of plasma-panel products. IBM has paid an initial $2 million to use the Owens-Illinois Digivue panel display. A non-refundable $1 million is earmarked for future royalties and the rest covers royalties and payments for IBM's past use of the technology in data-processing terminals for banks. Industry experts say that the panels may turn up next in IBM terminals for airline scheduling and stock-quotation systems.

Solarex to buy Centralab's solar-cell operation

In a move that would markedly expand its fledgling photovoltaic cell business, tiny Solarex Corp., Rockville, Md., has agreed in principle to buy the solar-cell operation of Globe-Union's Centralab division, El Monte, Calif. Price and details of the final agreement, which hinges on Solarex's ability to raise the capital, are expected in a few weeks. Committed to terrestrial uses, Solarex [*Electronics,* Feb. 21, p. 32] would acquire Centralab's photovoltaic-production line in space leased from Globe-Union and gain such customers as TRW and Lockheed.

Computer to ease Bay Bridge traffic

A minicomputer that is programed to ease traffic congestion is going into operation this month on the San Francisco-Oakland Bay Bridge. Part of a Department of Transportation project, the $350,000 installation consists of a Data General Corp. Nova 1210 with 8,000 words of memory at the bridge's plaza and magnometers at the bridge's midsection to record traffic volume. Cars will be sent from the toll booth at intervals of 4 to 10 seconds.

Western Union starts service center

Service support for their more than 13,000 leased terminals is being offered by Western Union Data Services Co., Mahwah, N.J., through Termicare, an automated computer center for diagnosis, documentation, and service dispatch. Users calling the center will receive preliminary assistance from a service analyst who can call up each malfunctioning terminal's service history on a CRT. If a field engineer is dispatched, data on the service call is recorded in the file for further updating.

Japan opens exhibit to foreigners

Japan's Printed Circuit Association show (June 1-4) will be open to non-Japanese exhibitors for the first time this year, providing an entree for American electronics firms. The Tokyo show includes exhibits of materials, production machinery, and components, as well as seminars, and demonstrations of printed-circuit techniques and labor saving technology.

Buckbee-Mears expands metal-plating line

Buckbee-Mears, St. Paul, Minn., a major supplier of etched lead frames for ICs, has completed a $200,000 expansion of its precious-metal-plating line. Vice president Lee Barton says this will "more than double the company's capacity to supply over-all silver-plated and spot-gold-plated lead frames" at a time when IC makers, demanding more product output, are also worrying about material shortages.

Addenda

A new high temperature for superconductivity of −418°F has been recorded at Bell Laboratories. The superconducting material was a niobium germanium alloy. . . . The initial phase of a $17 million contract to provide 27 large-diameter antennas for a radio-telescope system has been awarded to E-Systems Inc. by Associated Universities Inc. . . . Hughes Aircraft Co. subsidiaries have signed an $18.4 million contract with Greece to strengthen NATO's air-defense coverage in the Eastern Mediterranean . . . Scientists at Westinghouse Research Laboratories are developing a lock that opens by voice command to sell for less than $100.

Electronics review

it is well within established silicon technology.

Weissglas admits that a dc up-converter is needed to get 60 v from the standard 12-v standby batteries. Yet, he says, the extra cost is cancelled "because you can cut out the Schottky-diode detector from the receiver system." The Baritt diode used as transmitter has sufficiently low noise to serve as detector as well, he says, whereas a Gunn radar needs a Schottky detector because the Gunn is too noisy for detection. In support of this, Prof. of electrical engineering, George I. Hadad, of the University of Michigan, Ann Arbor, who has extensively studied microwave devices, says that the low conversion loss and low noise of Baritts will offset their disadvantages in doppler-radar applications where self-mixing is impossible.

Not all agree. Jim Charters, engineering manager of Microwave and Electronic Systems Ltd. Newbridge, Midlothian, Scotland, one of the biggest makers of doppler intruder alarms, thinks the 60-v requirement is a serious drawback. Any up-converter, he says, will need to be very stable to avoid fluctuations at 12 v being multiplied and causing frequency changes.

Charters says the frequency stability and reliability of Gunn devices are not problems. And the longer life of Baritt diodes remains to be proved. In practice, higher sensitivity is not useful, according to Charters, because if the range is extended to take advantage of it, the sensitivity becomes too great close in. Furthermore, insects, such as moths, near the antenna can set off the alarm. Nonetheless, he acknowledges that an alarm maker not committed to Gunns might find Baritts attractive.

Despite the controversy in the area of doppler alarms, the Lucas Electrical Co. of Birmingham, England, is investigating the possibility of using a Baritt-powered radar as part of a vehicle anti-skid system. The company hopes that the radar will be able to pick out consistently the instant before the wheel locks, and trigger release of the brakes. Mechanical sensors aren't accurate enough, and a Gunn radar can't remain stable and sensitive enough through the wide temperature range involved.

IMA's samples use a simple pnp structure made with standard varactor technology. A p^+ substrate holds an epitaxial n layer into which is diffused a shallow p^+ top contact. The only critical factors are the n-layer thickness, which is 6 to 7 micrometers for X band, and its doping level, which is 2×10^{15}. This structure is mesa etched to make devices about 8 mils in diameter.

The power density is low, and junction temperature is not more than 100°C. Samples are scheduled for year-end distribution. Weissglas says they will make good low-noise local oscillators in full-size radars and communication systems. □

Satellites

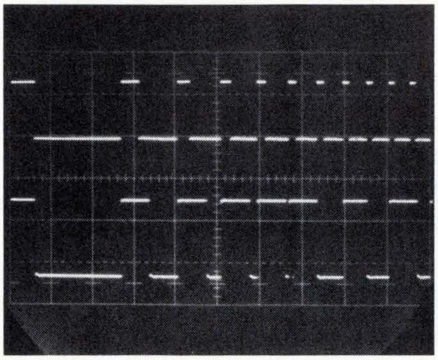
ASC, CML revise domsat plans

When Western Union launches its own Westar satellite this spring, it likely will be launching several competitors' systems as well. This may happen because building expensive technological systems in an uncertain market is causing several companies to change their plans.

American Satellite Corp. (ASC) has drastically revised its plans and will now start its system by using Westar. CML Satellite Corp. plans to lease this fall one or two transponders on Westar for test and sales purposes over two years. Moreover, Western Union and RCA Globecom are talking about a possible link-up. And, Western Union is said to be talking with AT&T and Southern Pacific, among others, in an effort to fill its spacecraft.

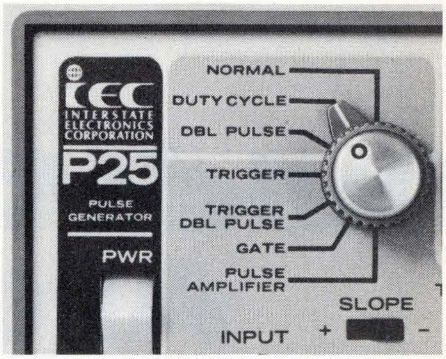
Although the companies' actions may dampen a spacecraft market, it will allow them to go into operation earlier and cheaper without the high hardware costs of their own initial systems. It also will give them time to test out techniques and better gauge the market before they send

yes, yes, no, yes, no.



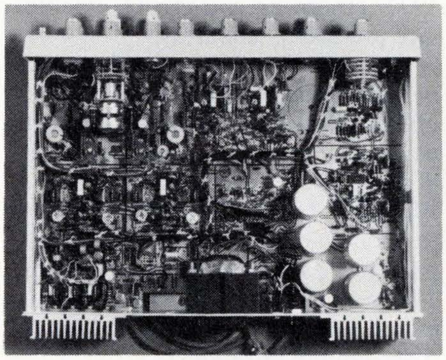
Upper trace: Constant Duty Cycle pulses over a 10:1 frequency range.
Lower trace: Normal pulses over same range.

"Standard pulses with predetermined width are fine for most requirements, but when I'm changing repetition rates I have to fiddle with the width control to make sure that I don't lose the pulse. Does your 'Constant Duty Cycle' mode let me set width as a percent of pulse period so I can change rep rates *without* tweaking the other controls?" (YES)



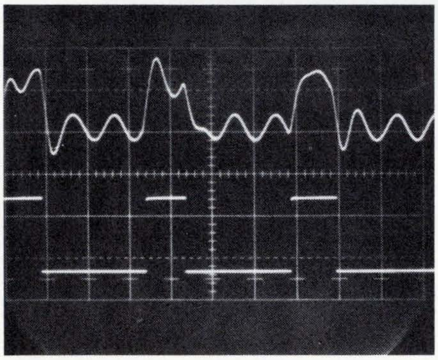
A single control selects all 7 modes.

"That Duty Cycle mode could come in handy, but I also want the regular pulses that I'm used to, and double pulses, and 50% squarewaves to 50 MHz. How about trigger, gate, triggered double pulse, and pulse shaping? (And all of these modes better be easy to set!)" (YES)



All components are fully accessible.

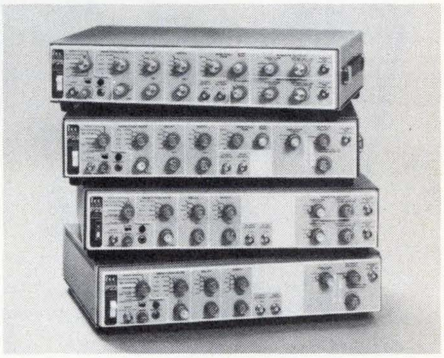
"Reliability and maintainability count, too. I want a generator that works! But in case it needs service I'd like to specify plug-in sockets for dual in-line IC's, and a parts list minus factory widgets. If I put my money on your model, will my QC man hate me?" (NO)



Upper trace: distorted, noisy input.

Lower trace: pulse generator output (Pulse Amplifier Mode).

"My application calls for pure pulses with a bare minimum of overshoot and squiggles. And I need to clean up distorted signals — you know, send in a crummy pulse train and get out a nice squared-up pulse with the offset, amplitude, and rise/fall times I've set up on the generator. Can do?" (YES)



Four SERIES 20 models are available from $575.

"Your $1095 P25 Pulse Generator has it all, including simultaneous positive and negative outputs, each with adjustable d-c offset and variable rise/fall times from 5 nanoseconds. But if I only need a single output or faster, fixed rise times, am I out of luck?" (NO)

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up their own spacecraft. For Western Union, it means short-term customers and a long-term effort to fill the gap when the customer-competitors leave for their own systems.

ASC originally was going to start with Canada's Anik 2 domsat and then buy three satellites from Hughes for a $25 million second phase while developing a "permanent" third-phase system under the over-all $100 million program. Instead, beginning this summer, the company will lease three transponders from Western Union's Hughes-built Westar series for $4.8 million a year, drop the use of Anik 2, and cancel the Hughes contract, for which it already has made $5 million in progress payments. The company still plans to launch a three-axis-stabilized spacecraft by 1977, according to John G. Puente, vice president, technical.

"By this move, we save up-front money," Puente says, including $30 million in launch costs and $90,000 per year for each transponder, as Westar is cheaper than Anik. The Western Union contract is extendable beyond 1976, and the company has Anik as a possible backup. The new system will cost an estimated $70 million, including launch costs, Puente estimates.

The revised plans will allow both ASC and CML to further develop newer 12- and 14-gigahertz transmission techniques for direct rooftop communications. ASC's second phase will be a mixture of communications at 4 and 6 GHz and 12 and 14 GHz. CML's satellite will use only 12 and 14 GHz. In June, CML expects to go out for bids for a subcontract to develop the higher-frequency technology and within a year after that it plans to award the prime contract to build three spacecraft.

These satellites will be built while it leases Westar. The company basically is looking at spin-stabilized 1,500-pound spacecraft for its $130 million system. Getting partners Comsat, MCI, and Lockheed to agree has also helped delay plans that originally called for bids to go out last fall [*Electronics*, June 21, 1973, p. 72). □

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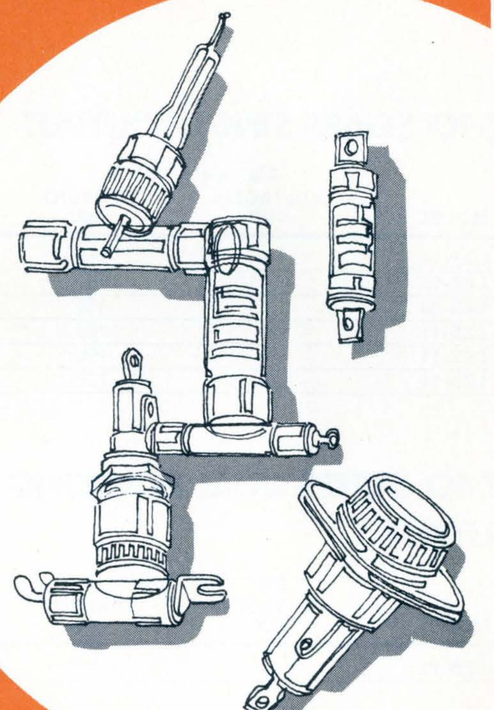

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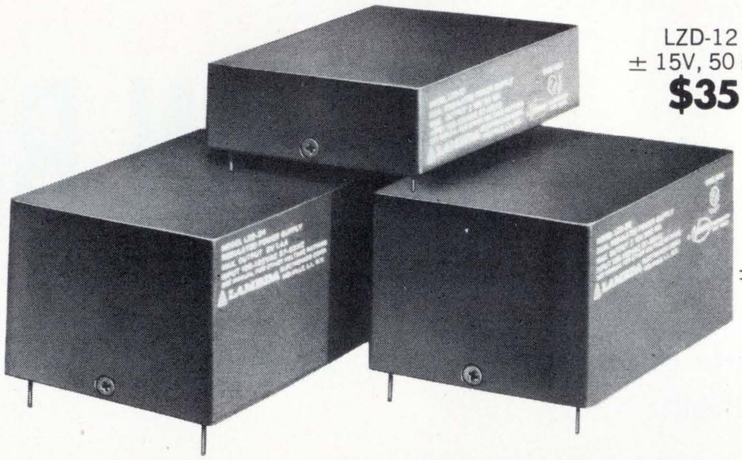

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2½" x 3½" x ⅞"

MODEL	VOLTAGE(1) VDC	CURRENT mA	PRICE(2)
LZS-10	3	317	$35
LZS-10	4	384	35
LZS-10	5	450	35
LZS-11	10	225	35
LZS-11	12	195	35
LZS-11	15	150	35

LZ-10 SERIES DUAL TRACKING OUTPUT

2½" x 3½" x ⅞"

MODEL	VOLTAGE(1) VDC	CURRENT mA	PRICE(2)
LZD-12	±15V	50	$35

LZ-20 SERIES SINGLE OUTPUT

2½" x 3½" x 1¼"

MODEL	VOLTAGE(1) VDC	CURRENT mA	PRICE(2)
LZS-20	10	247	$55
LZS-20	12	268	55
LZS-20	15	300	55
*LZD-22	24	73	40
*LZD-23	24	129	55
*LZD-22	28	84	40
*LZD-23	28	143	55

*Single output ratings for dual output models connected in series

LZ-20 SERIES DUAL TRACKING OUTPUT

2½" x 3½" x 1¼"

MODEL	VOLTAGE(1) VDC	CURRENT mA	PRICE(2)
LZD-21	± 3	217	$55
LZD-21	± 4	258	55
LZD-21	± 5	300	55
LZD-22	±10	61	40
LZD-23	±10	114	55
LZD-22	±12	73	40
LZD-23	±12	129	55
LZD-22	±15	90	40
LZD-23	±15	150	55

LZ-30 SERIES SINGLE OUTPUT

2½" x 3½" x 1⅞"

MODEL	VOLTAGE(1) VDC	CURRENT mA	PRICE(2)
LZS-30	3	633	$65
LZS-30	4	767	65
LZS-30	5	900	65
LZS-33	10	293	65
LZS-33	12	336	65
LZS-33	15	400	65
LZS-34	3	950	95
LZS-34	4	1180	95
LZS-34	5	1400	95
*LZD-32	24	186	65
*LZD-32	28	208	65
*LZD-35	24	240	95
*LZD-35	28	280	95

*Single output ratings for dual output models connected in series

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LZ-30 SERIES DUAL TRACKING OUTPUT

2½" x 3½" x 1⅞"

MODEL	VOLTAGE(1) VDC	CURRENT mA	PRICE(2)
LZD-31	± 3	333	$65
LZD-31	± 4	417	65
LZD-31	± 5	500	65
LZD-32	±10	163	65
LZD-32	±12	186	65
LZD-32	±15	220	65
LZD-35	±10	200	95
LZD-35	±12	240	95
LZD-35	±15	300	95

LZ-30 SERIES TRIPLE OUTPUT

2½" x 3½" x 1⅞"

MODEL	VOLTAGE(1) VDC	CURRENT mA	PRICE(2)
LZT-36	5	500	$70
	±15	50	

NOTES: (1) LZ models are adjustable between the following limits: LZS-10 2.5 to 6V LZS-11 8 to 15V LZS-20 8 to 15V LZS-30 2.5 to 6V LZS-33 8 to 15V LZS-34 2.5 to 6V LZD-12 ± 14.5 to ± 15.5V LZD-21 ± 2.5 to ± 6V LZD-22 ± 8 to ± 15V LZD-23 ± 8 to ± 15V LZD-31 ± 2.5 to ± 6V LZD-32 ± 8 to ± 15V LZD-35 ± 8 to ± 15V LZT-36 2.5V-6V for + 5V output only, ± 14.5 to ± 15.5 for ± 15V output only. Contact factory for current ratings at voltage settings not indicated in the tables. (2) All prices and specifications are subject to change without notice.

SPECIFICATIONS FOR LZ SERIES

Regulation
0.15%—line or load; models LZS-10, LZS-30, LZS-34, LZD-21 and LZD-31 have load regulation of 0.15% + 5mV; model LZD-12 has line or load regulation of 0.25%; LZT-36 line regulation 0.15% (±5V) 0.25% (±15V); load regulation 0.15% + 10mV (+5V), 0.25% (±15V).

Ripple and noise
1.5mV RMS, 5mV, pk-pk

Temperature coefficient
0.03%/°C

Overshoot
no overshoot on turn-on, turn-off, or power failure

Tracking accuracy
2% absolute voltage difference for dual output models only and only for the ±15V output in LZT-36; 0.2% change for all conditions of line, load and temperature

Ambient operating temperature range
continuous duty from 0°C to + 50°C

Wide AC input voltage range
105 to 132 Vac, 57-63 Hz

Storage temperature range
−25°C to +85°C

Overload protection
fixed automatic electronic current limiting circuit

Input & output connections
printed circuit solder pins on lower surface of unit. For model LZT-36 the ± 15V outputs are independent from the 5V output.

Controls
screwdriver voltage adjustment over entire voltage range.

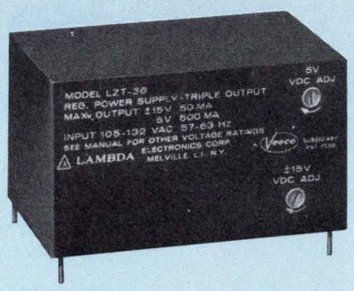
Mounting
tapped holes on lower surface

Physical data

Size	Weight
see tables	LZ-10 series 10 oz. net 18 oz. ship.
	LZ-20 series 17 oz. net 25 oz. ship.
	LZ-30 series 24 oz. net 32 oz. ship.

60-day guarantee
60-day guarantee includes labor as well as parts

LZ SERIES NOW AVAILABLE IN NEW TRIPLE OUTPUT MODEL



MODEL	VOLTAGE(1) VDC	CURRENT mA	PRICE(2)
LZT-36	5V	500	$70
	±15V	50	

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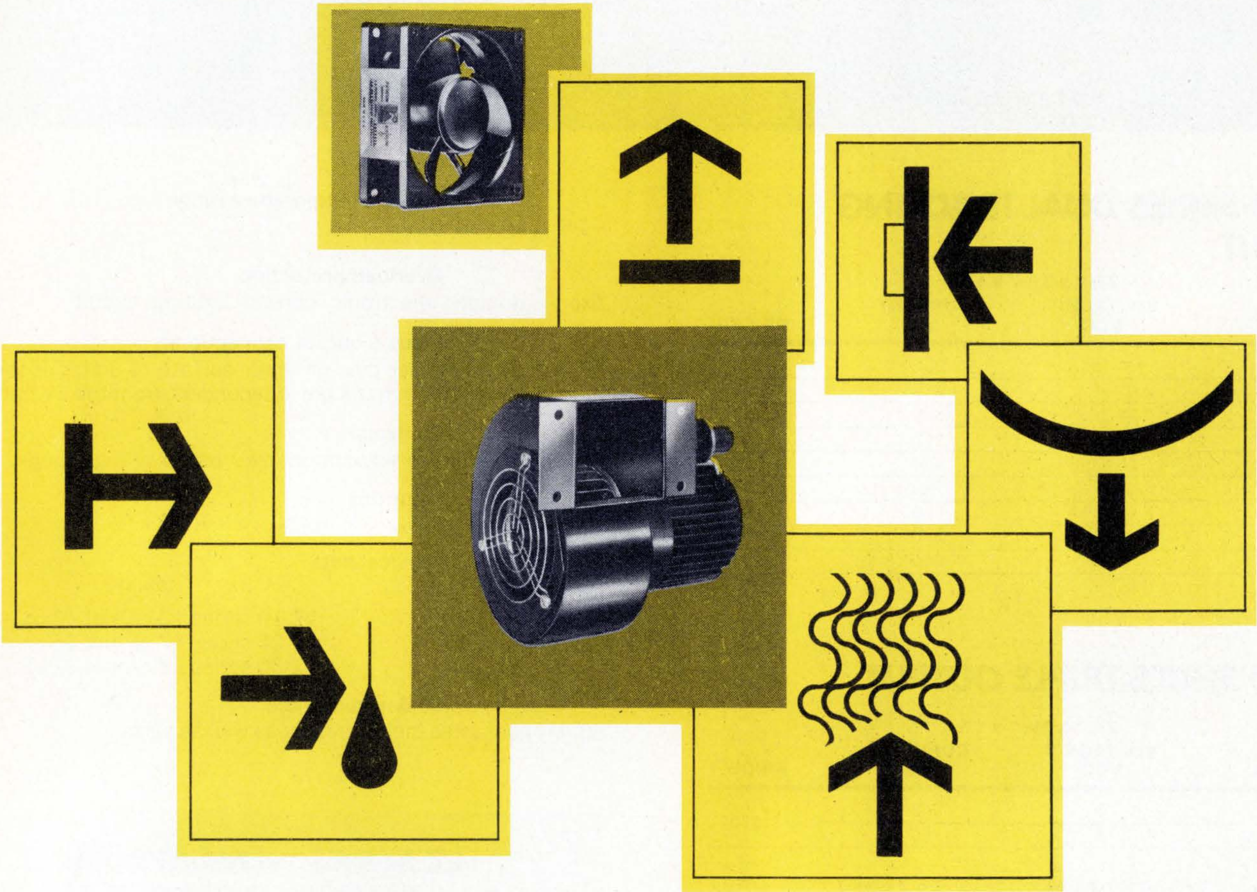

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Washington newsletter

New engineers quit DOD over salaries, promotions

Engineering salaries in the Pentagon's in-house laboratory system have failed to keep pace with those of private industry, unlike most Federal pay scales for most administrative and other specialties. So says the Directorate of Defense Research and Engineering, which complains that **the starting Federal salary for a new BS in engineering in the spring of 1973 is about $1,500 a year less than that of private industry** because of the latter's increased demand for engineers and physical scientists. Because, too, **controls on the number of Federal jobs have slowed down Civil Service promotions,** DDR&E says "many of the bright, young people we were able to attract two or three years ago are leaving."

OMB chokes plan for emergency medical services

Despite congressional, departmental, and medical support, the powerful **White House Office of Management and Budget is strangling a program to fund local emergency medical services,** confide officials at the Department of Health, Education, and Welfare. **Congress has authorized $185 million over three years to pump life into local emergency communications networks** [*Electronics*, Jan. 10, p. 80], **but OMB has cut the fiscal 1974 funding from $45 million to $27 million.** Moreover, the regulations on how to grant the money are coming out so late that the fiscal year could end before all the money is spent.

Will Congress notice? "Congress has so many things to be upset about right now that it might not do anything," one official worries. Another official offers **a possible solution: get funds committed for as many networks as possible and hope for more money in fiscal 1975.**

Navy researchers develop high-power satcom test facility

Details of **a new Naval Research Laboratory installation for high-power testing of communication satellite components and materials** are to be disclosed at the March 26-28 millimeter-wave-technique conference in San Diego, Calif., at the Naval Electronics Laboratory Center.

The installation at the Microwave Space Research Facility, Waldorf, Md., has a 1-kW K_a-band power capability in the 36-38-GH2 band. As a result, says NRL's R.E. Cushing, principal investigator for the project, **system designers can now obtain complete high-power testing of system components during development of a satcom terminal,** saving time and money and preventing component failure in future satcom system use. A small interior radiation chamber is for antenna and materials evaluation at high rf flux densities and power levels to 1 kW cw for long intervals of time. **Direct-reading digital calorimetric water loads have been developed for waveguide and radiation sources.**

Secure voice unit formed for military communications

A Secure Voice Consortium made up of representatives of all defense communications users has been **established by the Directorate of Defense Research and Engineering to eliminate duplication and coordinate military programs on secure communications.** The SVC will oversee implementation of the interim system, Autosevocom Phase 2, as well as **development of narrow-band 2-8-kilobit/second voice-processing equipment** for use where wide-band digital transmission will not be available. **Large-scale integrated circuits, are "the key to the economic implementation of the relatively complicated voice-processing algorithms needed,"** says DDR&E director Malcolm Currie.

Washington commentary

The domsat shakeout

When the Federal Communications Commission gave its long-delayed blessing two years ago to the competitive development of domestic satellite systems, there was much speculation about whether the marketplace could support the six systems proposed. It was then that Dean Burch—who is now leaving the commission to join the White House staff—displayed the characteristic common sense that was to mark much of his rule as FCC chairman.

Burch's law was simply "let the marketplace decide." In judging petitioners' applications to launch satellites for domestic service, he said, the FCC would base its decisions on technical considerations only.

The wisdom of that judgment is borne out by the news that American Satellite Corp., CML Satellite Corp., and possibly RCA Globcom and AT&T, will now buy transponder space on Western Union's Westar satellite—the first domsat scheduled for operation and to be launched in April (see p. 42). The shakeout in domestic satellites clearly is well under way.

The shakeout also demonstrates the wisdom of Western Union's gamble in placing its order for satellites before it received FCC approval of its plan. By getting its order for satellites and NASA launch rockets in first, WU achieved a significant leg up on the competition.

Financing their respective entries into the new and undeveloped communications satellite market proved the principal problem for most of the companies. Fairchild Industries, which now has total control of American Satellite after a two-step acquisition of Western Union International's 50% interest, has had difficulties as well. Predominantly known as a military aircraft maker, Fairchild's push to get public investment for its infant American Satellite flopped last year. CML Satellite, with holdings equally divided among Comsat Corp., MCI Communications Corp. and Lockheed, has also had fiscal problems. Comsat, it seems, is the only one with money to spare, yet is precluded from bankrolling its partners by FCC's restrictions on investment in and control of CML.

However, AT&T, RCA Globcom, and Hughes-GTE have sufficient resources to leverage their way into the domsat market later, should it prove lucrative for Western Union. Fortunately for Western Union, it managed to find the funds to make its commitment first. As one company official now says of Westar, "my guess is that we'll go to launch sold out."

Problems of innovation

Starting a totally new industry in 20th century America is more than difficult. It is almost impossible—particularly if your resources are limited and the new business threatens to disrupt the existing marketplace. This is the hard lesson being learned by Richard Ahern, the young entrepreneur promoting the concept of electronic shopping in the home by means of an AT&T Touch Tone telephone linked to a computer catalog with voice answer-back.

Ahern's Computer Shopping Inc. is hardly an industrial giant. And in an industrial society where oligopoly is the rule rather than the exception, Computer Shopping's limited resources are a large part of its problem. The other part is a very human fear of the unknown, from which no corporate leader is immune. It is a fear that can destroy the innovator seeking to alter the *status quo*.

Since Ahern unveiled his computer shopping system last year—one he contends can save the U.S. "a minimum of 600,000 barrels of gasoline a day" by eliminating unneeded supermarket shopping trips—the new company has struck out in its efforts to get a major food retailer to participate in a demonstration prototype system. Ahern says the food retailers fear that such a system could severely reduce purchases of their highest-profit items customarily bought on impulse—fresh produce, meats, and such unnecessaries as costly frozen chocolate cakes, pies, or cocktail glasses. Moreover, says Ahern, large food chains with an estimated $100,000 invested per store balk at a concept that might make such outlays unprofitable.

Unfortunately, Computer Shopping is unable to afford the high cost of a demonstration prototype system—something that most of the conservative industries he expects to service want to see first. Working hardware is virtually essential to any high-capital-risk venture.

Now, however, Computer Shopping believes it can get a $100,000 commitment from the Federal Energy Office for a demonstration system, provided it can find a customer to make a comparable investment. At the very least, this is what computer shopping needs. If it does not get it, another innovative concept may fail—and with it will go a significant potential market for electronics technology. **—Ray Connolly**

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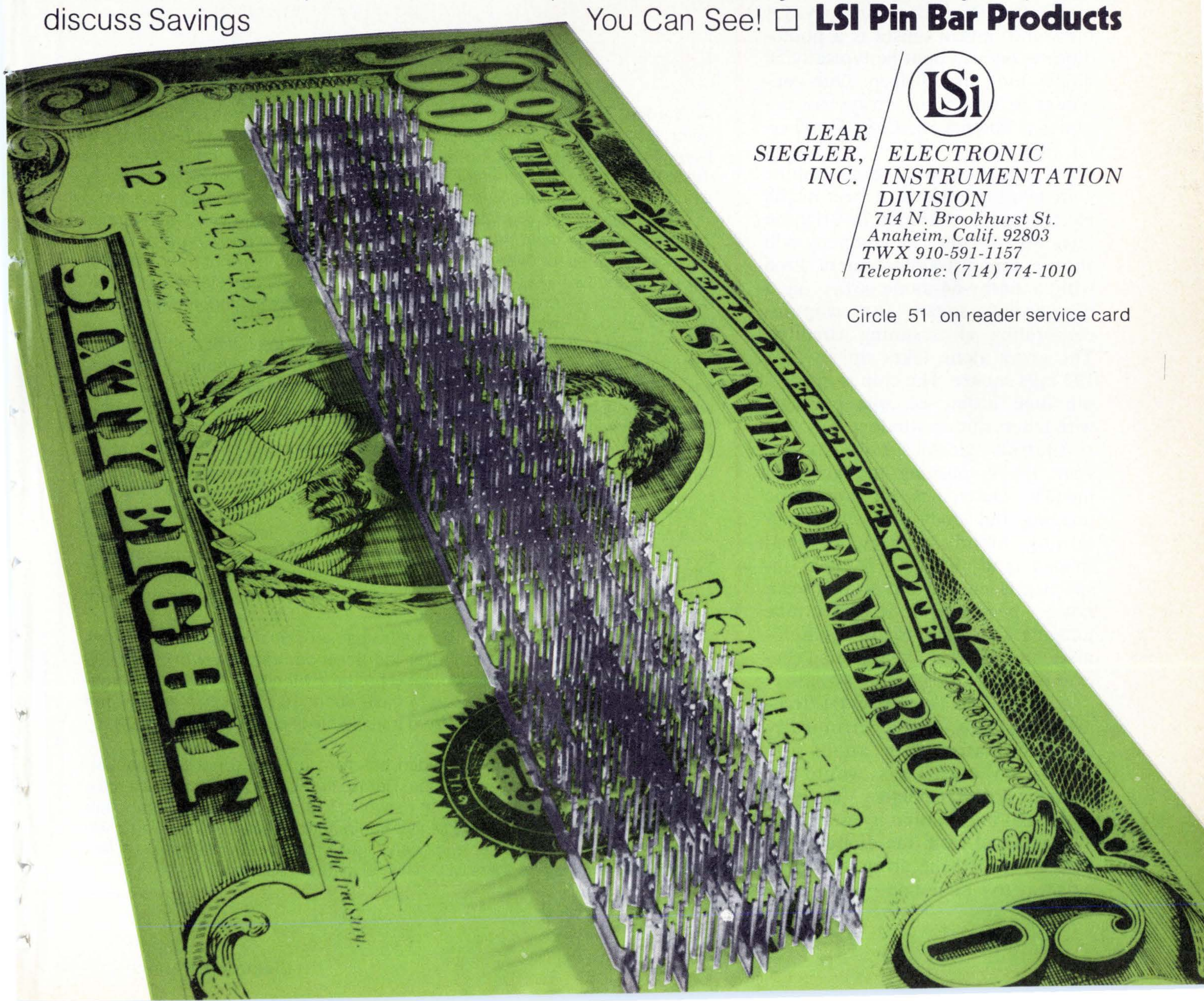
Savings you can achieve by using LSI Pin Bar for your common spaced bussing applications. □ Whether low production or high (up to 8,000 pin terminations per minute), the job can be done for 3 to 6 cents per pin—compared with two recent independent studies that show wire bussing costs, including rework, approaching a minimum of 10 cents per termination in high production quantities. □ A major manufacturer of telephone products is convinced. He saved $68 dollars per chassis when Pin Bar replaced every common spaced wire bussing circuit for high frequency multiplexing, data transmission, power and ground applications. □ And while saving, he gained foolproof terminations at higher production rates, lower uniform contact resistance, efficient back panel design, and a "spec" performance component produced to his exact requirements. □ Give us your common spaced bussing problem. We'll send free samples and prices immediately. Or we'll visit your plant to discuss Savings You Can See! □ **LSI Pin Bar Products**



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Circle 51 on reader service card

IPL readies photodiode array for merchandise mark reading

All the noise being made about the use of charge-coupled devices for solid-state imaging arrays has tended to push the older photodiode sampling arrays into the background. Nevertheless the first large orders for two-dimensional arrays are likely to be for photodiode, not CCD, devices.

U.S. point-of-sale equipment makers National Cash Register and Singer will use optical wands for merchandise mark reading in some new equipment ranges, and currently the favored technology for the wand optical sensor is a photodiode array. It might be typically 50 diodes long by 15 deep. One contender to supply the arrays is Integrated Photomatrix Ltd., Dorchester, England.

IPL will show what can be done with two-dimensional arrays at the electro-optics exhibition in Brighton later this month. The company will show a demonstration camera fitted with a 64-by-64-diode array on a quarter-inch square MOS chip incorporating all scanning circuitry. The array alone takes up an area 192 mils square. The chip is in a 24-pin dual in-line ceramic package, with a borosilicate window.

Analysis. Besides point-of-sale gear, IPL is pushing the array in medical electronics for automatic imaging and analysis of slides containing blood samples, cervical smears, and the like. Manual inspection is lengthy and hospitals can not get people to do it. Video-tube imaging has been tried, but automatic analysis is complicated because of the analog output signals.

According to Peter Fry, IPL technical director, an electronically scanned matrix with about 100 diodes on each axis would be enough for satisfactory analysis. Positional information is automatically obtained from the diode co-ordinates, so that the array is already half-way to a digital output.

Like Reticon Corp., Mountain View, Calif., IPL has made devices and systems based on a single row of diodes. But there are important differences between the technology necessary for a line and a matrix. In a line, the diodes can be as close together as possible—1-mil centers are possible—to get maximum utilization of silicon area, because the sample and recharging circuitry can be on the side.

However, the matrix obviously can not have the circuitry alongside. Address lines between each diode line in both axes force the diodes apart. Fry believes that 3-mil centers will be the best compromise because that spacing is far enough apart to allow diodes that are big enough to be properly sensitive, but close enough together to allow a big matrix on a reasonably sized chip.

The address lines connect with

French ready packet-switching link to start data network

As the first step towards a digital data network, French government engineers last month began testing an experimental packet-switching link between Paris and Rennes in Brittany. By early next year they hope to tie in industrial and commercial customers on a trial basis. Long-term plans call for a network—code-named Hermes— tied into the national telephone system.

Telecommunications administration officials are in no rush to get Hermes into service; their main thrust right now is to solve the pressing problem of providing phones for everyone who wants them. But in the brand new laboratories of the two-year-old Centre Commun d'Etudes de Télévision et Télécommunications (CCETT), development of packet-switching techniques is being pushed, anyway.

In contrast to the other major French experiment in packet switching, the Cyclades project, which links together big scientific computers [*Electronics*, Feb. 21, p. 56], the Paris-Rennes link is oriented toward a network serving many clients with simple data-transmission problems. Also, the multiclient link will give CCETT a look at how to compute the data volume that flows from individual terminals into the network. This is needed so that future charges to Hermes customers can be scaled down as volume increases.

CCETT calls this first system RCP, for Réseau de Commutation par Paquets. In the first stage of system experiments, data packets are being transmitted at a speed of 4,800 bits per second on ordinary telephone lines. Each packet, made up of about 63 eight-bit bytes, is grouped with up to three others in a frame along with error-correction codes and addresses. In addition, the system automatically modifies the transmission speed to adapt source capacity to receiver capacity.

Next year, the CCETT will set up a third packet-switching center in Lyons and boost transmission speeds over the three-cornered network to 9,600 bits per second in each direction between the switching computers. Sometime next year, also, CCETT hopes to have about 10 computers tied in and probably 100 or more terminals from trial clients like banks feeding directly into the packet-switching centers.

Several more years will be needed before a complete national packet-switching grid is opened to everyone. Before that stage, the CCETT will have to design a replacement for the RCP network. The new switching computers must be larger than the present Digital Equipment Corp. PDP-11s. And it will be some time in the 1980s, engineers figure, before the Hermes system linking telephone subscribers will finally be in operation.

shift registers along two sides of the matrix. One shifts quickly and selects individual diodes. The other shifts at 1/64 the speed and selects lines. Line selection is via aluminum interconnects, and diode selection via diffused interconnects. The diffused interconnect carries the charge sample out of the array.

Fry explains that the metal line ideally should carry the charge, and using the diffused line brings serious delay problems due to resistance and capacitance. For instance, if simple sequential scanning of each diode were used, delay would cut the sample rate of the 64-by-64-diode array to about 0.5 megahertz, which is far too slow to be useful.

Thus, he has devised a parallel scanning technique that removes the delay. He can not switch the line functions about and carry the charge on the metal lines, because IPL uses metal-gate MOS technology with only a single metalization layer. Using the metal line to carry the charge would make processing far too complicated.

The 64 diffusion lines feed into 64 integrated capacitors along one side of the chip. A complete line of 64 diodes is sampled simultaneously, and the charges pass in parallel to the capacitors, from which they are read out in sequence. A space of 4 microseconds is allowed for sample and transfer. Readout takes 200 nanoseconds per capacitor, so the fastest frame scan time is just over 1 millisecond. □

Around the world

System automates windshield wipers

Frankfurt automobile-accessory maker VDO Adolf Schindling GmbH has developed an electronic system that automates just about all the steps involved in cleaning a car's windshield. The system's circuitry shortens the intervals between the wiping cycles as the vehicle goes faster. It sees to it that windshield cleaning water is sprayed in small amounts at the right moment during the wiper cycle. And it makes sure the wipers sweep several times after spraying so that the windshield becomes dry.

The control circuitry can be used with existing, separate wiping-washing systems. All that's required is installation of the control circuit box, the tapping of a speed-proportional signal, and a few connections. This simplicity means that the control can be sold through retailers directly to car owners.

Audio power IC has 4-watt output

When they set out to make a multi-purpose monolithic audio amplifier, mainly aimed at portable tape recorders, designers at Mitsubishi Electric Corp. decided to throw in some extras. The amplifier, which gives a 4-watt output from a 9-volt supply, causes no pop noise when a set is turned on nor does it radiate high-frequency noise that would degrade a radio's signal-to-noise ratio, as do some power ICs. What's more, it can be run on power supplies as low as 3 w, with decreased power outputs.

To ensure price and performance consistent with the widest range of applications, the power IC was designed to provide sufficient gain for a full 4-w output when driven by a radio's a-m detector or fm discriminator. A tape recorder preamplifier was intentionally omitted. Simple ICs for this application are readily available at low cost, and for some applications—like radios without recorders—the preamplifier is not required.

France

Philips develops Gunn amplifiers

Over the past few years, Gunn diodes have made their way as low-power sources from the laboratory into the real world of microwave equipment. Now, Gunn-effect amplifiers—also called transferred-electron amplifiers—are about ready to move out, too.

At Laboratories d'Electronique et de Physique Appliquée, a Philips Group research facility near Paris, researchers spearheaded by Robert Spitalnik and Alain Rabier expect to complete by May prototypes of a C-band transferred-electron amplifier module they have developed. RTC-La Radiotechnique-Compelec, a sister company in the Philips Group, will fabricate the prototype and then produce 50 of the modules by September with diodes from LEP.

Space. These particular modules are slated to go into the French satellite-communications ground station at Pleumeur Bodou, where they'll serve as drivers for traveling-wave tubes. In this application, the amplifiers have a gain of 8 decibels with a maximum ripple of 0.5 dB from 5.9 to 6.4 gigahertz.

Actually, the 500-megahertz bandwidth isn't much for the Gunn amplifiers that LEP has developed. Other modules have a 6-dB gain over the X-band range of 7 to 11 GHz. The noise figure is a remarkable 15 dB, and the power output is 100 milliwatts with no more than 1 dB drop over the whole bandwidth. To be sure, field-effect transistors out-perform Gunn diodes where noise is concerned, and avalanche diodes outdo them in power. But there's a niche between the two for Gunn amplifiers, Spitalnik feels, particularly in wideband countermeasures receivers.

To build devices that can fill this niche, LEP combines a notched cathode for the diode itself and a beam-lead mounting. The gallium-arsenide diodes, fabricated in an epitaxial layer grown on a GaAs substrate, have cathode notches about 2 micrometers wide with an impurity concentration of 2 to 3 $\times$ 10^{14} atoms per cubic centimeter.

After the notch comes a flat transit-time region of about 10 μm doped at 7 to 9 $\times$ 10^{14} atoms/cc. With this doping profile, the electric field is flat at 11 kilovolts per centimeter along the active length of the diode, and the diode operates stably when biased at 13 V.

To keep the gain flat over the bandwidth, LEP matches the diode to a 50-ohm output by a microstrip equalization network. The diode itself is mounted on the microstrip by means of a beam lead that can handle currents to 1 A. □

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International newsletter

Thomson-CSF readies a translucent video disk

Thomson-CSF intends to unveil a video disk player within the next four or five months. Company officials now say their research group has been getting **very good color images with a player that pairs a soft translucent plastic disk and a laser-based readout system.** The bandwidth of the encoded video signal is 4.5 megahertz, the disk spins at 1,500 revolutions per minute, and it carries up to 40 minutes of program.

Robert Pontillon, who directs Thomson-CSF's audio-visual activities, says that **the French company is pushing hard for an agreement on a single standard for video disk players.** The other European contenders are Philips Gloeilampenfabrieken, and the Telefunken-Decca venture, Teldec. Like Thomson-CSF's, Philips' player uses optical readout, but the Dutch company opted for a rigid, reflecting disk. Thomson-CSF, therefore, can't make its player compatible with Philips', but Pontillon maintains that the French playback system could be made compatible with Teldec disks, which have a pressure-sensitive readout.

German company to mass produce electronic speedometer

VDO Adolf Schindling, a leading European automobile-instruments maker, is about to begin production of electronic speedometers on a large-volume basis, making it the first company to have readied such speedometers for mass production. **The units will go into passenger cars that will come off the assembly lines of a German automobile producer starting this spring.**

The new VDO speedometers offer several advantages over conventional mechanical systems, the prime one being that the vehicle no longer needs a flexible shaft. Instead, a wire–one that can easily be run in the car's cable harness–is used for sending the speed and distance pulses from the transducer to the speedometer and its mileage indicator. The key component is an integrated circuit developed by Intermetall GmbH, an affiliate of the ITT Semiconductor group. **The price of the electronic speedometer, VDO says, will be about the same as a conventional one plus its flexible shaft.**

Electric bus to use sophisticated electronic controls

Chloride Technical Ltd., part of the British Chloride Group–whose activities include automobile batteries–**has developed an electrically powered 50-seat single-deck city bus that makes considerable use of electronic controls.** It will go into trial service in Manchester in a few months. Maximum speed is said to be 40 miles per hour and range 40 miles on a single charge of the 330-volt lead-acid battery. Normal battery recharge time is not more than 5½ hours, so that it can be recharged between morning and evening peak use times.

The bus uses a series-wound dc main-drive motor controlled by a 1,000-ampere thyristor chopper-controller, which incorporates a regeneration system that recharges the batteries during deceleration and braking. The controller has been developed by Sevcon Engineering Ltd. of Gateshead, a subsidiary of Technical Operations Inc., Burlington, Mass. It includes logic on the speed/time relationship, which keeps down acceleration and deceleration to comfortable levels. A pulse regeneration technique is used: current builds up in the armature and contacts until at a pre-set level it transfers through a diode to the battery.

International newsletter

Siemens turns to MOS ICs for remote TV control

Watch for West Germany's Siemens AG to offer an all-MOS set of integrated circuits for remote control of color-television receivers. The complete set, to hit the market during the second half of this year, will consist of three standardized MOS circuits—one each for the control system's transmitter, receiver, and memory. **It will sell for about $15, roughly equal to the price of all other integrated circuits—between eight and 10—used in German-built color-TV receivers today.**

Desk-calculator makers in Japan set quality standards

In the near future, desk calculator purchasers may look for a new mark—a stylized B and M—that goes with the quality standard to be introduced on March 1 by the Japan Business Machine Makers Association. **The association hopes the standard will help to maintain product quality despite the current high level of competition.** Eligibility for the mark includes registration of the model, inspection of the company's plant and after-sales service setup, and inspection of the quality of calculators. **The quality test will include repeated computation, to assure that there are no errors, and a vibration test.**

The association now has 14 manufacturers who produce calculators. Estimates of the number of "outsiders" that produce calculators range up to 50 companies. Most of the outsiders' calculators are exported.

SAAB-Scania takes over Facit's computer systems

Sweden's SAAB-Scania has taken over development and marketing of complete computer systems developed by office-machine maker, Facit. Now, SAAB, which has concentrated in large computers and large-computer bank-terminal systems, will be able to move into the lower level of computer applications. The Facit systems include an electronic invoicing system, multi-access office computer system, and a program-control system using magnetic tapes and alphanumeric CRT display screen.

At the same time, the take-over will also enable SAAB to use the well-developed world-wide Facit marketing organization. SAAB has concentrated its computer sales in Scandinavia and some East European markets, although last year it established a U.S. subsidiary, Data-SAAB Systems Inc. SAAB has one bank-terminal system in operation in the U.S., at New York City's Central Savings Bank.

Facit will retain development and marketing of its computer peripheral equipment, including tape punches and readers, which it sells to a number of computer makers. **Facit will also continue to handle production of the computer systems that SAAB is acquiring.**

Cables and Wireless picks Italian group for earth-station gear

Cable and Wireless Ltd., operators of seven satellite communications earth stations around the world—all built for it by Marconi Co. Ltd.—is moving to the Italian consortium Consorzio per Sistemi di Telecommunicazioni via Satelliti SpA. (STS) for its next two stations. These stations will be in Fiji and in Dubai in the Persian Gulf. **STS has a contract worth some $5 million for the antenna structures and some other equipment,** possibly including much of the transmit and receive gear. Marconi has to be content with an $800,000 order for some receiver subsystems and modulators. Other UK companies have taken smaller orders for ancilliary equipment.


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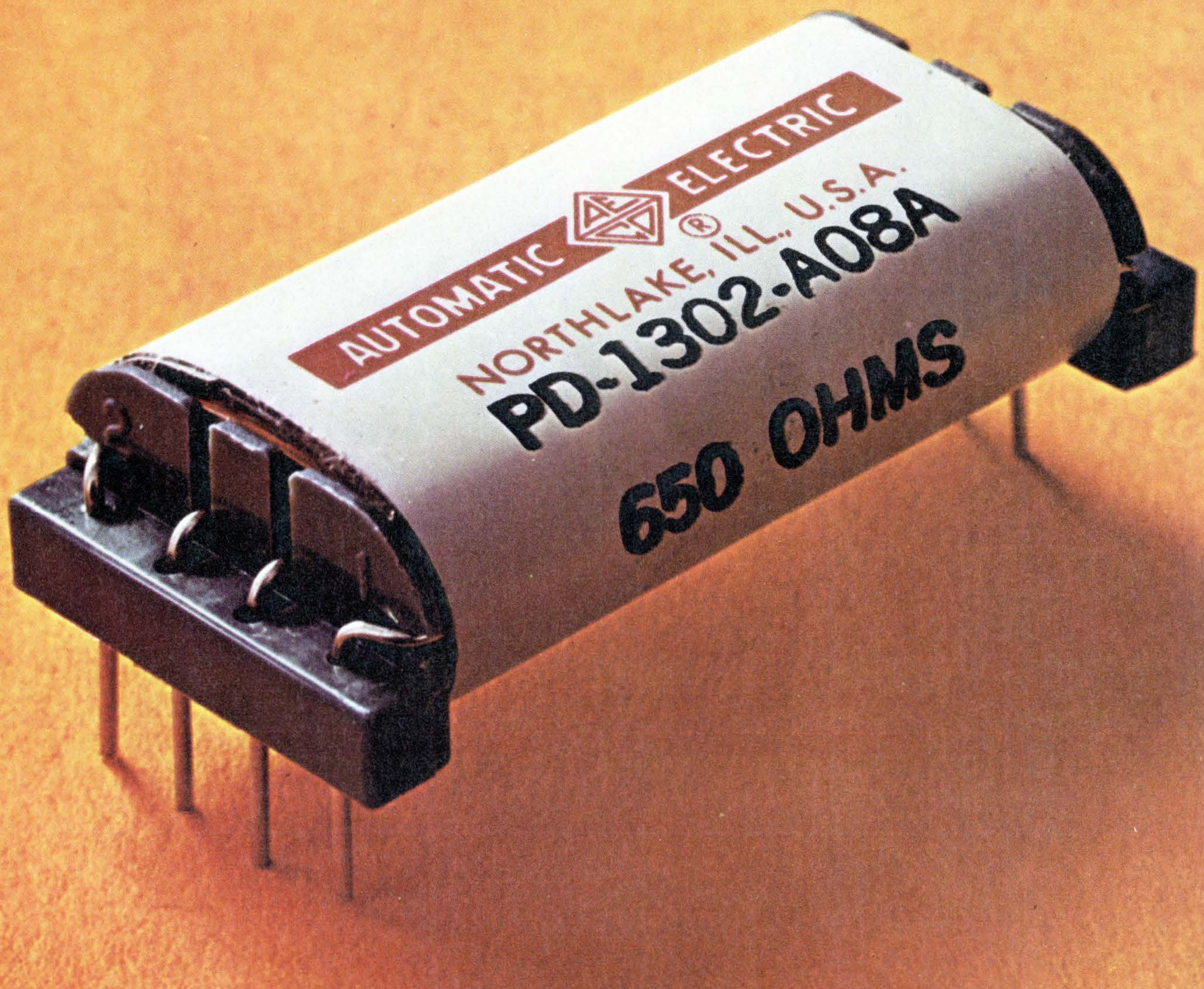
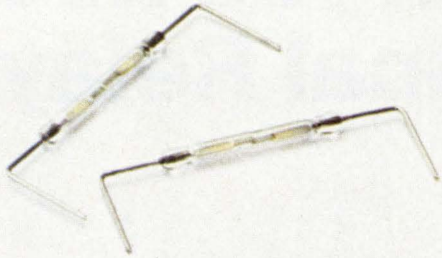


here's the way it looks.



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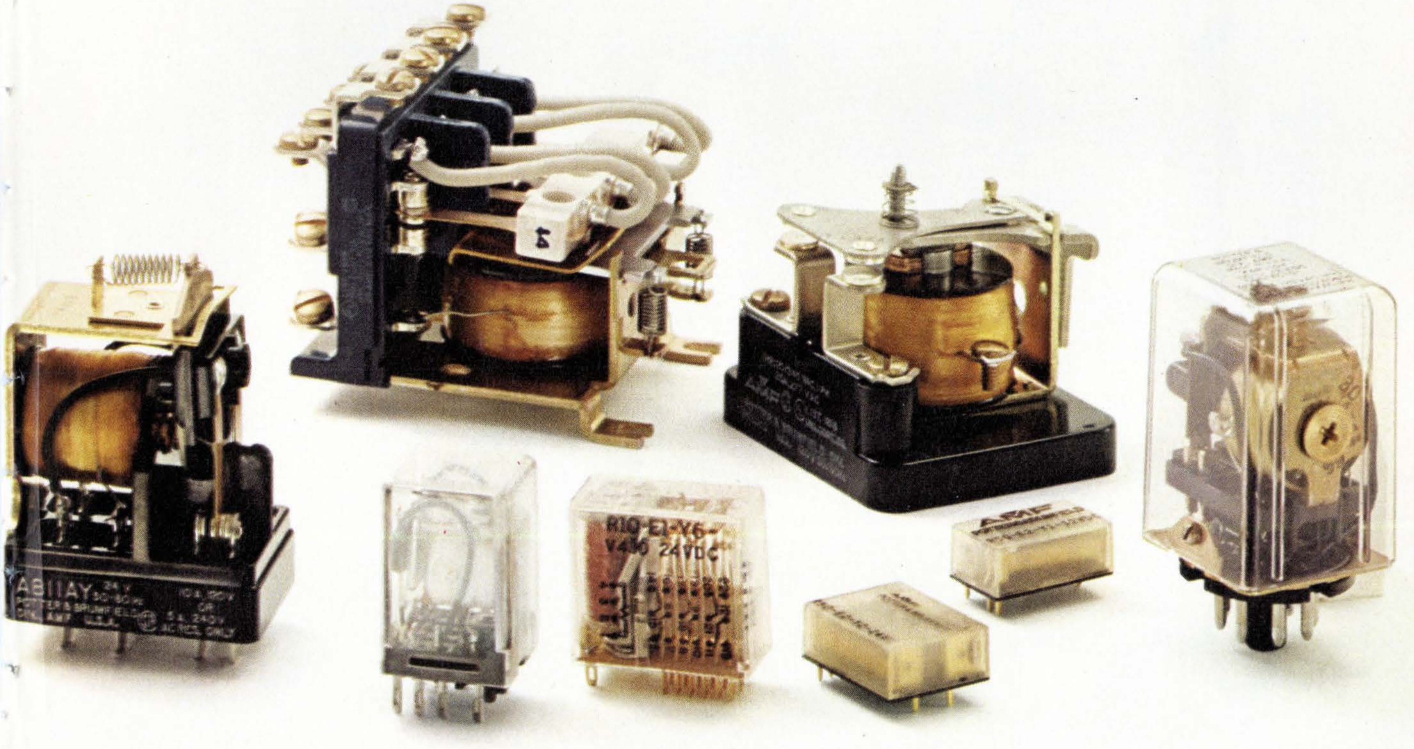

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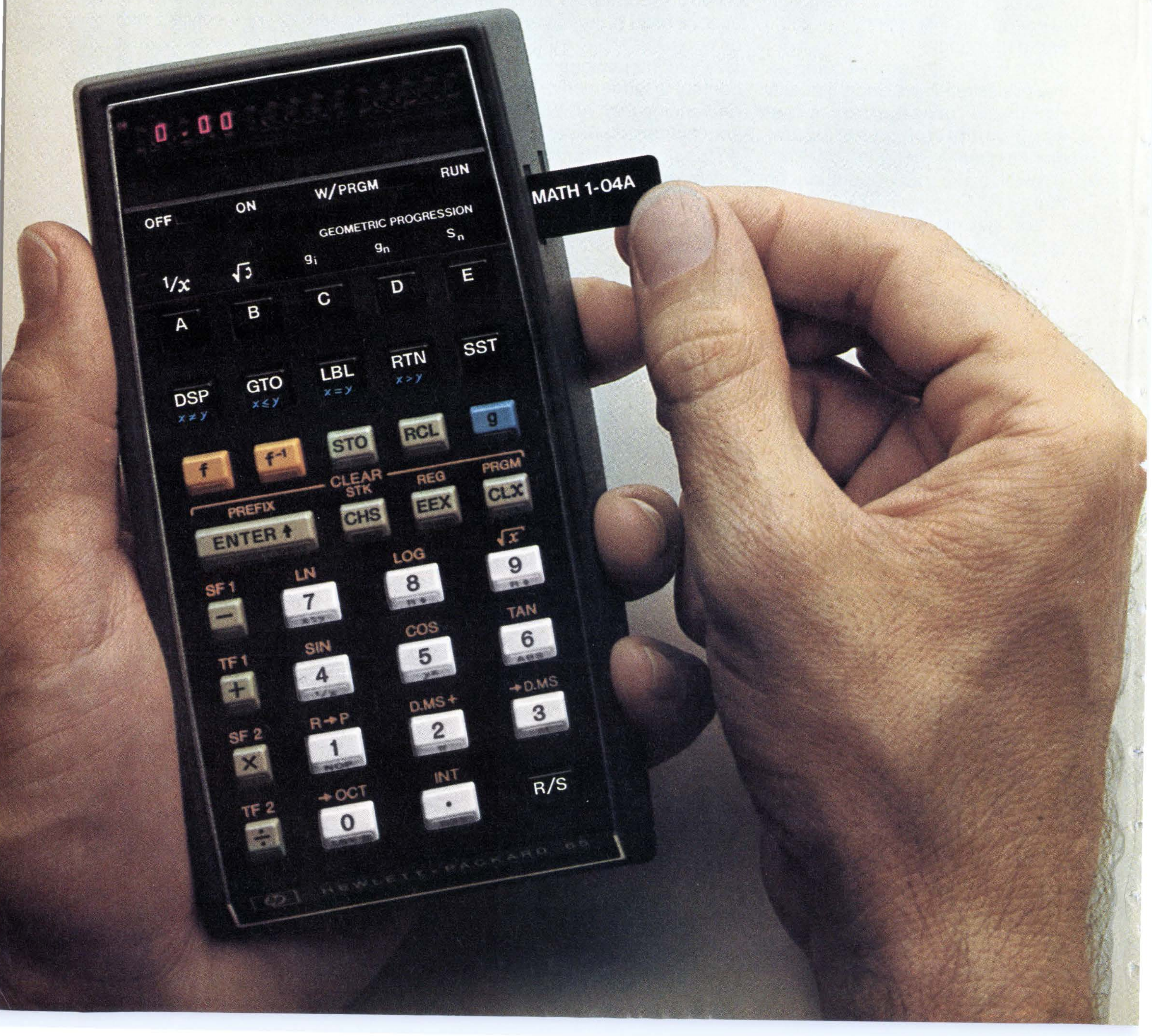

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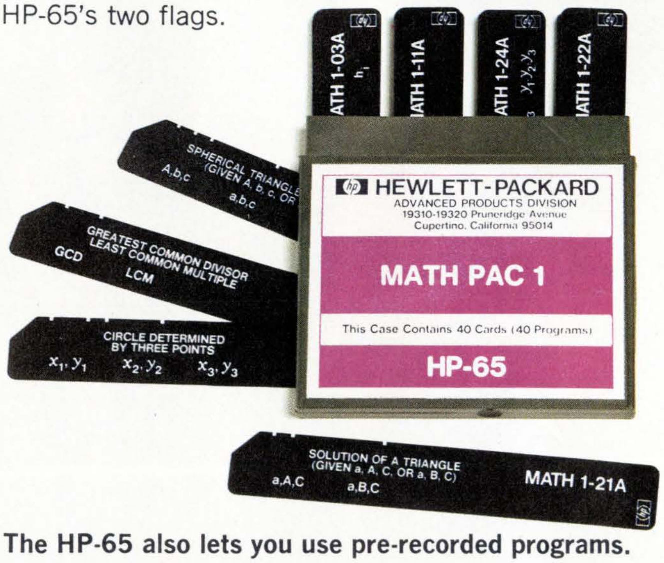

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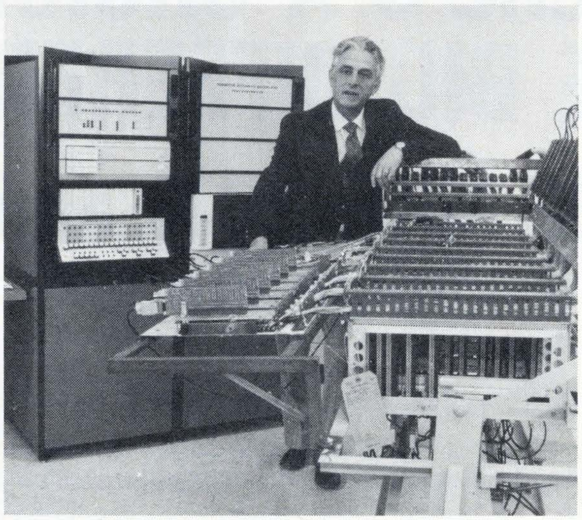

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Solid-state imagers halfway there

Industrial-quality CCD, injection, and MOS versions are available, but broadcast-type equipment is still several years away

by Laurence Altman, Solid State Editor

Solid-state imaging devices, hailed as the new generation of camera technology as early as 1970, are still not commercially available for high-density facsimile and video-camera applications. And while it is becoming clear that cameras that can meet the tough demands of manufacturers of broadcast and consumer equipment are still at least two or three years away, a wide variety of industrial equipment has become available. These products include lower-resolution linear and area imagers (charge-coupled, injection, and MOS devices) for such applications as slow-scan optical character recognition and basic-recognition intrusion systems.

Consider the developments of the last month:

■ Bell Laboratories has built a CCD vidicon capable of full Picturephone resolution (250 by 225 lines) for data-transmission systems, and, in the process, designed a high-yield device structure that greatly reduces the manufacturing tolerances.

■ An injection-type MOS camera has just been introduced by General Electric. While capable of only 100-line video resolution, it's so sensitive that it can detect images illuminated by nothing more than the light from a candle. Signal-to-noise ratio is 1,200 to 1, and peak sensitivity is about 300 milliamperes per watt. This camera joins the 100-by-100-element CCD imager from Fairchild Camera & Instrument.

■ A new MOS photodiode readout structure from Stanford University reduces the noise of MOS self-scanning arrays. The structure will add to the applications of the industrial-type self-scanners available from Reticon Inc. and Photomatrix Ltd.

■ Finally, and perhaps most significant in foretelling developments, workers at RCA Lancaster are operating a CCD video camera that's capable of the full 525-line video resolution. This 512-by-320-element array is technically capable of performing in today's TV systems.

But it should be pointed out that available camera components fall short of the resolution and picture quality required for most video applications; standard industrial-quality data-transmission, video, and facsimile equipment; and toughest of all, low-cost consumer cameras capable of displaying good pictures on home TV monitors at a price less than $200.

Indeed, some observers have begun to question whether solid-state techniques will ever be capable of producing imaging devices comparable in quality and cost to today's vidicon tubes—a standard 525-line black-and-white video camera from Japan can be bought for less than $200.

These new developments indicate that solid-state imagers are clearly

Soft light. GE's injection-type MOS camera is so sensitive that it can detect objects illuminated only by candlelight.

ready to penetrate many industrial markets. One user, Richard Van Thyne of Recognition Equipment Co., Dallas, states that "all three types of solid-state imagers–CCD, injection, and self-scan–are being evaluated for both simple character-recognition systems, like card and postal readers, and the tougher-to-implement point-of-sale applications. "For the OCR systems," says Van Thyne, "a linear scanner is sufficient because the material has to move past the image head anyway. And the available CCD and MOS scanners can already do the job. The problem is cost–we'd buy all we could at $5 apiece, and the vendors would supply all we wanted at $100 apiece. It's mostly a question of getting the economics together."

But Van Thyne indicates that it's not just the cost of the image component that must be considered–the total system saving can be considerable with solid-state imaging devices because they are smaller, use less power, and are generally more reliable. "You'll pay more for a device you know is reliable" and can operate at a fraction of the power dissipation and light levels that generally are available from tube imagers, he points out.

Whether industrial users know it or not, device manufacturers see them as providing a foot in the door for many special-purpose imaging applications. According to Gilbert Ameleo, in charge of CCD device work at Fairchild, "The industrial market provides a proving ground where many of the advantages of solid-state imaging can be tested." Even the early low-resolution image devices, like the 100-line camera, are already in demand for fly-by surveillance and monitoring applications because they are lightweight and rugged. But Ameleo cautions that penetration into industrial, let alone the broadcast or consumer markets, rests with the ability of solid-state-imager manufacturers to increase device density to the standard 525-line TV level. At this level, the solid-state device would begin to penetrate such fields as facsimile and page-reader equipment, to name two.

The density gap is quickly being filled by devices such as Bell Labs' 250-line and the RCA's 525-line imagers. The Bell device is promising because it greatly relaxes the manufacturing tolerances required in dense image arrays. Michael Tompsett, supervisor of the Bell CCD group, points out that the structure "considerably relaxes demands in mask making and photolithography because no narrow gaps have to be etched." The smallest device feature is the electrode itself–in this case, it measures larger than 15 micrometers.

This means that yields on CCD imaging chips can be quite high, even though the chips themselves are very large–500 mils and larger on a side–pointing to much lower manufacturing costs than might be expected for jumbo chips, "In fact," says Tompsett, "the problem with the commercial production of CCD imaging chips from the supplier's viewpoint may be that the price may fall too fast." And although most device manufacturers say they will supply both chips and complete camera systems, low prices on chips would stimulate more interest in supplying complete camera and monitoring systems.

RCA, which has been a major supplier of video-camera tubes, is clearly aiming at the systems market–a realization that may not be too far away, to judge from its 525-line CCD camera. According to Robert Rodgers, manager of the Lancaster camera group, the device, although still developmental, is technically capable of competing with many vidicons. "We have it hooked up to a standard TV monitor, and it's hard to tell it from a standard TV image. The CCD-camera cost, however, would be high, and because of this penetration into the general vidicon market, is still some years away."

This goes for both the broadcast camera market and the consumer home-video market. "For the broadcast market," says Rodgers, "even a 512-by-320-element camera is not good enough because sponsor pressure requires that the image quality must be higher than that shown on a home-TV monitor." And for the home-video market, the $200 vidicon presents a formidable competitor.

But as a special purpose camera, such as for low-light-level news and sports applications, teaching aids, and medical applications, the solid-state video camera may soon be in the picture. □

Bell ringer. This CCD vidicon built by Bell Labs can produce Picturephone resolution (250 by 225 lines). Researchers there also managed to reduce manufacturing tolerances.

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Automotive electronics

Electric vehicles draw interest

Electronic control systems are part of struggle to overcome cost, performance limitations in transit efforts

by Ray Connolly, Washington bureau manager

Consumers of the Western world waiting for an electric vehicle to rescue them from their dependence on gasoline pumps still have several years to wait. And when the first EVs arrive in quantity, they will most likely be in the shape of buses, rather than passenger cars. Moreover, those buses with their electronic control systems probably will have been made in Europe or perhaps Japan, rather than in the United States.

Surprisingly, those conclusions drawn from the Third International Electric Vehicle Symposium in Washington didn't discourage the electronics engineers at the three-day meeting near the end of February. "That may be discouraging for car drivers, but it is good news to us," contended one Westinghouse Electric Co. engineer, who noted that solid-state technology is still a newcomer to the EV marketplace. "There is still a chance."

How chancy is the potential for electronics as the principal control system for electric over-the-road vehicles? Most Americans acknowledge that they do not yet know, because the domestic market has not yet been tapped as it is beginning to be in Western Europe, where vehicle development is further along. There, the emphasis is on city buses and delivery vans with the capacity to carry the large, heavy battery packs now required by EVs. But the potential for electronic control systems unquestionably exists, if they can be proved economically competitive with older, established mechanical contactor systems and torque converters.

"It is still feasible to consider the mechanical contactor systems, for these have been greatly reduced in size and relative cost from the early days of streetcars and electric cars," says Ford Motor Co.'s Lewis E. Unnewehr. "However, many investigators feel that solid-state devices and circuits hold the most promise, and there is no doubt that such systems can give a smoother, more sophisticated type of control and would be much smaller in size."

Conflict. However, some European EV specialists have different views of the economics and performance of electronic control systems. On the cost side, David Gurwitz, managing director of Britain's Sevcon Ltd., says that electronic controls as they now exist are too expensive. To move a small, in-plant personnel carrier, for example, a minimum solid-state system could cost \$200. For a large vehicle capable of accelerations to a top speed of 60 miles per hour with the torque equivalent of 200 horsepower, a control system could cost as much as \$1,000 each in quantity. "These costs are not competitive," says Gurwitz.

Gurwitz' frustration with solid-state control costs was matched by one French engineering executive's concern with the performance of present controls. General manager Pierre Margrain of Establissements E. Ragonot, an affiliate of the Thomson Lucas Group, called for

Is there a consumer market?

In 1972, the New York-based Electric Vehicle Council commissioned a market study that determined there were about 55 million Americans who would be interested in a plug-in automobile for urban use if it could deliver a top speed of 40 miles per hour, would travel 150 miles without recharging, and could be bought for less than \$2,000. Both that range and price are still beyond the state of the EV art—now limited to about 50 miles and a price tag closer to \$4,000—but much has changed in America in the past two years.

Chief among these are the attitudes of the consumer, lately discontented with seemingly unending waits to buy limited quantities of gasoline. If there is an indication in the number of consumers who called the Third International EV Symposium anxious to see the exhibits—and in some cases, "place my order for an electric car"—then the principal obstacle to developing the consumer market would seem to be only the absence of a proven consumer product.

Offsetting the EV's high first cost and range limitations are its distinct advantages in the area of low fuel costs—about one-half cent per mile—as well as its low pollution level and relatively simple maintenance compared to conventional vehicles.

Of the 42% of U.S. consumers who expressed an interest in an electric vehicle, more interest was shown by women then men (43% vs 41%), by younger people than older (half of those in the 18 to 29 age bracket), and by big-city dwellers (48%) than those in rural or other urban areas. Said one analyst of the data, "in developing the market, it seems that college students and liberated women should come first."

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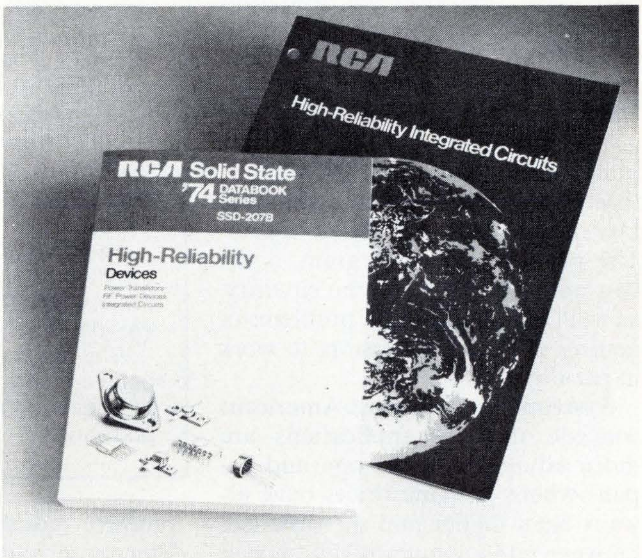

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development of high-power transistors with collector currents as high as 500 amperes so that the company's urban-vehicle controller can achieve economies as high as 80% in labor costs by replacing 33 components with no more than four or five that could cost 20% less. Margrain says he believes such components will be developed for use as choppers in EV speed-drive systems. Ragonot's prototype urban-vehicle controller has 11 independent power blocks, each consisting of three parallel transistors, driven in a Darlington assembly by a fourth. The problem, says Margrain, is the cost and complexity of the circuitry, as well as the associated problems of getting so many transistors to work in parallel.

Systems. Though most Americans concede that EV applications are more advanced in Europe and Japan—where gasoline prices have always been higher and the distances between cities comparatively shorter than in the U.S.—the belief that the higher level of American systems-engineering expertise may prove an advantage in the long run.

While all participants acknowledged that the limitations of battery technology are still the biggest handicap facing EV programs, Edward E. David Jr., Gould Inc.'s executive vice president for R&D, condemned the lack of system design. The former Science Adviser to the President said: "On-road truck and passenger vehicles are not realities today [because] too little effort has been spent optimizing electric vehicles from a total systems standpoint. Until recently, most electric vehicles were developed by removing an internal-combustion engine from an existing vehicle and adding standard batteries, motors, and controls. That is not adequate, and we now see that for a lead-acid battery to support broader vehicle applications, we must optimize all portions of the vehicle" before it can be economically marketed and manufactured.

That view was echoed by Siemens AG's Rudolf Wagner, who observed that "we EEs are technically inferior to machinery designers" in the automotive industry when it comes to determining with precision the long-range production costs of a mass-produced vehicle. But, Wagner added, "we accept the challenge."

Before an EV can be successfully marketed, much needs to be done to determine accurately the product's reliability and performance data in order "to make decisions on mass production, requiring a very high capital investment." By Wagner's estimate, "at least 10,000 cars will have to be built so that all technical data will be solidly grounded." Moreover, he urged the infant industry to move quickly to develop technical standards, especially in such areas as battery chargers, "so that the electromotive engine does not fail at the start."

Postal program. Some symposium registrants saw a certain irony in that the biggest EV effort in America is being sponsored by the U.S. Postal Service, an agency not ordinarily associated with innovative technology. Of the USPS program to move from 30 prototypes to 300 operational electrically powered postal vans in one bound, one Briton said, "a very, very brave jump indeed." Building even 100 vehicles "is enough to drive anybody mad," he argued, warning that "problems are going to exist" in the program because "none of the companies operating in the U.S. could expect to build even 10 vehicles at anything resembling real cost."

Westinghouse Electric Corp.'s Pittsburgh R&D Center identified some of the EV postal-route requirements in that city, reported a team of its specialists at the meeting. On three routes, mileage requirements varied from 12.3 to 28. Stops and starts totaled 375 on the longest run and 477 on the shortest. Kilowatt hours per mission ranged from 8.75 to 15.1, according to the study.

Are these and other proposed electric vehicles efficient? For the long term, the answer is a definite "yes," according to analyses by Westinghouse and others. In a study by Westinghouse's A. H. Long and three of his colleagues, the comparative costs per mile for an EV in 1973 were already competitive with conventional cars. They are 18.7 and 18.5 cents, respectively, on the basis of combined fixed and variable costs. And, as U.S. gasoline costs rise and emission-control systems continue to reduce the mileage per gallon, the Westinghouse study estimates that internal-combustion vehicle costs will nearly double by 1983 to 33.3 cents per mile. □

Why R&D's stalled in America

There seemed a common sense of frustration among the more than 1,000 entrepreneurs, economists, and electronics engineers at the Third International Electric Vehicle Symposium. But the origins of the concern were different for the Americans than they were for the more experienced EV specialists from Britain, France, and West Germany, who dominated the meeting. While the Europeans pondered the need for new electronic controls and power sources, the Americans griped at the slower pace of their own programs.

"Various European cities have found the electric bus an efficient and economical answer to mass transportation, but here in the United States, the Urban Mass Transportation Administration has announced grants of funds in the millions of dollars for internal-combustion buses, and not a dollar for the electric type," complained Sen. James A. McClure (R., Idaho). Asked later to respond to the criticism, Undersecretary of Transportation John W. Barnum could do no more than confirm the accuracy of McClure's assertion.

Japan, meanwhile, is well on its way to spending a $13.89 million government grant for R&D on electric vehicles, following the development of 320 prototype vehicles to transport visitors around the grounds of the Tokyo World's Fair.

Why has the U. S. experienced such problems with innovation? Many EV buffs are convinced that the shadow cast on their progress is one made by "the oil companies—a lobby for which there is no counterpart in Europe and Japan."

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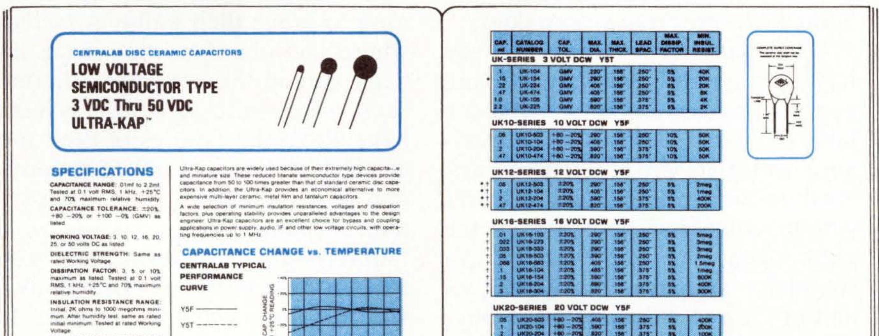

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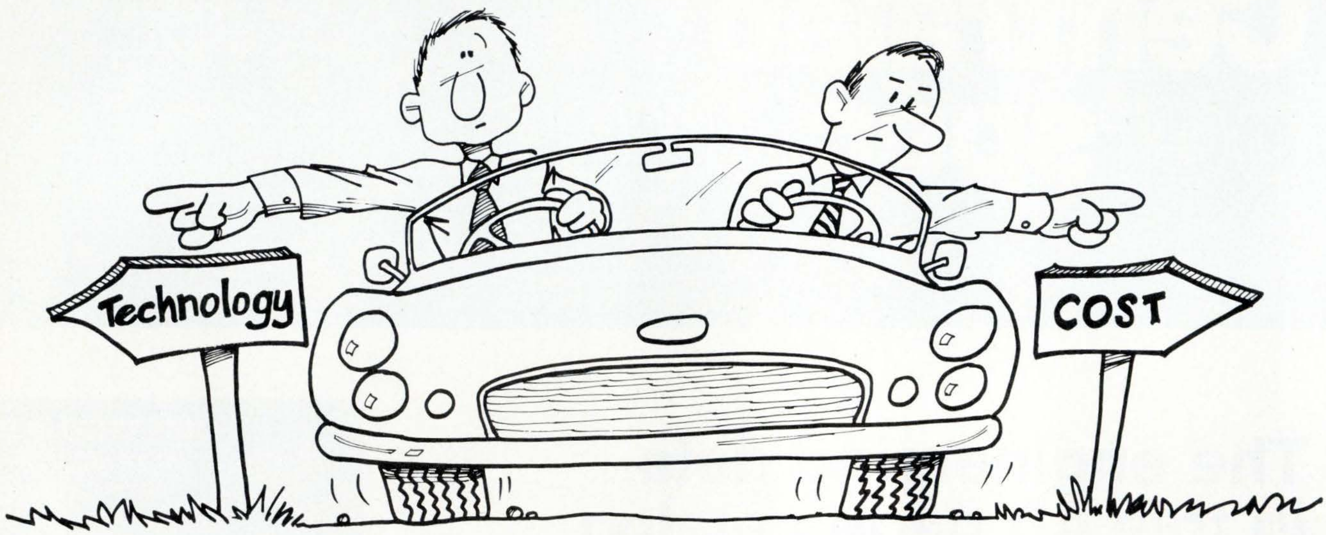

Automotive electronics

Is electronics heading wrong way?

Auto makers complain that semiconductor devices for cars need to be more cost-effective and more reliable

by Lawrence Curran, Managing Editor, News

In the eyes of the automobile industry, semiconductor manufacturers still have a long way to go both in understanding the penny-watching economics of the auto makers and in demonstrating that semiconductor devices are reliable enough for automotive use. Those were two of the salient points made at a panel entitled "Automotive Electronics Revisited," during the International Solid State Circuits Conference last month in Philadelphia, and at a follow-up discussion there with *Electronics* editors.

Auto company representatives stressed, too, that reliability and economics are tightly intertwined in their industry–the auto manufacturer has to pay not only for the electronic systems but also for their service during that part of a car's life that's under warranty.

Regarding reliability, the auto spokesmen said flatly that they don't want to pay for any bad semiconductor devices. Their reliability requirements are often more stringent than those in the aerospace industry, they maintain, where semiconductor suppliers have become accustomed to talking with their customers about "lot tolerance percent defective" levels– the acceptable percentage of defective parts in a lot. Automotive manufacturers have no such tolerance. John Webster, manager of electronic-product development at Chrysler's Huntsville, Ala., division, perhaps best crystallizes his industry's view when he says that semiconductor manufacturers have to learn to subscribe to the "childish simplification" embodied in a grocery-store analogy.

Economics. Says Webster, "If you buy a 50-pound bag of potatoes and you get three bad potatoes, you can take them back, and that groceryman will give you three new ones. He'll do it happily because he wants you to come back again." By the same token, Webster says, if a semiconductor supplier "is shipping us half of 1% bad parts and we're buying 20 million of them, he can forget about doing business with us the next time around."

Frank E. Jaumot Jr., director of research and engineering at the Delco Electronics division of General Motors Corp., Kokomo, Ind., also hammered at economics to his ISSCC panel audience when he said that automotive manufacturers still aren't necessarily enamored of electronic systems. If the choice is between an electronic solution to a problem and a cheaper mechanical or electromechanical solution, the auto maker will pick the cheaper unit.

Jaumot, though, made the point that electronic systems are beginning to prove their value in systems where considerable experience has been gained. For example, Jaumot says, electronic ignition systems have 1% of the failures of their mechanical predecessors. "The problem with the electronic-ignition system," Jaumot says, "is that the failure is usually catastrophic; it's a tow-in job 40% of the time," whereas the mechanical system degrades slowly.

Chrysler's Webster agrees that switching to electronics for the ignition system, which Chrysler pioneered and now is installing in all its autos, has cut the failure rate in that system. At Chrysler, there have been about 20% fewer electronic failures than the mechanical systems had, although the age-old problem of semiconductor "infant mortality" still haunts users (see "Electronic ignition: the first 100 miles").

At West Germany's Volkswagenwerk AG in Wolfsburg, the use of electronic fuel-injection systems gives fewer failures—70% fewer—than the old carburetor, says Klaus Stamm, of Volkswagen's research-and-development staff. Stamm says, though, that failures in the electronic-injection system are 2.3 times more costly to repair.

Unfulfilled promise. Further, says Stamm, the advance billing of greater reliability for integrated circuits promised by their manufacturers hasn't proved out. Some 25% of the failures in Volkswagen flashing warning lights have been traced to faulty integrated circuits. Nevertheless, Volkswagenwerk is going to an injection system that is more fully integrated than the original. The new version, made by Robert Bosch GmbH, uses three ICs and a total of 80 electronic components, compared with 300 discrete components in the original.

The toughest lesson for the semiconductor industry in dealing with Detroit, Chrysler's Webster believes, is to learn that automotive manufacturers aren't going to change their way of operating to accommodate the semiconductor manufacturer; the reverse will have to happen.

Regarding Detroit, Webster says "They've been building cars for lots of years, and they really know what they're talking about. They're almost unbelievable in their demands from the economic standpoint." With a car that contains all kinds of combinations of options—a lot of them involving electronics—coming off production lines each minute, the auto makers have to make sure that parts are available at the lowest possible price. "The rest of us have to do it their way, and that's true of electronics, as well," Webster emphasizes.

For ICs, Chrysler's Huntsville division has worked out a sampling plan that applies an acceptable quality limit (AQL) of 0.15 until experience is gained with a given semiconductor maker. Then if he's found to be delivering good parts, the AQL level is cut back so that fewer of those parts are tested. An AQL level of 0.15 means one bad device in 315, "and that's pretty mean," Webster admits.

The AQL challenge. For their part, panelists representing the semiconductor industry aren't wild about working under the shadow of such stringent demands as that AQL level or the need to supply huge volumes on a fast-turnaround basis (which happened with seat-belt-interlock systems for 1974 models).

Will Steffe, analog design manager at Fairchild Semiconductor, observed, "We may argue about whether we'd want to sign a contract with that AQL number in hard, black writing." William Davis, who is responsible for design engineering for consumer, linear, and non-entertainment products at Motorola's Semiconductor Products division, argues for more understanding of semiconductor cycle times on the part of automotive manufacturers, just as semiconductor makers must realize that Detroit won't stop production lines because promised devices aren't there.

We have a problem with cycle times, too," Davis says. "It takes a certain amount of development time, mask time, and production time to get the material through and get it out. We don't feel they really understand that."

Robert Hood, Fairchild's manager of automotive systems engineering, says the problem in the auto industry "is that the underlying concept is, 'All right. Today, let's shoot the designer and go into production,' and that's not the best thing to do—either from a cost or reliability standpoint. How we all learn to grapple with that over the coming years is going to be interesting." □

Electronic ignition: the first 100 miles

Chrysler statistics show that the first 100 miles are the riskiest for electronic-ignition systems. In fact, during the first 10 miles, there is a substantial semiconductor "infant-mortality" rate. For more than 6,000 failed systems from a total of about 2 million produced for a given model year, 24% of them failed in the first 100 miles, and 15% of those failures happened in the first 10 miles of driving.

Interestingly, almost half the units that came back to the dealer as faulty turned out to be functioning properly, but, of the true failures, 78% resulted from component failures, "most of which were semiconductor failures," says John Webster, manager of electronic-product development at Chrysler's Huntsville, Ala., division.

'Self-repairing' seat-belt systems

Little statistical data has been gathered by automotive companies on seat-belt interlocks because the systems still haven't been in the field long enough. Delco's Frank Jaumot Jr. says Delco itself had to supply far more semiconductor devices than it had expected because outside suppliers were late with deliveries. But now that large quantities are coming from the semiconductor industry, he's pleased that the solid-state industry "really turned to on seat-belt systems and really put the relay people down." GM had designed a backup relay system for use if semiconductor suppliers dropped the ball, but it wasn't needed.

One reason, though, that few statistics are available on seat-belt-system failures, says Chrysler's John Webster, is that if the system fails, yet the car still runs, "we'll never hear about it. Out numbers are unbelievable at this point. Our digital clocks weren't that good, and they use the same C-MOS technology." Besides he says, "the seat belt is a self-repairing system." By that, Webster means that consumers are finding ways to disable what many regard as a nuisance, even though the system is a federally mandated safety feature.

Computers

Unidata starts long climb upward

European computer combine must deal with problems of nationalism as it prepares to do battle with the dominant IBM

by James Smith, McGraw-Hill World News

On Jan. 15 the nameplate came down on the headquarters of Siemens Data SpA at Via Fabio Filzi 25A, Milan, and a new sign went up announcing Unidata—the tripartite company formed by Philips, Siemens, and CII to cut into IBM's domination of Europe. The event, repeated in Spain, Belgium, the Netherlands, Austria, and elsewhere, coincided with introduction of the 7720, the first computer in Unidata's new line of five or six machines.

Six months after its formation, Unidata seemed on the right track: A troika of managers from the parent firms was presiding over working sales offices in seven countries, a second machine was scheduled to appear in a few months, and the group was working on an advanced second-generation lineup. But as good as this record is, setting up a transnational European rival to IBM and other American firms isn't easy. Competitors are predicting Unidata will have to do a lot more before its success is certain. For example, a squabble over French contributions, only just settled, threatened to break up Unidata at the start.

So far, the organization is not much more than a sales operation directly headed by a three-member board of management consisting of the president of CII (Compagnie Internationale pour l'Informatique) and the heads of the Philips and Siemens data divisions. Many of the sales operations are still not formally incorporated, and some consist mainly of changes of the name on the door.

Accommodating various market shares is probably the least of Unidata's worries. Any real merger of sales operations involves tremendous fiscal, managerial, and psychological problems. In addition, Unidata must step into a maze of contracts and offers made by the original sales organizations and persuade customers to accept Unidata.

With such complications on the marketing side, it is not surprising that Unidata has scarcely broached the possibility of eventual fusion of production facilities—the area in which Common Market Commission experts estimate that real operating efficiencies lie. While Unidata's management board has direct control over selling operations, it has merely coordinating control over supply centers, which in the foreseeable future will remain in the hands of the partner companies.

Research and development, plus investment in production, is apparently left largely to each individual partner. Unidata's role is to coordinate development of software and hardware and to negotiate production contracts for specific machines.

Moreover, while the partners may effect some economies by phasing out overlapping machines in their existing lines, little production rationalization is probable on the present generation of machines, the technologies of which are essentially different. The Unidata 7720, for example, is basically the P2000, designed by Philips.

Subsidies. In addition, government subsidies to the various national partners present another obstacle to merger that the complicated Unidata formula does not seem likely to overcome. French partner CII, expected to build two of the eventual five or six Unidata units, will get the bulk of the funds for its Unidata R&D commitments this year from the French government's Délégation à l'Informatique

Split. In Germany, to protect Philips' share of office-computer market, there will be two companies. One will be 80% owned by Philips with the rest in the hands of a planned holding company. The second, for medium and large units, will be controlled by Siemens. In the French setup, to be in existence by the end of this year or early '75, CII will have the 80%.

WHO OWNS UNIDATA?
(BY %)

	Philips	Siemens	CII	Holding
West Germany	80	–	–	20
West Germany	–	80	–	20
France	–	–	80	20
France	80	–	–	20
Holland	67	13	–	20
Spain	20	40	40	–

Probing the news

as part of the Plan Calcul. Says a Siemens man, "Care must be taken to see that these funds don't wind up with German and Dutch partners."

On the other hand, such financial backing cuts both ways. Most governments subsidize the local computer industry in some fashion. In Belgium, for example, the government takes 50% of its hardware needs from Philips and Siemens, in return for which both firms operate manufacturing facilities in the country. French public authorities have earmarked $160 million from 1971 through 1975 for hardware under the Plan Calcul. And Germany will spend more than $200 million in the same period. Taken together, such funds would make a tidy subsidy if they are directed mainly toward Unidata efforts.

What's more, the French government has favored CII extensively through its buying policy. Early last year, CII equipment amounted to 26% of the hardware installed in government administrations, compared to 16% the year before. At the same time, shares of Honeywell-Bull and IBM went down slightly. In Italy, the government tie-in, which accounts for nearly half of all investment spending, is not expected to hurt Unidata in the least. Aldo Carlevaro, one of the three sales managers of Unidata SpA, estimates the group will get 30% of its future sales from government and public administration uses, and another 20% on the local level.

The blandishments of government assistance are not lost on Unidata's U.S. competitors. Honeywell-Bull's French president Jean-Pierre Brulé and Univac's top executives have clearly stated they would like to do business in Europe under Unidata's colors. As John C. Butler, head of Univac's European operations, puts it, "We are aware that in the future we will find ourselves between the hammer [IBM] and the anvil [Unidata], since Europe will certainly become more and more nationalistic. Thus, it is our intention to seek a solution through assisting a European company to combat IBM's dominant position."

U.S. out. So far, any participation by U.S. firms has been vetoed by the French government. As the French partners in Unidata see it, every effort has to be made to get Britain's ICL (International Computers Ltd.) into the combine.

"It will take five years to build such a European company," says a senior French-government source, "and only when it exists will we discuss anything with possible international partners. Any talks before

The British are coming

All concerned agree that Unidata would be playing a much stronger hand if it could add a fourth to the three computer makers that have combined to form the new super-company. The fourth they have in mind is Great Britain's International Computers Ltd.

Although the president of Compagnie Internationale pour l'Informatique, Michel Barré, says that discussions with ICL are under way, what is happening seems to be a replay of French and British failure to reach agreement two years ago. As Common Market Commission sources note, ICL's line is not compatible with those of the three partners, and ICL is interested in keeping things that way to protect its 35% share of the British market.

Joining Unidata, whose machines are compatible with IBM hardware, would simply expose it to the U.S. giant. What's more, the British, fresh from success in East European markets, are now preparing an attack on West Europe. "ICL's machines are competitive with Siemens' upper line, and as far as use is concerned, they can substitute for the IRIS, CII's line," says a Brussels consultant.

Some industry experts think the British company can easily get 10% of the existing European market share in France and Germany in the next five years—the time in which Unidata is expected to take to develop its second-generation line. A Philips Electrologica spokesman declines to call the contacts with ICL "negotiations." "There is no base for negotiations," he says flatly. "And the British market is heavily protected."

that stage with non-European companies would mean the failure of the all-European effort. We do not want such a solution."

The question of American participation may be the first ripple of a major disagreement between Unidata's partners. Though Unidata's sales figures—about $700 million by the three partners—and number of installed computers—17,000 machines—look good on paper, the fact is the combine, with 8% of European sales compared to 13% for Honeywell-Bull and 60% for IBM, is just on the borderline of what experts consider economically sound.

"We would favor contact with anyone, including the Americans, provided they have a similar base," says a spokesman for Philips Electrologica, the Dutch giant's computer arm. Even CII's big private shareholder, Compagnie Générale d'Electricité, wants a U.S. link to promote the viability of the group before investing the additional funds needed to meet CII's Unidata research commitments. The furor over CGE's reluctance to put up its share of the needed investment money threatened to break up Unidata before it got off the ground, and was settled only the last week in February by the French government's willingness to increase to $52 million the amount required to carry CII through this year.

Unconcerned. Officially at least, CII's partners do not seem bothered by the French firm's problems. "No company can pull out," explains a Siemens official, "because they would be left with a torso—one or two machines—without a complete line. The longer Unidata lasts, the greater the momentum built up."

Even if Unidata gets the size it needs and manages to rationalize its production, other problems may still exist. Computer experts say Siemens, which relied heavily on its old license ties with RCA to beef up its research and development, may gradually move out of the mainframe business and broaden its telecommunications activities.

CII, anchored to large machines, might stand to broaden its market penetration outside France, where it has practically no presence. But the main partner to benefit from Unidata, according to this argument, would be Philips. The giant would gain the market needed to develop its general-purpose computer line—which thus far seems to be losing about $70 million a year.

Not everyone agrees. One of Unidata's Italian competitors sees the 7720 as a further design of the Siemens 4004—a point which Unidata hotly disputes—and he thinks Siemens may come out ahead.

In either case, the French firm, which is by far the smallest of the triumvirate, when measured in total sales, appears likely to be on the short end. That prospect may already be troubling some of CII's non-government shareholders. If and when the Dutch or Germans start getting most of the benefits, what will happen to French-government participation? □

Production

Changing MOS wafers in 36 hours

Western Digital uses special equipment and facilities to cut time from the usual weeks or, in—some cases—months

by Paul Franson, Los Angeles bureau manager

Making changes in MOS masks can delay production for weeks or even months. That's what motivated a three-year-old MOS firm in Newport Beach, Calif., using some ingenuity and modifications of tools that are readily available, to cut that time down to 36 hours and sometimes even less.

The company, Western Digital Corp., uses a combination of tailored equipment, in-house facilities, and carefully thought-out procedures to effect the dramatic saving in time. William Roberts, vice president for R&D, says that, while several factors enable Western Digital to respond so quickly, the most important is its use of a photoplotter, rather than rubylith masks. Other important contributors are a much-modified Applicon design system and the fact that the company has its own mask shop.

Perhaps the most interesting aspect of Western Digital's system isn't so much that it is unique, but rather that the company has attacked the time problem and licked it to the extent that president Alvin B. Phillips can declare flatly, "We have the world's fastest system."

The photoplotter is perhaps the key to the process. The company uses an inexpensive ($38,000 original price) machine from the Gyrex Corp. rather than the more common $300,000 David Mann photomask maker. Roberts points out that the Gyrex machine wasn't designed for LSI work–it was originally intended for circuit boards–and doesn't have anywhere near the resolution of the Mann machine. But "it turns out that we don't need it," says Roberts. "The mask aligners can't align accurately enough to take advantage of the Mann's capability."

Western Digital has modified the Gyrex machine substantially. It is controlled by cassettes generated by a Digital Equipment Corp. PDP-11, rather than the paper tape originally used. Richard Perrin, manager of product design engineering, says: "We took the Gyrex controller out of the loop. We use ramping techniques that give a 3-to-1 improvement in speed over the paper tape, and, in the process, eliminated many errors that resulted from use of the paper."

Along with the photoplotter comes another practice that is unusual for Western Digital, a small semiconductor firm: The company

The shrewd timing of Western Digital

Western Digital started in business at what is considered a terrible time by most standards—April 22, 1970, in the midst of the worst slump ever to hit the semiconductor business. However, the company's progress since then has been most impressive. The latest figures show $3.5 million in sales and 25% pretax profits in the quarter ended Dec. 31. This is almost three times the sales of the corresponding 1972 quarter. Nevertheless, the chairman and president, Al Phillips (left) gets annoyed when people seem surprised. "It's all according to the plan I established over three years ago," he points out.

Phillips says that the bad times when he started didn't cause problems. It even might have been an advantage. "My business plan said I would lose money for two years, and its realism probably helped me get capital." Emerson Electric made an initial investment of $1.5 million in the company. And the St. Louis parent is happy about the relationship. Says a spokesman: "They're doing very well—in fact, we just added to our equity."

Phillips, who likes to call his own shots, had previously set up and managed the Rockwell Microelectronics facility, and before that, Sylvania's integrated-circuit operation. There he watched the company pioneer in SUHL TTL, then lose its lead to the Texas Instruments 54/7400 series—because, says Phillips, of overly cautious and conservative higher management. He has also worked at Motorola and General Electric.

To get his infant company started,

makes all its own masks from bare glass. This obviously helps turnaround in the present tight market, and Phillips says it gives far better quality and lower cost. The company has even applied for a patent on its techniques.

Cassette control. The Gyrex machine is run from a cassette generated by the Applicon design system. The firm feels that this is also vital—but not for initial layouts. "The aid for us in this computer-aided-design system is in making changes quickly and accurately," says Perrin. He points out that in designing a chip with 100,000 components, it's difficult to avoid a few mistakes, but he feels that the system corrects them fast. The Applicon setup could be used on-line with the Gyrex plotter, but Roberts says that would sacrifice much flexibility just to save some hardware, and it would be especially unfortunate if the system were to break down during mask making.

Western Digital uses manual layout and design initially, since the company feels that the Applicon is "a very expensive drafting machine," says Perrin, adding that people seem to be much better at layout than machines. But the Applicon is used for rote work, such as the repetitive cells in circuits, and to prepare completed segments of the circuits. "The designer thinks; we draw." Input to the Applicon is through an Autotrol digitizer. The company doesn't use standard cells, usually considered a time-saver. "We've gotten away from them," says Perrin. "They work, but they're not dense enough for the high-volume parts we're making."

The initial logic simulation is done by a program Western Digital developed. The Applicon itself operates from a PDP-11, and is one of the first Applicon design systems to use a minicomputer, rather than a large computer. The present system has about 20,000 words of core memory, which will soon be increased to about 28,000, plus a 500-million-word disk memory. This is to be increased to 10 million words, which will permit all current design efforts to be stored and eliminate the need for loading from cassettes each time. A multicolor California Computer Products model 936 high-speed drum plotter is used to generate artwork copies.

Interactive editing. The Applicon CRT interactive terminal is used in the actual editing; Perrin says it's very fast and effective for editing designs. The company also has programs to check design-rule violations, many developed in-house.

Comparing his computer-aided-design process with that of larger firms, Roberts points out that it is a small, dedicated system ready for use. "The bigger a CAD system is, the more cumbersome it is to use. And when we get a tape off the Applicon, we don't worry about it. We know it's good."

Though almost all semiconductor companies talk about fast turnaround, few in practice aspire to times like those of Western Digital. Fast turnaround at most is four to six weeks, and the average may run into months; some can do the job in a week under crisis conditions. Smaller firms generally have to wait in line for outside maskmaking and other services, and at the large companies there is fierce competition for in-house services. And some experts maintain they could do the job faster, but see no real reason for it.

Roberts says that the CAD system will be even more valuable when the company gets into the read-only-memory business; Western Digital will announce shortly an 8,192-bit silicon-gate n-channel ROM. "We expect to be able to go from customer tapes to mask in 12 hours or so," says Roberts. "We will be able to directly generate the cassette for the Gyrex, plus a test program for our Spartan tester. I can't imagine why anyone would get involved with rubies for ROMs, but I know many companies are trying to do it that way. The result is weeks or months of delay. We'll have parts in a few days." □

Phillips picked a new technology. He settled on silicon-gate technology, even though it is a more difficult process than the more popular aluminum-gate technology. He concentrated on that one process: "Companies that try to do too much get poor yields." The process has been p-channel, but a compatible n-channel variation will shortly be added for 4,096-bit random-access memory and microprocessor chips.

Initially, the company concentrated on calculator chips with a contract from Ise Electronics of Japan to get things under way. Now, Phillips is looking for 25% of the U.S. personal-calculator-chip market this year with its "chipstick" eight-digit, floating-decimal-point circuit with memory. This part is being sold in large quantity to Bowmar and Commodore, two of the three largest calculator companies (the other is TI), and others. This would rank Western Digital among the top chip suppliers, with TI, Rockwell, and MOS Technology Inc. But unlike the first two, Phillips has no plans to go into the end-user-equipment business—except to market his Spartan LSI test system, originally developed for in-house use. What is unusual for a small semiconductor company, Western Digital also makes its own masks and molds its own plastic cavity packages. The company also makes custom chips, including units for the 40,000 credit verifiers installed by TRW Data Systems, but its moving away from custom chips to standards. And Western Digital's data communications parts go to more than 600 customers.

For now, Phillips is forecasting sales of $18 million and profits 20% higher than this year; the current order backlog tops $30 million. And the company's first plant expansion is in progress; when Western Digital moved into its present facility three years ago, the building was almost empty, but it's full now and being expanded by one half, to 40,000 square feet. The company is also adding 12,000 square feet in Malaysia.

Phillips is especially happy with his location near Los Angeles and far from Silicon Valley: "Am I glad we're not there! Labor is scarce up there, and there are no secrets and no discipline among workers. Here it's warm, it's close to Newport Beach, where I keep my Islander 29 sailboat, and there's plenty of labor around."

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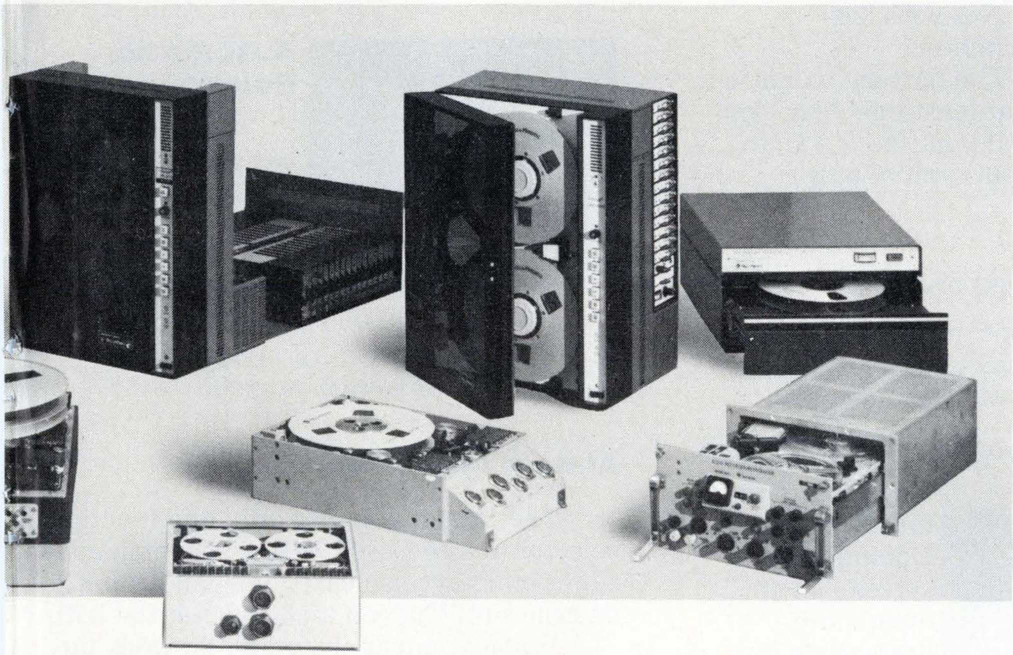

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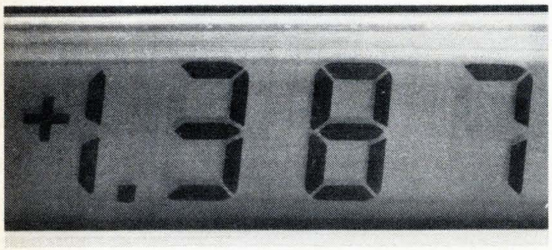

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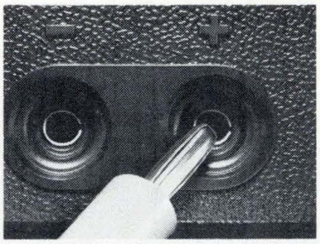

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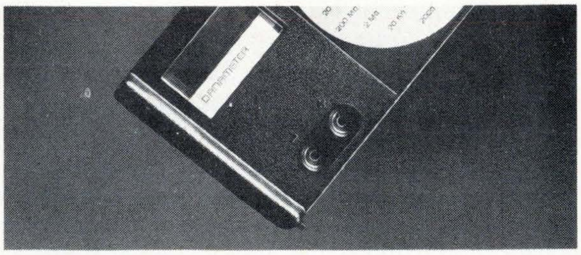

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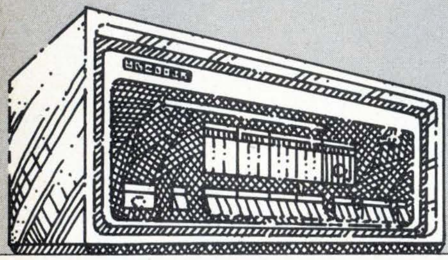

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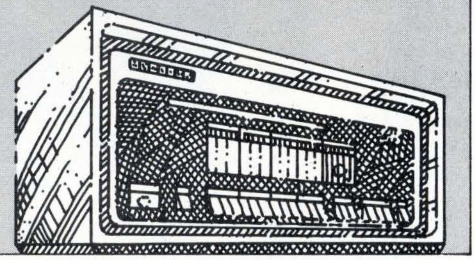

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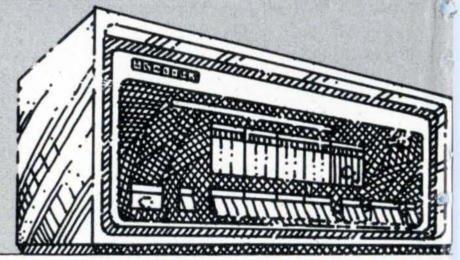

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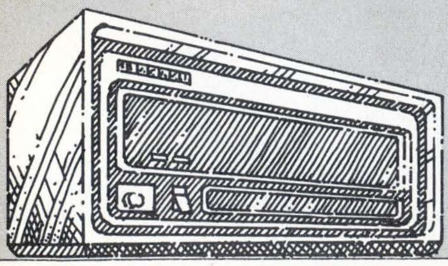

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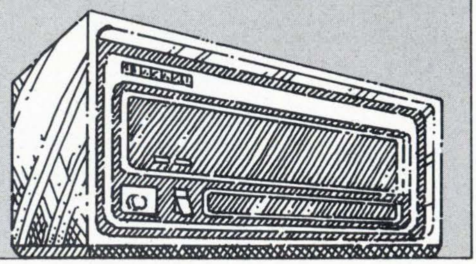

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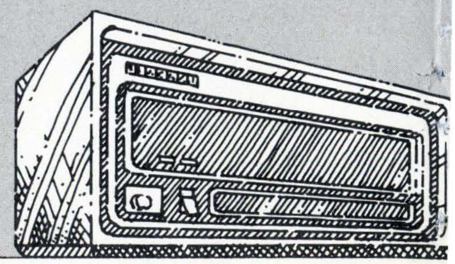

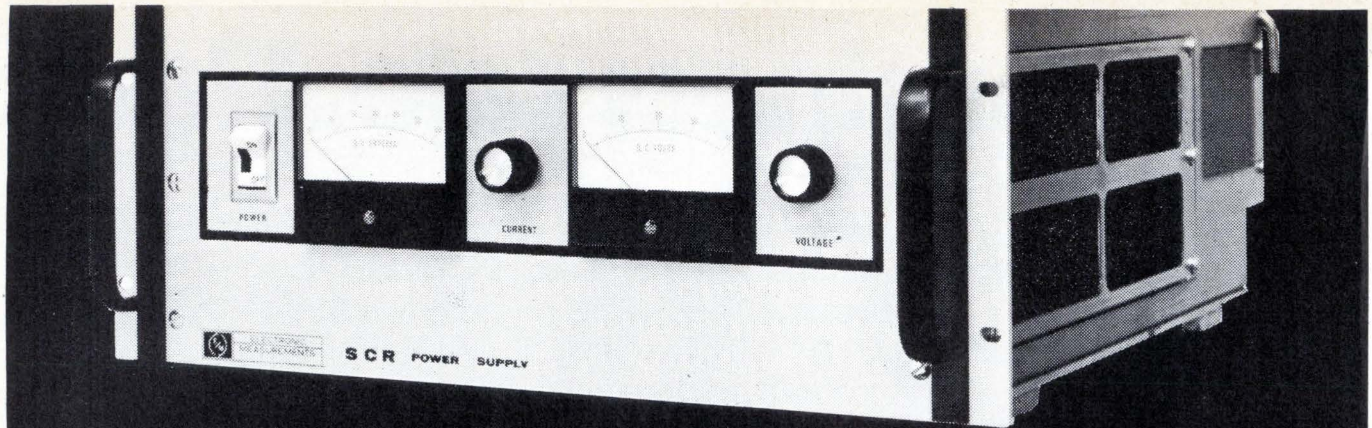

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Plasma's progress: gas-discharge technology moves into analog realm

Screen-printing and internal-address techniques used in digital displays are combined to form a digitally addressed analog bar graph with no moving parts; 200-segment bars yield a resolution of 0.5%

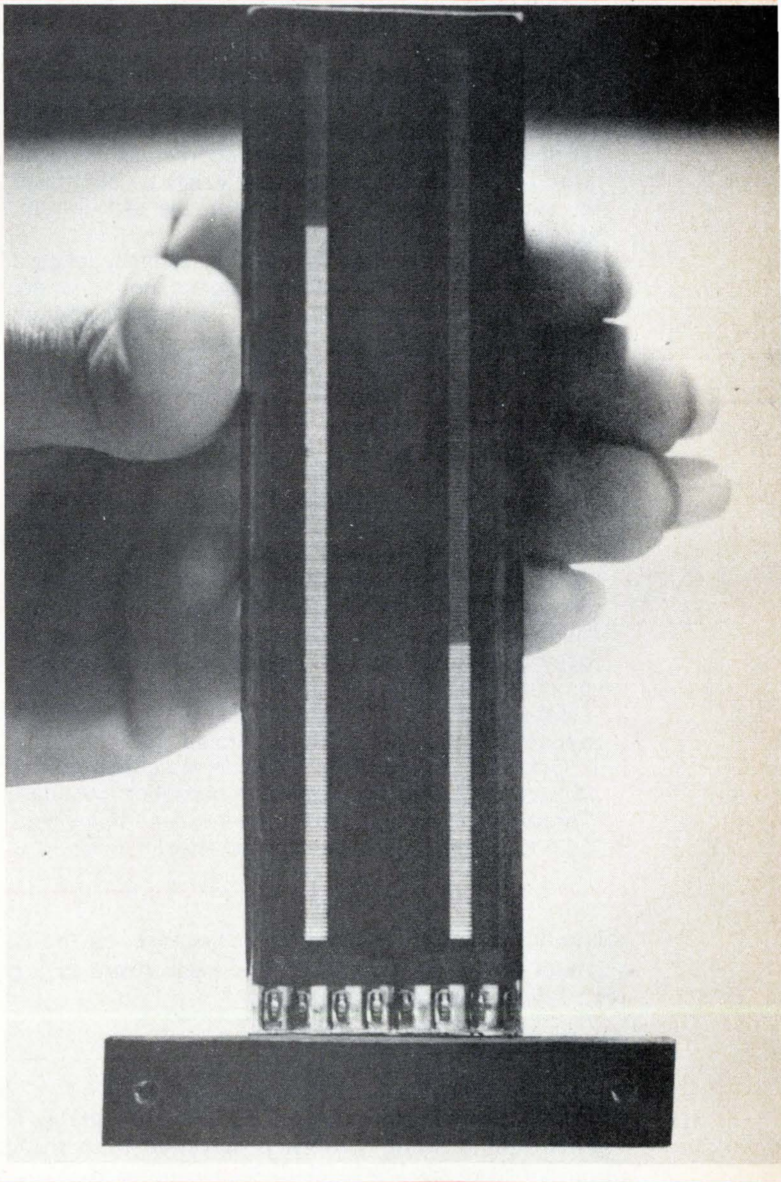
by Richard Saxon, *Burroughs Corp., Electronic Components Division, Plainfield, N. J.*

☐ Despite all the brouhaha reverberating through industry about the relative merits of light-emitting diodes, liquid crystals, electrochromics, and other exotic display technologies, many of the most successful displays in use today are of the gas-discharge variety. Not only is this technology doing well commercially, it is also advancing at an unprecedented rate on a technological level. In fact, more progress has been made in developing new gas-discharge products and processes during the past two years than had been made in the preceding 10. Large message-display panels have become a reality, multicolored displays are just coming out of the laboratory into limited production, and compatibility with MOS drivers has been achieved.

One of the most exciting new developments in this area is a digitally addressed Self-Scan (a registered trade mark of Burroughs Corp.) analog bar-graph display (Fig. 1). Unlike the electromechanical indicating devices it is designed to replace, the new display has no moving parts. A combination of the screen-printing technique used in the manufacture of Panaplex (a trademark of Burroughs Corp.) II display panels, and the simplicity of the internal-address drive circuitry in the Self-Scan panels has made possible an extensive family of extremely rugged, low-cost, linear indicating devices.

The first in the series of new displays is a flat panel containing two separate bar graphs. Each bar is composed of 200 closely spaced segments so that, at normal viewing distances, the glowing segments blend into a continuous, but precisely controlled, bar length.

The display is designed to be used in a scan mode, with a cathode-drive circuit common to both channels. Corresponding segments of both bars are bused together in a three-phase configuration with two independent anodes and separate reset cathodes (Fig. 2). These techniques enable only six active drivers to operate both channels. If more than two channels are needed, it is a simple matter to add additional panels. The cathodes of the new panel or panels are simply connected in parallel with the old ones, and a new driver is provided for each new anode.



1. Glowing. Digitally addressed analog bar-graph display has no moving parts. Each bar contains 200 segments, providing 0.5% resolution. Only six transistors are needed to drive the device.

Since each element represents a discrete, reproducible display step, each segment of the display is directly

The many faces of gas discharge

Burroughs' new bar-graph display is only one manifestation of recent progress in gas-discharge readouts. Large panels having as many as 250,000 display cells have been developed, as have devices capable of producing a full spectrum of colors. Some displays, such as the Digivue panel made by Owens-Illinois, even have an inherent storage capability that eliminates the need for a refresh memory, while others allow the production of precisely controlled gray scales.

Gas-discharge panels are particularly well suited for large displays with variable brightness because of the ease with which large numbers of cells can be matched for both optical and electrical parameters. Unlike light-emitting diodes, which must be individually selected for brightness matching and which may match at one drive current and not at another, the cells in a gas-discharge panel are inherently well matched. In a typical device, the cells are all enclosed in a common envelope with a common fill gas. When the panel is operated so that each cell is turned on for a length of time that is long, compared with its ionization time, the slight variations in ionization time caused by minor geometrical variations are not important, and all of the cells in a panel can be regarded as identical. The result is that brightness can easily be controlled by varying either the duty cycle or the cell current, with no visible cell-to-cell variation.

Gas-discharge displays have traditionally offered the user a choice of about three colors: neon orange, plus the red and amber hues that can be filtered from it. Now, two techniques for the generation of other colors have been proven feasible.

The first method uses the ultraviolet component of the gas discharge to excite a phosphor coating within the panel to produce visible light. Different colors can be obtained by using different phosphors or by filtering the output of a phosphor that produces white light.

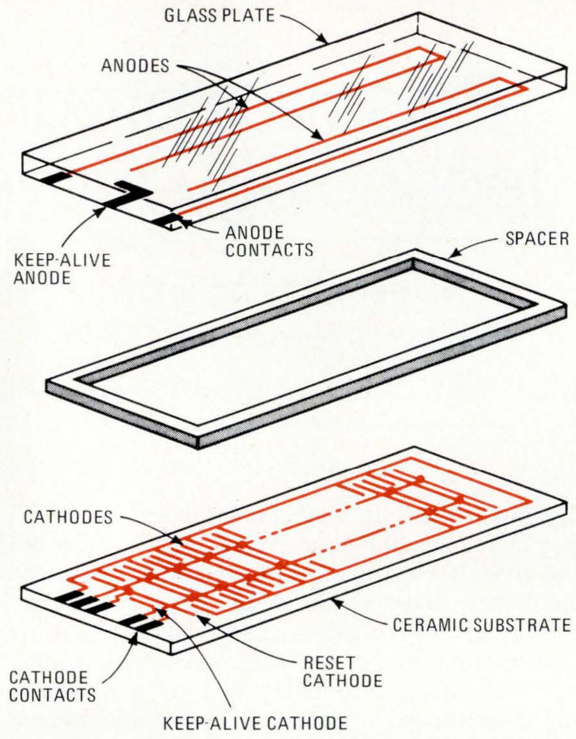
The second method is more versatile and permits color to be changed electronically. With this method, both the ultraviolet and visible outputs of the gas discharge are exploited. At low drive-current levels, very little visible light is produced, but enough ultraviolet is generated to saturate a zinc orthosilicate phosphor, producing a green glow. As the drive current is increased, the visible neon orange emission becomes stronger, changing the display output to red.

Other color combinations beside red-green can be obtained by selecting different phosphor coatings. These can be expected to lead to inexpensive multicolor graphic displays in the not-too-distant future.

relatable to a digital number. For instance, on the 200-segment bar, a digital count of 127 will result in a bar with 127 elements illuminated.

Sandwiching the panel

As shown in Fig. 2, the display consists of a rear ceramic substrate, a spacer, and a glass front plate. The segment-metalization pattern is screened onto the ceramic substrate, as is a black dielectric material that surrounds the metalization. The black material creates a light-absorbent background that enhances the display's contrast ratio. Two transparent conductive anodes are applied to the glass front plate, and the rear substrate, spacer, and front plate are then sealed together in a sandwich-like construction. The display is evacuated through a small hole in the back substrate and is then filled with a neon-gas mixture.



2. Sandwich. Cathodes comprising bar segment pattern are screened onto ceramic substrate, while transparent anodes are deposited on inside of glass front plate.

In almost every respect, except the shape of the metalization pattern screened onto the substrate, the construction of the display is the same as the construction of the Panaplex II digital display [*Electronics*, April 12, 1973, p. 92].

At first, it may seem impossible to generate 400 discrete bar lengths (2 bars × 200 segments per bar) in a device that has only seven input lines. The trick is to exploit the glow-transfer principle in which the glow is first established at the reset cathode, and then, by using a repetitive scan, the glow is transferred sequentially up to the desired segment height.

When the panel is energized, the current flow between the keep-alive anode and cathode establishes a glow discharge at the keep-alive cathode (Fig. 3). In the vicinity of this glow discharge, there is a heavy concentration of electrons, ions, and metastables*. The area around the keep-alive cathode is open so as to allow the metastables and charged particles to diffuse into the region of the reset cathode.

A three-phase clock with a fourth reset phase controls the transfer of glow along the panel. To initiate a scan, the reset input to the J-K flip-flops is brought to ground potential, which sets both Q outputs of the J-K flip-flops to the logic 1 state and turns off reset transistor Q_1, grounding the reset cathode. The anodes are connected through limiting resistors to the +250-volt power source. When the reset cathode is grounded, the gas is ionized above this single cathode. The glow occurs within a fraction of the 60-μs clock interval because of the presence of the metastables that have diffused into the region from the keep-alive cell.

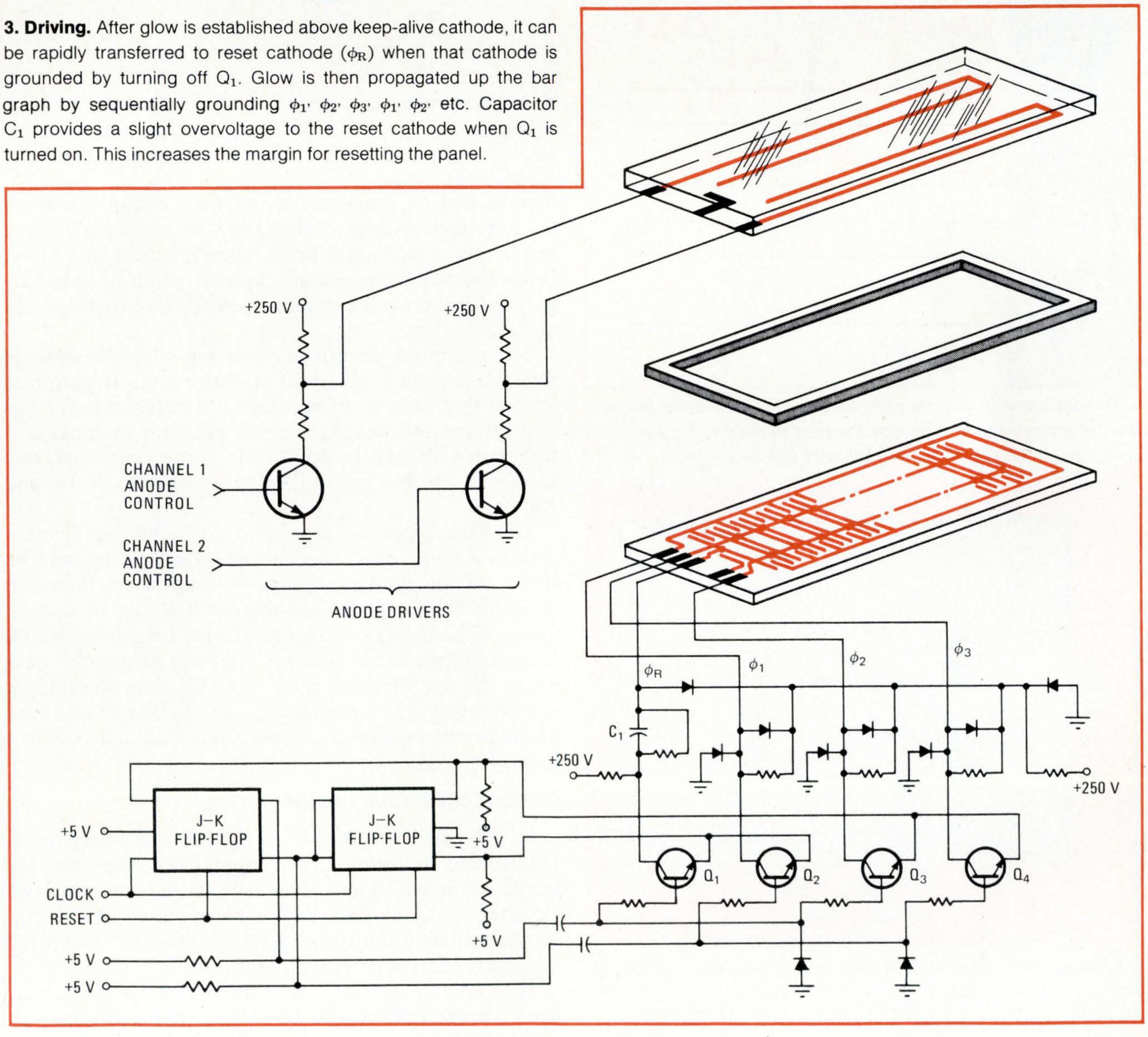
After the gas around the reset cathode is ionized, and the reset pulse is returned to the logic 1 state, the first negative transition of the system clock advances the counter (which is made up of the two J-K flip-flops). The relationship between the reset pulse and the three clock pulses is shown in Fig. 4.

When the counter advances, reset transistor Q_1 is turned off, and transistor Q_2 is turned on. Transistor Q_2, coupled to the phase 1 bus, grounds every third cathode, while the reset cathode is returned to off-bias potential. While the reset cathode is grounded, ionizing particles diffuse along the anode cavity to the adjacent (No. 1) cathode. When the phase 1 cathode is brought to ground, the gas near cathode 1 ionizes very rapidly, while ionization is no longer supported at the reset cathode, since this electrode has been returned to off-bias potential. The rapid transfer of the ionization glow from the reset cathode to cathode 1 is attributable to the high concentration of priming particles near cathode 1.

As soon as a glow is established near cathode 1, the flow of current through the anode-current-limiting resistor reduces the anode voltage to a level that is sufficient to maintain the glow at cathode 1 but too low to cause ionization at any other grounded cathode. In other words, although every third cathode is grounded at the same time, ionization takes place much more rapidly at the primed cathode than at any of the others (Fig. 5). And once it takes place, the anode voltage drops so low that none of the others can ionize at all.

The next clock pulse turns off transistor Q_2 and turns on Q_3. This grounds the phase 2 cathode and returns the phase 1 cathode to the off-bias condition. While ionization was present at the ϕ_1 cathode, the concentration of charged particles was heaviest around the adjacent cathodes (ϕ_R and ϕ_2). When the counter advanced, the ϕ_1 cathode was reset to off-bias potential and the ϕ_2 cathode was grounded. Since the ϕ_R cathode was still at off-bias potential, ionization could not form on the reset

3. Driving. After glow is established above keep-alive cathode, it can be rapidly transferred to reset cathode (ϕ_R) when that cathode is grounded by turning off Q_1. Glow is then propagated up the bar graph by sequentially grounding ϕ_1, ϕ_2, ϕ_3, ϕ_1, ϕ_2, etc. Capacitor C_1 provides a slight overvoltage to the reset cathode when Q_1 is turned on. This increases the margin for resetting the panel.



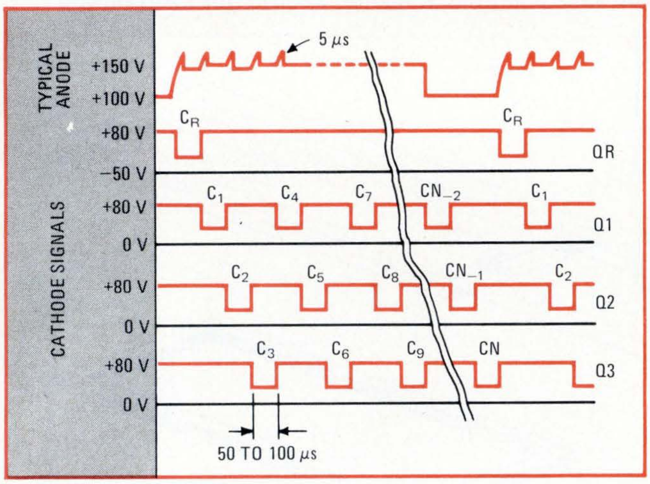
cathode, so the glow is formed on (or transferred to) the ϕ_2 cathode. The next clock pulse turns off transistor Q_3 and turns on transistor Q_4, so that cathode ϕ_2 is returned to off-bias potential and ionization transfers to the preionized, and now grounded, ϕ_3 cathode.

As the counter advances, the cathode buses are sequentially grounded, causing the glow to transfer down the panel. After the glow is transferred to the last cathode in the display, the reset pulse again grounds the ϕ_R cathode, and the scan cycle begins again.

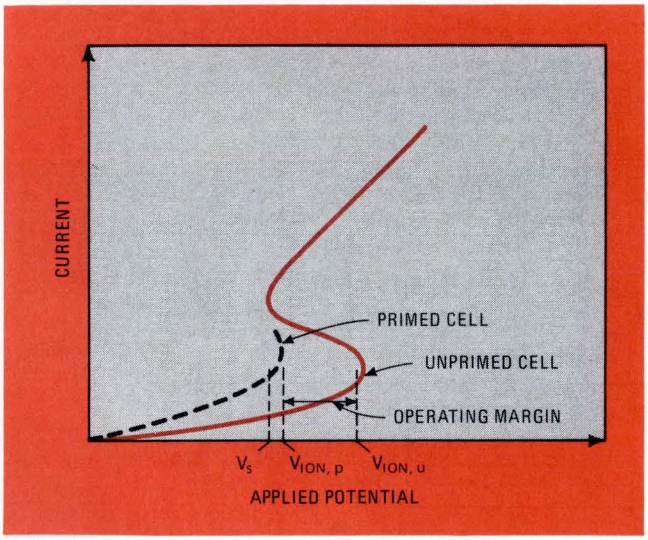
Selecting the scan rate

To eliminate perceptible flicker, the scan rate must exceed approximately 60 Hz. A 60-Hz scan rate requires 16.6 milliseconds per scan; thus, for a 200-element bar graph, each element is turned on for a maximum of approximately 83 μs.

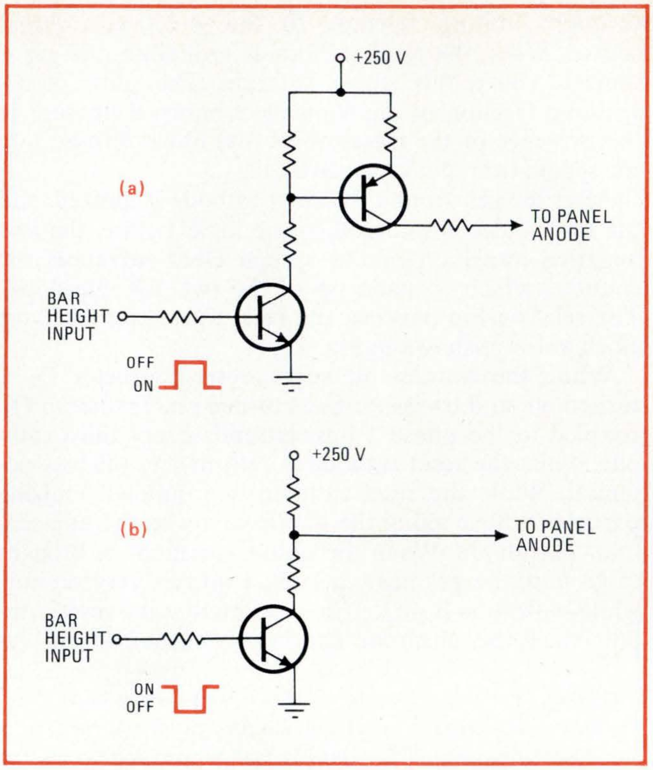
To ascertain if these numbers are reasonable, one must ask what determines the maximum scanning rate of the display. The limiting factor turns out to be the requirement that any cathode that has been ionized and



4. Timing. Although all cathodes bused to a common driver are activated at the same time, glow only transfers to the one that has been primed by ionizing particles from adjacent glowing segment.



5. Priming. Presence of priming particles not only reduces ionization time, it also cuts ionization voltage from high value of unprimed cell ($V_{ion,u}$) to a value ($V_{ion,p}$) close to the cell sustaining voltage (V_s).



6. Anode drivers. Power-conserving anode driver (a) needs two transistors to control 250-V potential with 5-V logic swing. One-transistor circuit (b) is cheaper, but dissipates power when anode is off.

then turned off must remain off long enough to allow the ionization to decay below the level at which it could prime that cathode into firing when it is next turned on. With the three-phase-clock system used in the bar-graph display, each element is on for one clock period and off for two.

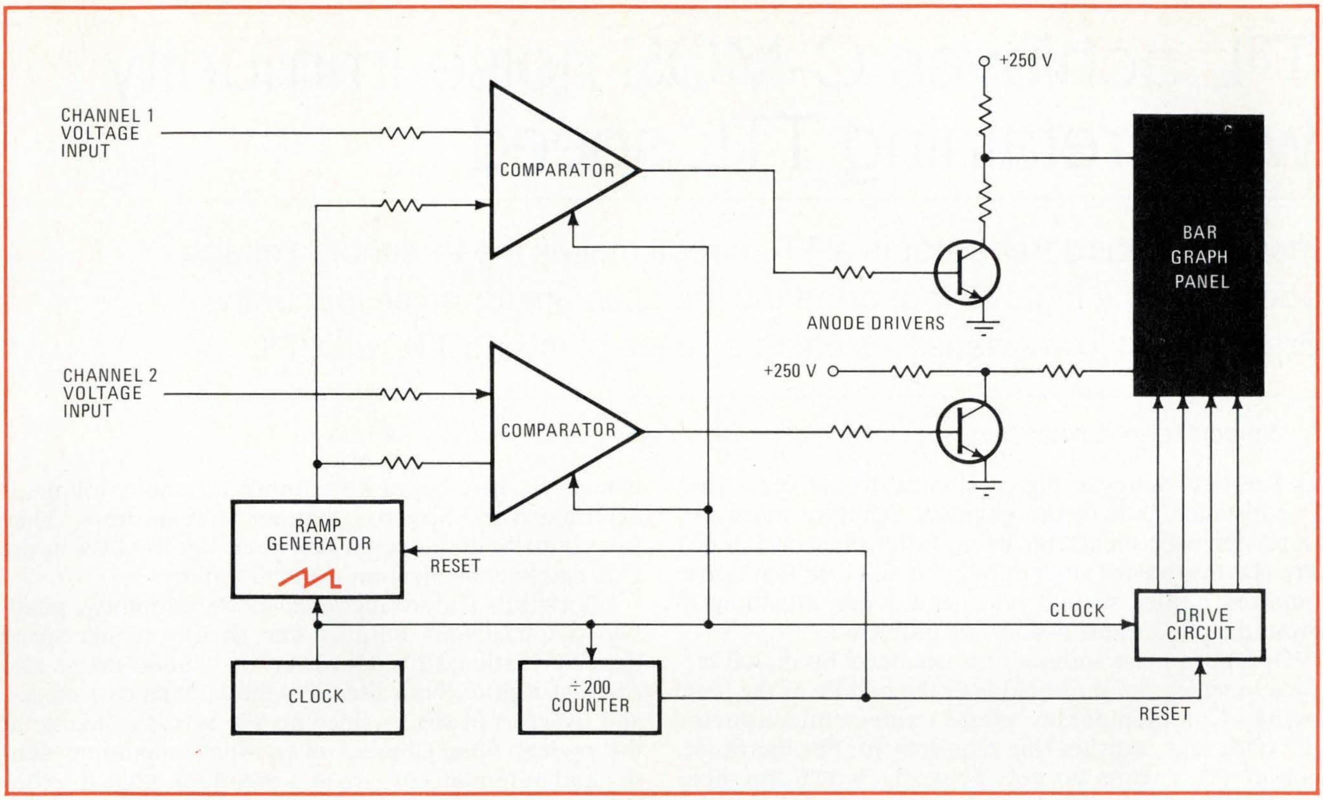
The minimum length of time for which a cathode must remain off is about 80 μs. Since a 60-Hz scan rate implies that each element is on for a maximum of 83 μs and off for 166 μs, there is no problem in making a flicker-free display. In point of fact, the usual scan rate used with the bar-graph display is between 70 Hz and 100 Hz.

The 83-μs figure is a maximum for a full 200-element scan at a 60-Hz rate. This cathode dwell time could be increased for greater brightness when fewer than 200 elements are energized, but the result would be uneven aging of the display. Also, the display brightness would then vary with bar length. For uniform aging and maximum display life, the cathode-dwell time should not exceed the figure determined for a full 200-element scan at the lowest possible rate consistent with a flicker-free display.

Controlling the bar height

As described thus far, the bar graph will always show a full-scale indication. How then does one vary the length of the bar? The answer is to let the cathode drive circuitry continuously scan the entire array of 200 segments and simply turn the anode voltage off when the bar has reached the desired length.

With this approach, a common drive circuit can be used for the cathodes of both bars in the display, al-



7. Comparator display. Typical application of bar-graph display is to compare two or more voltages. Simple setup shown here provides excellent results, since both comparators are driven by same ramp generator. Scheme is easily extended to handle more than two inputs.

though each anode must, of course, be driven separately. On each scan, the anodes are both turned on at the beginning of the rest period, and they are turned off independently when the desired bar heights are reached.

One design for the anode drive circuit makes use of a series pass transistor, either as a saturating switch with an appropriate anode current limiting resistor or, preferably, as a switched-current source. This technique conserves power, but requires either a capacitive or an active level-translator to control the +250 V with the normal logic-voltage swings. An alternative approach utilizes an npn transistor to turn the panel anode off by clamping it to a voltage lower than its sustaining voltage. This latter technique wastes power when the anode is off, but it saves a level-translation stage. Both configurations are illustrated in Fig. 6.

One advantage of this method of determining bar height is that the brightness of the bar does not vary with its length. No matter how long or short the bar is, each segment that is to be turned on at all is turned on for the same length of time as every other energized segment—83 μs for a 60-Hz scan.

Bar graphs are practical

When one considers that the indicator of the familiar analog panel meter moves in a circular arc because it's easier to build that way, not because the world wanted it to have that configuration, one realizes just how attractive a truly linear display can be. For a marine depth sounder, for example, downward is clearly the direction for the bar length to go as the depth increases.

Two applications that are made to order for the bar graph are matching and comparison. If an operator must adjust some controls until two (or more) voltages (flow rates, pressures, or other measurements) are matched, there is probably no simpler way than to adjust them until two adjacent bars are the same length.

Similarly, if a pilot wants to find out at a glance if all four engines of an airplane are equally loaded, what could be easier than a look at an array of four bars? If it is necessary to read off a number to several decimal places, a digital meter is required; but for many applications, the bar graph fills the bill.

A nearly universal comparison setup is shown in Fig. 7. Voltage inputs are shown, but any other quantities could be displayed by putting suitable signal-conditioning circuitry in front of the voltage inputs.

A 50-μs clock controls the three-phase drive circuit and a divide-by-200 counter. When the counter reaches 200, a reset signal energizes the reset cathode on the panel and initiates the ramp generator. The ramp generator starts at zero and is at maximum at a count of 200.

This ramp signal is routed to two comparators whose outputs are connected to the anode drivers. The other comparator inputs are the signals to be monitored. The comparators hold the anode transistors off (the segments glow) until the internally generated ramp voltage reaches the level of the externally applied voltage, when the anode turnoff transistor quenches the glow. □

*Metastables are gas atoms that have been raised to an intermediate energy level from which they cannot return to the ground state without interacting with other particles or the walls of the chamber. If this interaction takes place with an atom of lower ionization energy, then the metastable causes this other atom to ionize. In the panel, the metastables of the neon ionize the atoms of an additive gas upon collision.

T^3L achieves C-MOS noise immunity while retaining TTL speed

Inserting a third transistor in a TTL circuit makes the threshold voltage about half the logic swing, or nearly the optimum for noise immunity; drawback of lower density is offset by ease of mixing TTL with T^3L

by Werner Fleishhammer, Günter Schneider, and Gerd Koppe, *Siemens AG, Munich, West Germany*

□ The best things in digital circuits do not come free. For instance, part of the payment Schottky transistor-transistor logic makes for being faster than unclamped TTL is a heightened susceptibility to noise, so that it also requires tighter wiring rules and more attention to grounding and transmission-line problems.

Optimum noise immunity is obtained by digital circuits in which the threshold is in the middle of the logic swing. Complementary metal-oxide-semiconductor (CMOS) logic satisfies this requirement, but the faster, noisier TTL circuits do not. Typically, a TTL threshold voltage of 1.4 volts is only about 37% of the 3.5 V (0.1 to 3.6 V) logic swing, and noise immunity is both asymmetrical and around 1V at a low level, which is only 28% of the logic swing. The percentages are even worse with low-level logic and Schottky-clamped TTL.

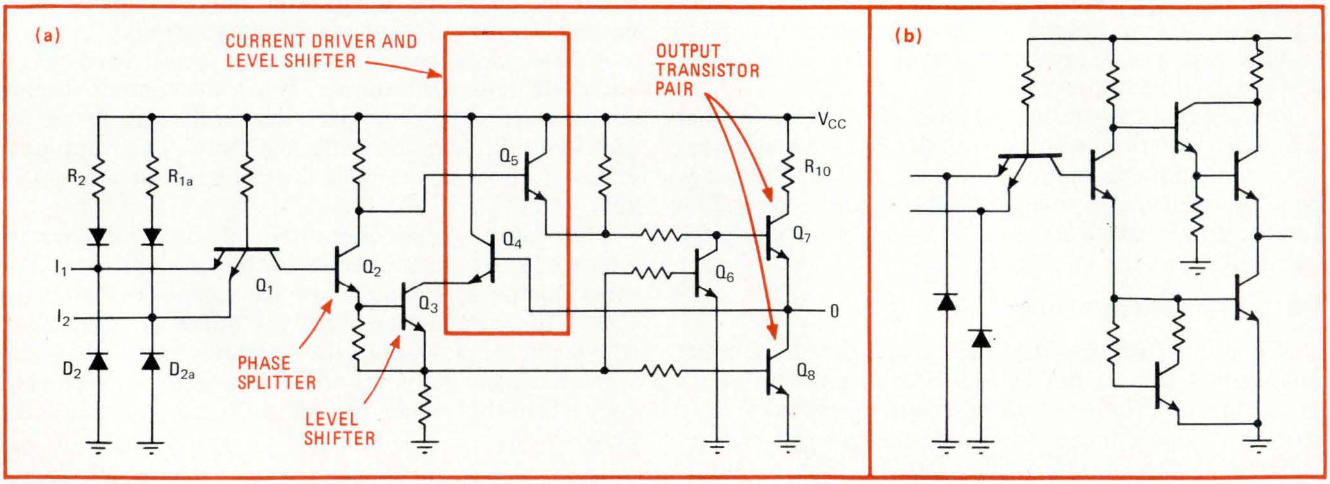
Therefore, a logic family combining C-MOS noise immunity with TTL speed would fill a gap in existing logic families. The lead came from noting that one diode voltage drop of 0.7 V will shift threshold voltage and the logic swing to 2.1 V and 4.2 V (0.1 to 4.3 V), respectively, making the threshold voltage near the optimum 50% of the logic swing. The shift also provides a symmetrical noise immunity range of about 1.7 V, or about 40% of the logic swing. Similar improvements are achieved with Schottky TTL.

Circuits that feature this extra diode drop have been named T^3L here because the input threshold voltage is determined by three base-emitter voltage drops. They were initially developed a few years ago by RCA in the U.S. and later by Siemens AG in Germany.

T^3L circuits feature increased noise immunity, possibly complementary outputs, and slightly higher speed than conventional T^2L. However, these good things also come at a price, both literally—the circuits cost more—and in terms of space—since no T^3L MSI is available at the present time. Consequently, when maximum density and minimum cost are at a premium, T^2L will probably prevail. But, since T^3L can readily be interfaced with T^2L, mixed systems can be designed that exploit the advantages of each family.

How it's done, what it does

Figure 1 shows a T^3L NAND gate alongside a typical T^2L NAND gate. At inputs I_1 and I_2, resistor R_1 and R_2 are provided with clamping diodes D_1 and D_2, allowing unused inputs to be left floating because they are tied internally to V_{cc} through resistors R_1 and R_2. The shifts in threshold level to three base-emitter drops, or 2.1 V, is accomplished by the insertion of transistor Q_3 between the phase-splitting transistor Q_2 and the output transistors. This insertion, coupled with the need for an output voltage of 4.3 V in the high state, required the upper output stage to be modified from the standard



1. T^2L to a new power. A T^3L NAND gate and its T^2L counterpart demonstrate the essential differences between the two families. Transistors Q_3, Q_4 and Q_5 provide an extra pn junction drop that improves noise immunity by increasing the gate threshold for the same supply voltage, and also improves switching speed and driving capability. The amount of cell area is only slightly increased.

T^{2}L configuration. The upper output transistor Q_7 is turned off by Q_6 whenever Q_8 is on.

Two other modifications of the T^{2}L gate in Fig. 1b should also be noted. They are provided by transistors Q_4 and Q_5, which improve the switching speed and the dynamic current drive capability without increasing static power dissipation. If the output switches from a high to a low level, Q_4 turns on and provides extra current to the base of the lower output transistor Q_8. During switching from a low to a high level, Q_5 turns on and delivers additional base current to the upper output transistor Q_7. The increases in threshold and output voltage is illustrated in the voltage transfer characteristic curve shown in Fig. 2.

The output was designed to deliver full line current while maintaining logic voltage levels in both the low and high states and for 100-ohm lines. At low levels, this is done by having transistor Q_4 turn on transistor Q_8 when the output voltage exceeds 1.6 V. The small resistance of R_{10} allows high-level currents of 33 milliamperes at 2.6 V.

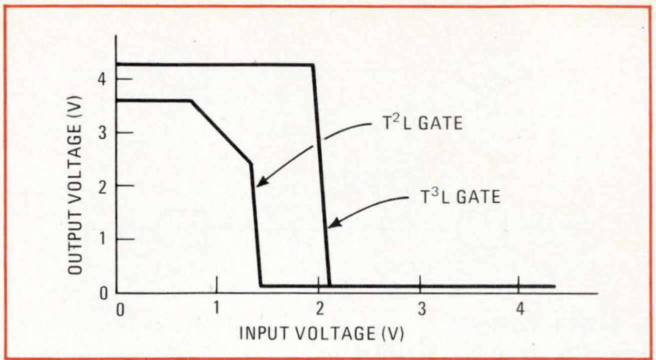
Typical input and output characteristics are shown in Fig. 3. In the low condition (dotted line), the input current is 2.5 mA. One output can typically drive eight T^{3}L inputs, which compares favorably with the fanout of 10 featured in most T^{2}L families. The output drive in the low state (dashed line) and in the high condition (solid line) demonstrate its high current drive capabilities. Despite the good drive capabilities and complexity, average power dissipation is only 28 milliwatts per gate, higher than standard T^{2}L. The typical gate delay time, however, is shorter. For a 50-picofarad load, T^{3}L has a 14-nanosecond maximum gate delay (10 ns typical) as against the 22 ns of T^{2}L. The speed-power product of T^{3}L, however, is about twice as high.

Where it's useful

The ease with which T^{3}L circuits can be interfaced with the T^{2}L logic family is illustrated by the hookup schemes in Fig. 4. To drive T^{3}L by T^{2}L, all that is necessary is to insert a resistance of 2.2 kilohms to V_{cc} between them. The reverse is even less trouble—T^{3}L logic needs no extra circuitry to drive T^{2}L. This makes it easy for a designer to combine in a single system the noise immunity, complementary output and drive capabilities of T^{3}L with low-cost and high density advantages of standard T^{2}L.

But the main usefulness of the new logic family lies in the area of design automation. T^{3}L's higher noise immunity in the low state and its smaller output resistance in the high state allow for simplified techniques of system wiring and the connection of two or more back planes, into each of which many printed-circuit boards may be plugged. Standard T^{2}L, and especially Schottky T^{2}L, requires good rf wiring practice utilizing ground planes, power supply decoupling and thorough consideration of line-to-line crosstalk—considerations that are difficult to include in design automation programs. At Siemens, the programs used in developing new systems around T^{3}L need few electrical restrictions.

To illustrate, within one backplane in a T^{3}L system, serially wired networks up to 7 feet long can readily be driven. Between different backplanes in a system, flat

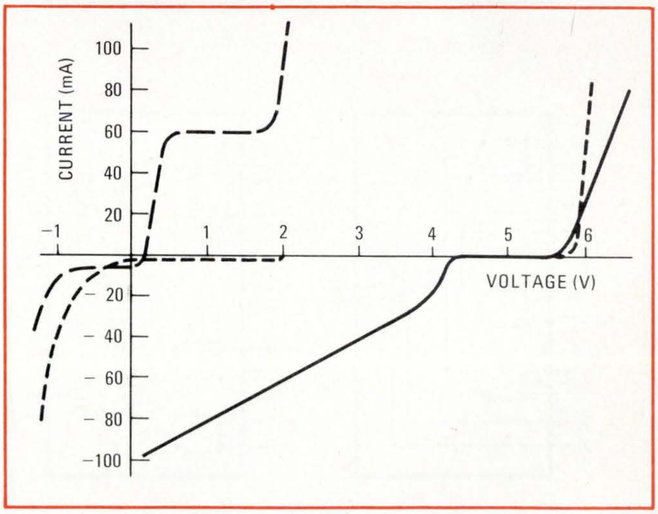


2. An ideal change. For T^{3}L, both the output voltage and threshold voltage increase by 0.7 V, leading to a threshold voltage that is 48% of the logic swing—almost the optimum for noise immunity.

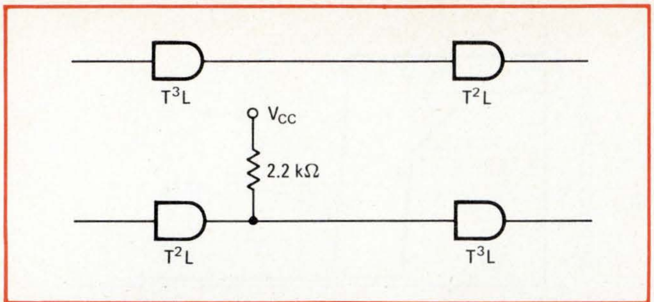
cables with an 100-ohm characteristic impedance can have lengths up to 34 feet without needing the special driving and receiving gates and line terminations that T^{2}L circuits would require.

At high speeds and for longer-line lengths, however, careful consideration of noise margins becomes critical. Three factors cause a device in the low state to suffer more from noise than when in the high state. First, ground noise is larger. Second, distortion due to reflection is also larger, since the voltage swing of the propagating signal wave is higher for the falling than for the rising edge. Third, the signal level of the falling edge deteriorates along the line because of the resistive component of the input impedance of the load gate circuitry.

Unlike T^{2}L, which has a lower noise margin at the low level than at the high level, T^{3}L has a higher noise margin in the low state. T^{3}L's low output resistance in the high state eliminates pedestal problems with the signals pulse's leading edge causing spurious triggering. When a long line is driven by one T^{3}L circuit, the signal swing is large enough for all gates on the line to be switched by the initially propagating signal. Thus a satisfactory noise margin is provided at every point of the line. Voltage induced by one line connecting logic circuits in an-



3. Current-voltage characteristics. Input current versus voltage (dotted line) is about 2.5 mA in the low state. Output low voltage (dashed line) and high voltage (solid line) versus current demonstrate drive capability of T^{3}L.



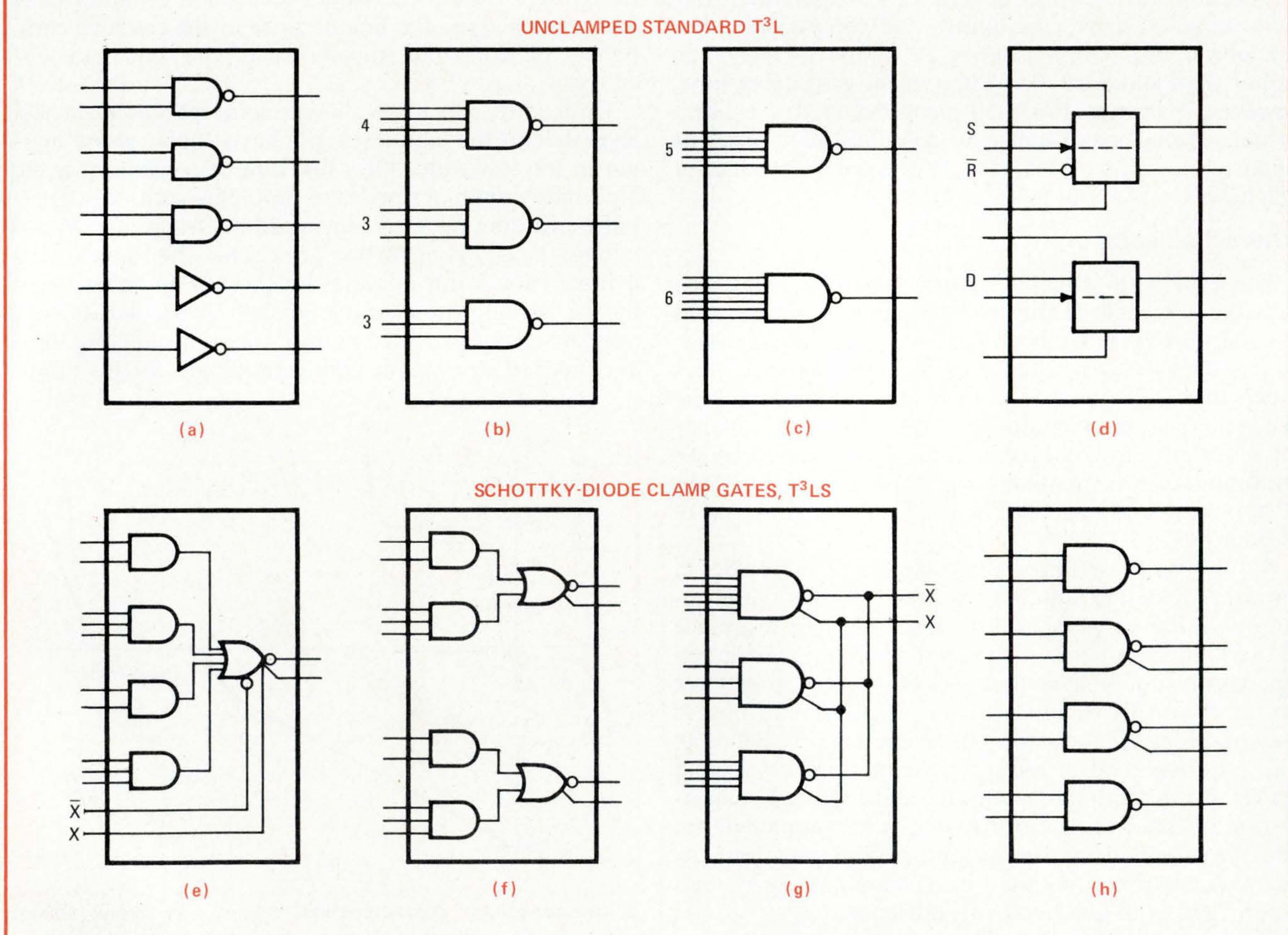
4. Saving interface. T³L can drive T²L directly (above) and can readily be driven by T²L (below), so that it can be used for special applications without complex interfacing and logic level shifting.

other line running parallel to it and connecting other networks are a critical factor in determing whether undisturbed signal transmission is possible. These induced crosstalk voltages are larger in T^3L than in T^2L, because of larger voltages on the signal lines. However, they are more than offset by T^3L's better noise immunity so that the permissible coupling length for T^3L logic is approximately 60% higher than that of T^2L.

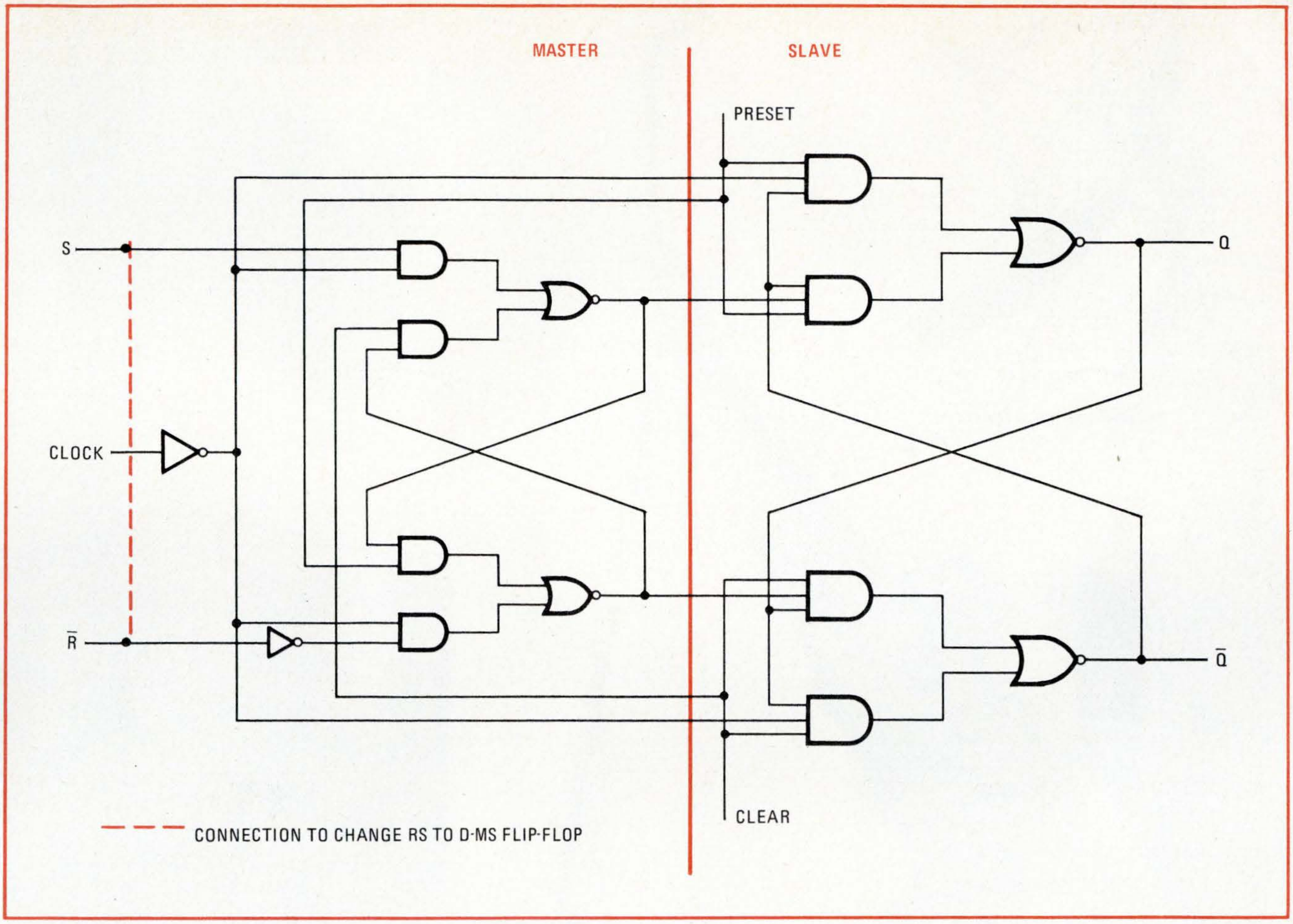
The initial development effort at RCA and then at Siemens AG led to the family of eight circuits shown in Fig. 4. Both Schottky-diode-clamped and standard unclamped circuits are available. They are being used to a large extent in medium-sized basic processor units, along with T^2L MSI circuits. Other semiconductor companies, like Motorola, Signetics, and Transitron, are building these circuits under subcontracts from Siemens AG.

The T^3L family consists of NAND gates with two, three, four, five or six inputs, inverters, and two master-slave flip-flops. These circuits are available in four different 16-pin dual-in-line packages. These are shown in the upper row of Fig. 5. The two master-slave flip-flops have the same noise-immunity and line-drive characteristics as the gates. Both flip-flops have the same internal structure except that the logic input can be altered to make one an RS-master-slave flip-flop, and the other a D-master-slave flip-flop (Fig. 6). They have independent preset, clear and clock inputs. Information from the logic inputs enters the master with the falling edge of the clock pulse and is transferred to the outputs with the rising edge. On the D-type flip-flop, information may change while the clock is low. The RS flip-flop can also be used as a D-type flip-flop by connecting together S and $\bar{R}$ inputs.

A family of similar circuits with Schottky diodes has also been developed. It consists of the four different packages shown in the lower row of Fig. 5. To make use of the higher speed of internal gates, most of the circuits



5. Family portrait. Various T³L gate combinations are available in four types of standard 16-pin DIP packages. Although not as fast as the fastest Schottky T²L, T³L is faster than available C-MOS, and provides comparable dc noise immunity.



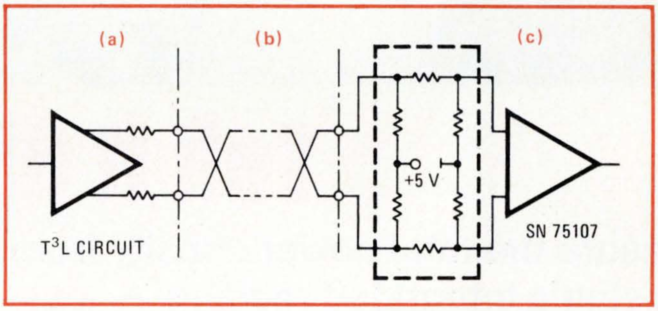
6. Dependency relation. An expanded diagram of Fig. 5d demonstrates how, by changing logic inputs, the same internal structure can be used to realize both an R-S- and a D-type master-slave flip-flop. Information enters on the falling edge of the clock pulse and is transferred to the output on the rising edge, but on the D-type flip-flop information may change while the clock is low.

have two-stage logic and complementary outputs. There are expandable AND-OR/NOR gates, an expander, AND/NAND gates, and NAND gates. The gates have the same characteristics and loading rules as the T^3L gates, except that threshold and output levels are slightly different because of the Schottky diodes and both speed and power dissipation have increased. The typical delay time for both outputs of an AND-OR/NOR gate loaded with 50 pF is 8 ns (11 ns maximum).

Typical applications

A signal-transmission circuit which combines the noise immunity and complementary outputs of Schottky T^3L is diagramed in Fig. 7. The circuits with inverting and noninverting outputs are used as a differential line transmitter. This, when coupled with a differential receiver such as Texas Instruments' SN 75107, realizes a transmission system for devices separated by as much as 200 feet. The system is operable even when a dc noise voltage of up to 19 V is applied between the grounds of both devices. Neglecting cable delay, the propagation delay over the differential transmitter and receiver is typically as low as 24 ns.

T^3L gates are also useful where high noise immunity is not a necessity but where the logical structure of these Schottky-diode circuits simplifies the design concept and improves circuit speed. For example, a very fast and simple RS flip-flop can be realized with only one AND-OR/NOR gate if the gate's noninverting output is fed back to one of its inputs.



7. It goes a long way. A T^3L circuit with both inverting and noninverting output (A) can successfully transmit over 200 feet of cable (B) to a receiver with a terminating network (C). Such a scheme would be impossible with T^2L but high drive capability makes it feasible with T^3L. in the presence of high common mode noise.

This logic family is still at a small-scale integration level. Future developments will include MSI development and mixing T^3L and T^2L in medium-sized basic processor units and peripherals, as well as and in input-output controllers. The use of T^2L wherever possible will optimize the systems' logic power and cost, while T^3L will be mixed in wherever noise immunity and complementary outputs are called for. □

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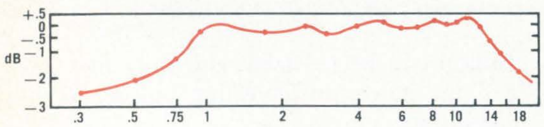

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Formalizing of evaluations helps EEs climb career ladder

Engineers and managers agree that regular performance rating improves communications, enhances job output, and aids in career planning; most companies have dual track for promoting specialists and managers

by Gerald M. Walker, *Associate Editor*

☐ Methods of evaluating job performance of engineers appear to have passed through two or three cycles during the last couple of decades. Although different companies may be at different points on the trend line, depending on size of department and management's current bent, the approach to rating EEs has swung from bland informality to strictly check-list formality.

Today, performance evaluation has stabilized at a point somewhere between these two extremes, combining the use of written forms with personal contact between the supervisor or manager and the working engineer. What's more, it also appears that today's engineer expects—in fact, desires— to be evaluated and then told about his rating.

These conclusions were gleaned from a sampling of a cross section of electronics companies throughout the country to find out how engineering departments evaluate job performance. In general, here's what *Electronics* reporters found out in this roundup:

- Most written evaluation forms are a combination of one-word ratings—excellent, good, fair, poor—and narrative description.
- Practically every department performs evaluation annually, but most stress that keeping tabs on how EEs are doing is an ongoing process throughout the year—usually on an informal basis.
- Some companies include space on their forms for the evaluated engineer to comment on his rating, and others also make room for a projection of goals for the coming year.
- Evaluation forms are generally designed by personnel departments, rather than the engineering departments. However, forms for EEs have different formats from those for hourly blue-collar employees.
- Although criteria may vary from company to company, engineering managers have clearcut ideas of what they are looking for in their men and stick to them.
- Every company reports the existence of a dual-ladder promotion system.
- Working-level EEs generally approve of the evaluation systems. Complaints center around failure of supervisors to be objective.
- Supervisors generally approve of the systems too. Their complaints: Engineering project schedules don't coincide with required evaluation dates, making it difficult to complete thorough ratings.

Times are changing, but why?

While there are variations from these generalizations, both the supervisors and the working EEs agree that thorough performance evaluations are more important today than in the past. The reasons for this attitude are not completely clear. To get a bench mark on this point, engineering managers were asked if they evaluate EEs any differently from how they had been evaluated as beginners. The responses were equivocal.

Many say that, as designers, they did not get the same amount of attention from their supervisors that they now give their people. Others recall that, in the past, evaluations were much too subjective. If they didn't make any waves, their ratings were high. In some cases, evaluation had been so distasteful to supervisors that they let each EE fill out his own check sheet. Still others

claim that there has been no change in the way evaluations are done, yet they agree that the results are more important today than they have been in the past.

One clue to the growing importance of performance evaluation comes from an engineering department manager in the Midwest who says, "there's more interest now by engineers in feeling they've contributed to a part of the end product. So they want to know what they're doing and how well they're doing it."

An East Coast engineering vice president points out that companies in general are opening up more to employees, perhaps in response to complaints in recent years by assembly-line workers of boredom and management indifference to their psychological well-being. This reaction has increased the value of personal contact, and the annual evaluation is the means to ensure it. Management is now striving to treat all employees as humans, rather than as cogs in the corporate machine.

A West Coast project manager stresses that career planning for engineers is more important today than in the past, and companies feel a responsibility to encourage short- and long-range employment goals. "Ten years ago we didn't give much thought to the next job or the next raise," he relates. "Now, engineers worry about where they're going, how they plan their future. That's why the evaluation process today covers the guy's goals and ambitions."

Reflecting appreciation for this concern, an EE in this department remarks that he has no respect for engineers who try to get ahead by job-hopping. His feeling is that performance evaluation is important because it affords an opportunity to work out a realistic career path without having to leave the company.

Not surprisingly, the way companies handle evaluation of engineers fits their general image very closely. For example, the hot, fast-moving semiconductor houses in California's Silicon Valley tend to rate performance on the run—virtually from day to day—and rewards come equally fast. Big aerospace firms like Hughes Aircraft, Los Angeles, and Grumman Aerospace, Bethpage, N.Y., have carefully programed systems that interface with education subsystems.

Such large, diversified manufacturers as General Electric and GTE-Sylvania rate generalized characteristics, but depend on their chiefs at the working level to track the specifics.

On the other hand, a small firm in a highly competitive market, Data Precision Co., Wakefield, Mass., is inclined to tie an engineer's performance to how the final product comes off the manufacturing line. As expected, small firms have the least formal evaluations, but the engineers have high visibility throughout the design and production cycles.

Evaluation reflects the company image

EEs in companies outside the traditional electronics industries are not necessarily ignored minorities. In the Chrysler Corp. Automotive division, for instance, there are few EEs, compared to the army of mechanical engineers, and they are involved in relatively new development projects, which causes them to stand out.

Says Robert Weir, manager of engine electrical development for Chrysler, Detroit, the problem with EEs in an auto company is not so much how to evaluate them,

Behavioral evaluation at Grumman

"Many evaluation methods fail because they try to accomplish too much" observes Daniel Knowles, personnel director at Grumman Aerospace, Bethpage, N.Y. "What we hope to achieve—by limiting our objectives in designing evaluations—is to assist individuals in planning development needs along their career paths."

Performance appraisal, Knowles explains, has evolved over the years from the haphazard to the traditional, and recently to the "behavioral" approach. "Today's employee wants to have the opportunity to ask why. There is more of a trend towards participatory and democratic management structures, with the emphasis on improvement of employee morale and decision-making. The autocratic management of the past is almost obsolete today," he observes.

As a result, Knowles has been revamping the entire evaluation system for the 44-year-old company, a project aimed at dealing with both the individual's performance and his career development. A new evaluation form, in effect for a little over a year, uses a narrative-discussion approach to provide a more flexible means of performance appraisal than in the past. The system is not limited to engineers. It covers all employees. Knowles emphasizes that the appraisal is strictly geared to the individual's development needs. It provides a more accurate and meaningful evaluation than the more formal concept, he adds, but it is not a means for obtaining salary increases or instituting disciplinary measures.

A one-page appraisal form, completed by the engineer's supervisor and reviewed by his superior, is broken down into six sections—performance evaluation, promotion considerations, level of education, training needs, over-all performance, and comments by the employee.

This evaluation form, which can be used one to four times a year, depending on the number of department assignments an individual gets, covers both engineers and supervisors, with a different set of criteria used for each group. For example, the engineers' characteristics are quantity and quality of work, cooperation, initiative, reliability, responsibility, attendance, work planning, communications, costs, and safety factors, among others. In addition to these qualities, supervisors are evaluated in terms of cost control, development of subordinates, delegation of responsibility, and "their efforts in the area of equal-employment opportunity."

This last point is of significance to Grumman's personnel administrators, who point out on their appraisal forms that supervisors should maintain "good-faith efforts" with affirmative action goals, especially noting "utilization, counseling, and development of minority and female employees."

The Grumman evaluation sheet also has space for the employee's comments. In addition, he has an opportunity to discuss the evaluation with his supervisor before signing the form.

Wayne Consolla, an electronics engineer, comments that this feature provides a viable outlet for the individual to voice opinions—either about the company or about the comments made on the appraisal form. He adds that the but how best to move them around. "We have to be concerned with handling a double-E if the area he is working on is de-emphasized. Chances are, he is an outstanding man, and we want to keep him, but the opportunities to relocate are limited, compared with mechanical engineers here."

This is not the situation for semiconductor companies. Because of the great competition to get enough engineers, the evaluation systems at Signetics, Sunnyvale, Calif., American Microsystems Inc., Santa Clara, Calif., and Fairchild Semiconductor, Mountain View, Calif., for instance, are geared to keeping EEs happy and productive.

Luther Hintz, manager of TTL design at Signetics, performs both an annual, formal review and an informal, biweekly review, but he says that the biweekly check is more important. While the annual review covers long-range goals for the engineer, the intermediate review touches on such questions as whether the project is running on schedule and what modifications have to be made. From this, the employee gets a good idea of how he would be doing even before he reads and signs the formal, annual evaluation.

At AMI, an annual check list must be filled out, but there's a great deal of emphasis on individual commentary. The evaluation includes the person's plans to develop his employability and plans to move ahead. The last section asks the employee what he has done to implement his goals of the previous year.

John R. Duffy, manager of computation products at AMI, says the interface between engineers and managers is so close that when a project goes exceptionally well, "it's easier to get approval for raises. It's related to the fact that groups in semiconductor houses are much smaller than in other companies, and it's easier to recognize one person's contribution," he adds. It's also easier to spot the poor performers in semiconductor companies. Fairchild, which has a procedure for giving midyear rewards for outstanding performance, also has procedures to try to boost the output of sub-par workers. If someone's performance isn't up to snuff, he gets a warning as soon as the problem arises, reports James M. Comstock, manager of MOS calculator products.

Comstock's philosophy is "if you have a problem, don't procrastinate. Kick it around. Sometimes engineers have skills that would be better applied in other divisions. Just because a guy doesn't match up on one place doesn't mean he can't do well elsewhere in the company."

R&D types are included

Managers and employees agree that performance evaluation—both formal and informal—is a good means of establishing communications. Beginners, especially, find that required evaluations during the year help them get on the right track in a company; a conversation with a supervisor may reveal that the employee did not fully understand departmental procedures.

Contrary to the myth that EEs working on research and development are above all these policies, the *Electronics* round-up indicates that performance evaluation is as important in advanced-product-development labs as it is in production-oriented departments.

This point was confirmed by Robert Harwood, man-

---

evaluation, which is used for employees throughout the company, probably is better than a form tailored specifically for engineers. A specialized form would create additional problems within departments, where diverse job skills would make a standardized appraisal ineffective, he contends.

In its last step, the form is forwarded to the personnel department for consideration of the employee's promotability and for the planning of training courses to assist in satisfying the individual's development needs.

Grumman's previous evaluation system required allotting points or checking standardized answers in response to each trait or characteristic. However, Knowles observes that the system became distorted, since it left little opportunity for the evaluators to give it some thought. By employing the narrative form, "the system is far more open-ended." Knowles points out that it provides more valid data than did the previous system on the individual's strong points, weaknesses, and development needs.

Another program under development is a new type of career path for engineers. Termed a tri-career ladder, the system will employ the titles of assistant, associate, engineer, and senior engineer. At the senior level, an engineer can go in one of three directions—he can continue as an "individual contributor" under the title of technical specialist, principal engineer, or technical advisor, or enter one of two management levels.

At one level, he is a supervisor in a design specialty—for example rf engineering—as a group head, section head, or manager. The other level is in program management, directing specific projects within the various disciplines as a project leader, project engineer, or project manager. Classifying this as part of Grumman's "matrix system," Knowles says it will be of advantage to engineers who reach the senior level and want to stay in design engineering. He adds that Grumman attempts to promote within the company and special efforts are made to retain its engineers.

If there is a general reduction in staff, the head of each department is asked to submit a list of names of individuals having the lowest performance records to a termination-review board. The board considers each name before making the final decision. The company, which employs about 6,000 engineers, also informs employees who are "vulnerable" to layoff. Termination of an employee who has been with Grumman for more than 10 years requires the approval of the vice president; recommended termination after more than 15 years requires the supervisor's appearance before the review board; after 20 years, the employee gets a personal interview with the vice president; and after 25 years, the case is reviewed by the chairman of the board.

Knowles also explains that when there is a reduction in personnel, employees are given the opportunity to look for positions available in other departments at Grumman.

As for employee reaction to the rating system, 29-year Grumman veteran, Richard Cyphers, chief of the structural system section, emphasizes that in evaluating, "they are not trying to destroy the individual, but rather offer constructive criticism. There would be no point to the evaluation unless it pointed out the individual's weak areas and offered suggestions for improvement."

ager of development engineering at the Pacom division of Amp, Harrisburg, Pa. He feels that his group may even be more careful in performance evaluations than the manufacturing divisions are. He points out, however, that the formal rating sheet provided by the personnel department for all engineers is actually "an excuse to get a conversation going. The check list has a tendency to look back. In evaluating the creative people in development engineering, it's fine to be aware of the past, but looking to the future is the main idea."

At Bell Laboratories, the engineers' association, the Conference of Professional Technical Personnel (CPTP), has also taken an interest in evaluation of personnel. A survey of engineers conducted last year by CPTP revealed that, of the almost 2,500 members of the staff responding, 51.4% felt the present merit and salary-review procedure is reasonably fair and accurate. However 87.8% of the respondents wanted a formal opportunity to rate their management on technical and administrative performance.

Keeping the promotion ladder clear

The purpose of performance evaluations is to keep track of an engineer's work, and, at the same time, keep track of the projects assigned to the engineer. These reviews also influence promotions, and probably the most nagging problem is the dual-ladder advancement system. The dilemma is how to reward a top-notch design engineer who's happy in his work and does not want to go into a supervisory position in order to better his lot.

All the commenting engineering departments claim to have some type of dual ladder, and most were satisfied that the plan is satisfactory. Generally, the solution for handling the top EE who wants to remain in nonmanagement technical assignments is to create a hierarchy of technical titles tagged with salary bursts at each stop. This arrangement leaves the supervisory ladder open for EEs determined to rise via management.

Engineering managers assert that the technical ladder can match the management ladder—in some cases, up to the vice presidential level. Because of this arrangement, it's not unusual for a technical-ladder engineer to be making more money than his supervisor.

The situation is not quite as cut and dried at the GTE-Sylvania Entertainment Products division, Batavia, N.Y. W. Daniel Schuster, engineering vice president, explains, "There's a corporate policy establishing the two paths, so, as a technical specialist, an engineer can go up to the equivalent of a vice president in salary. But we don't make it a hard-and-fast situation here. A man can switch back and forth from supervisor to design work without sacrificing his salary position. Thank goodness for that."

The Sylvania division has recently switched to a new, less formal means of evaluation that the EEs like because it's more personal. The supervisors like it because it requires less paper work than the previous checklist.

Because it uses one large "salary spectrum" covering all engineers, it's possible for an EE at Hughes Aircraft Co. to move within a design or management function without causing too much upset. The company rates all engineers on a "maturity-curve basis." An EE's maturity curve is related to his years of experience and his performance ratings. All of this goes into the master-pay spectrum through which the engineer can move from job to job horizontally—no matter if it's a technical assignment or a supervisory position.

However, some companies expressed reservations on how well dual-ladder procedures serve EEs. A components-company manager spoke for many when he declared his refusal to create phony supervisory titles to tack on to EEs as a reward, even though they continue to perform the same tasks. This strategy only blocks the way to management for other EEs.

One engineering-department manager put it frankly: "Let's face it, the guy with the management title is taking risks. He's under pressure to produce, so he ought to be paid for it. The technical man may be valuable to the company, and he deserves to get extra privileges and more pay. But which one do you think is going to make it in the company?"

For a fast-moving company like Digital Equipment Corp., employee mobility has not been a problem. The basic criterion, says Grant F. Saviers, manager of disk products, is how the man gets the job done—no matter what the title.

Perhaps he raises the most critical issue of all with the remark: "One of the problems of evaluating engineers is that it takes a fairly long time to measure technical contributions. This is determined by the product in real use after it is delivered to the customer; that's when you find out how well it is done. The engineer has limited perspective on the use of the products he designs, but we try to encourage that perspective." □

Evaluation of EEs: How's it done? Does it work? Is it changing? Here's a way to find out now

Rating performance of EEs appears to be important these days in large companies and small. But there are questions about how well evaluation is done, and whether or not engineers feel that they benefit from the results.

To get an idea of how readers handle this procedure, we've prepared the two questionnaires on the following pages with room for your written comments. The first questionnaire is for those being rated, and the second is for those doing the rating. If you are on both the giving and receiving ends, you may want to fill out both questionnaires.

To submit your questionnaire(s), clip the page, fill out your replies, and mail **before March 29, 1974** to:

Editor, Code E
Electronics
1221 Ave. of the Americas
New York, N. Y. 10020

Nonsupervisory engineers questionnaire

(Supervisory personnel, see next page)

How are you evaluated?

1. Are you presently working for a department in which you receive formal performance evaluations? Yes ____ No ____

2. If so, what is the frequency? Annually ____ More often ____ Less often ____

3. Does your supervisor personally review with you your work performance?Yes ____ No ____

4. Do you (a) *see* the evaluation, (b) *sign or initial* the evaluation, (c) *add comments* of your own to the evaluation? (Check *all* applicable spaces.)
(a) Yes ____ No ____
(b) Yes ____ No ____
(c) Yes ____ No ____

5. Who performs the evaluation of your performance? (Check *all* applicable spaces.)
Immediate supervisor ____ Peers ____
Department manager ____ Others ____

6. Do you think evaluations of your performance are fair? Yes ____ No ____

Comment: ____

7. Do you feel that you have enough opportunity to choose between either moving up the pay scale as an engineer or up the promotion ladder in management? Yes ____ No ____

Comment: ____

8. In event of layoffs, do you favor the "bumping" system in which senior engineers can take over jobs held by lower-ranking EEs at lower salaries, rather than leaving the company? Yes ____ No ____

Comment: ____

9. Would you like to have formal "up evaluation" of your supervisors or management, that is, you would evaluate their performance? Yes ____ No ____

10. If yes, which is more important to you? (a) Technical performance is more important ____
(b) Administrative performance is more important ____
(c) Both are equally important ____

11. What aspect of *your performance* is the most important to be evaluated?

Response: ____

Why? ____

12. Is your boss doing a reasonably good job of evaluating your performance now? Yes ____ No ____

Comment: ____

Title and function ____

Highest degree ____ Age ____

Total years in engineering ____

Your company's main products ____

City ____ State ____

Note: All responses will be kept in strictest confidence. Only cumulative totals and conclusions — without names — will be published. To be counted, returns must be received by March 29, 1974.

Supervisory personnel questionnaire

How do you evaluate?

1. Do you use a formal, written performance evaluation of EEs in your department?
Yes _____ No _____

2. Do you review evaluations with EEs personally? Yes _____ No _____

3. How often do you perform evaluations? Annually _____ More often _____ Less often _____

4. What are the three *most important* performance characteristics that must be evaluated?
(a) __________
(b) __________
(c) __________

Comment: __________

5. What is the purpose of employee evaluation? (Check *all* applicable items.)
Improve performance _____
Career planning _____
Promotion _____
Salary review _____

6. Is the format for evaluating EEs designed by
(a) The engineering department _____
(b) The personnel department _____
(c) Other _____

7. Do you have a dual-ladder promotion system for EEs who want to remain in technical work rather than move to supervisory positions? Yes _____ No _____

8. Do you believe that the promotion system works
(a) Very well _____
(b) Fairly well _____
(c) Poorly _____

9. Do you favor formal evaluation for your performance by your subordinates?
Yes _____ No _____ No opinion _____

Comment: __________

10. Do you show written evaluations to those EEs you evaluate? Yes _____ No _____

11. How do you handle EEs whose performance is under par?

Response: __________

12. In event of layoffs, how do you choose those who are terminated?

Response: __________

13. Do you evaluate personnel any differently than you were evaluated in the days when you were a beginner? Yes _____ No _____

Comment: __________

Title and function __________

Highest degree __________ Age __________

Total years in engineering __________

Your company's main products __________

City __________ State __________

Note: All responses will be kept in strictest confidence. Only cumulative totals and conclusions —without names — will be published. To be counted, returns must be received by March 29, 1974.

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At Intercon time, IEEE's 'getting down to business'

The show theme this year reflects the state of the industry, the state of Intercon, and the state of IEEE, as the institute and the show management settle into new images

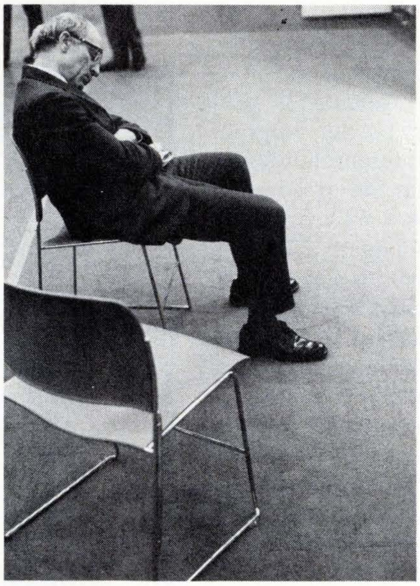
by Gerald M. Walker, *Associate Editor*

□ With an entrepreneur-engineer in the president's chair and with Intercon opening March 26 under the theme, "Getting down to business in electronics," the Institute of Electrical and Electronics Engineers takes on a decidedly business tone this year. Even the Intercon technical sessions have fallen in step, featuring mostly applications and marketing talks, rather than a *potpourri* of research status reports.

There are a number of reasons that IEEE is appealing as much to the members' account books as to their minds. While it's fair to wonder what electronics companies have been doing until now, other than getting down to business, the Intercon theme seems to reflect the industry's *gestalt.* The show is tracking the pervasiveness of electronics in the worldwide marketplace, the booming sales of last year, the necessity for tightening business practices in the uncertain year ahead, and the emphasis on applications that these trends impose.

For another, the institute's role in aiding engineers' careers is also starting to change IEEE's image to some extent. Thus, one session of the technical meetings is devoted to pension-investment plans, a subject that would seem to be more appropriate for a meeting of well-heeled doctors than EEs. Nevertheless, personal business and investment will, no doubt, continue to be a topic for future Intercon programs.

Membership in the IEEE gained slightly in 1973. Non-student members declined less than 1%, but student participation increased, despite a drop in total engineering-school enrollments. Interest among students has been spurred by IEEE's professional-development activities, instituted last year [*Electronics*, March 15, 1973, p. 95].



Intercon's sleepy past. Sales-oriented theme should wake up 1974 Intercon.

Finally, there's IEEE President John J. Guarrera, who is founder, president, and chief executive officer of SaCom, a microwave-equipment firm in Los Angeles. Even though Guarrera, a 1943 graduate of Massachusetts Institute of Technology, was once an engineering teacher and a developer of airborne and ground-based beacons and the triode microwave oscillators used in radar, his personality is much more business-like than academic. He too seems to fit the times.

By 1970, Intercon had reached a diminished state through a combination of factors, including the shift of the industry away from dependence on defense R&D, defection of semiconductor exhibitors, unresponsive show management, and a job-eroding economic downturn. A foundation of instrument manufacturers remained, but show activities on four floors of the New York Coliseum had been reduced to two. The show became an Austro-Hungarian Empire of exhibitions—a dream of past glories, while the edifice was being dismembered by specialized vertical shows.

New management took over for Intercon in 1973, and this year there's renewed confidence that the changes begun then will breathe new life into this year's conference. So the theme, "getting down to business," is as much a reflection of Intercon's new management as it is the state of the electronics industries. It means that Intercon will provide the place and the stimulus to get down to business.

The show is intended to emphasize commercial activity, rather than engineering development, and to include distributors and manufacturers' representatives on the Coliseum floors, along with manufacturers. Intercon management wants once again to make the show a place to introduce new products, as well as a place for representatives of new industrial, commercial, and consumer markets to attend. However, these goals have not yet been achieved.

William C. Weber Jr., operations manager for the show, estimates that attendance should increase from 24,000 in 1973 to 30,000 this year. Some 225 exhibitors are expected to occupy more than 400 booths, compared to around 175 in 350 booths last year. Both the New York area IEEE sections and the Electronic Representatives Association chapters have been active in planning the show, together with the IEEE Conference

Board. This participation should increase interest and promote attendance from these local groups, says Weber.

The energy crisis may also help attendance this year, he adds. Because employing companies will probably limit travel by engineers, a broad, horizontal show like Intercon could take precedence over attendance at several special exhibitions. In addition, the long-range outlook appears healthy, starting in 1976, when Intercon is to begin alternating between New York and Boston. At that time, the Nerem show in Boston will be phased into Intercon, so that the East Coast's two-city schedule will resemble that of Wescon. "Sooner or later it will make sense to have a show in the Midwest, too," Weber observes. "It would be a part of the growing importance of electronics in industrial and automotive centers."

Will Intercon ever climb back to the size of the mid-1960s? It's doubtful. Weber contends that the number of exhibitors could be doubled in the next five years, but times have changed too much to expect anything like the crowds of the past.

On the other hand, he envisions the IEEE show becoming a kind of industrial fair that provides an umbrella over a number of small, special-purpose exhibits, containing such elements as a small packaging show, a small medical-electronics show, a small automotive-electronics show, and a small industrial-electronics show under one roof.

Under this concept, these entries would join the product promotions mounted by the instrument and components houses that now make up Intercon. Then the "business" that Intercon is "getting down to" might once again represent the entire range of the electronics industries.

A tailored technical program

This year's technical sessions, to be held at the Statler-Hilton Hotel, complement the show theme. The program is the result of a conscious effort by the program committee to analyze and please the Intercon audience. Like the show, the technical program is the outcome of two years of rethinking and revamping. Last year, when the idea of accentuating applications began, 82.9% of the attendees rated the show excellent to good. Also more registrants attended more technical sessions than they had in the past—another objective set by the program committee. The most popular session last year was the panel featuring the three developers of the transistor, who appeared as part of the 25th anniversary observance of the transistor's invention.

Technical sessions that drew the largest audiences included discussions of minicomputer applications, MOS-LSI applications, computer-controlled test-system instruments, and automotive electronics. Also favored were sessions on microprocessors, solid-state imaging, and television.

Based on these votes of confidence, program chairman J.A.A. Raper, manager of advanced circuits and control for the Defense Electronics division of the General Electric Electronics Laboratory, Syracuse, N.Y., believes the program is on the right track for this year. Among the highlights of the three-day program, Raper lists a panel on marketing, design, and applications of electronic calculators; the foreign thrust to capture larger shares of U.S. markets; changes in CATV; and technology of point-of-sale systems. Also, recognizing the growing sophistication of a hobby, a panel will discuss development of radio hardware and its deployment by amateurs for communications in space.

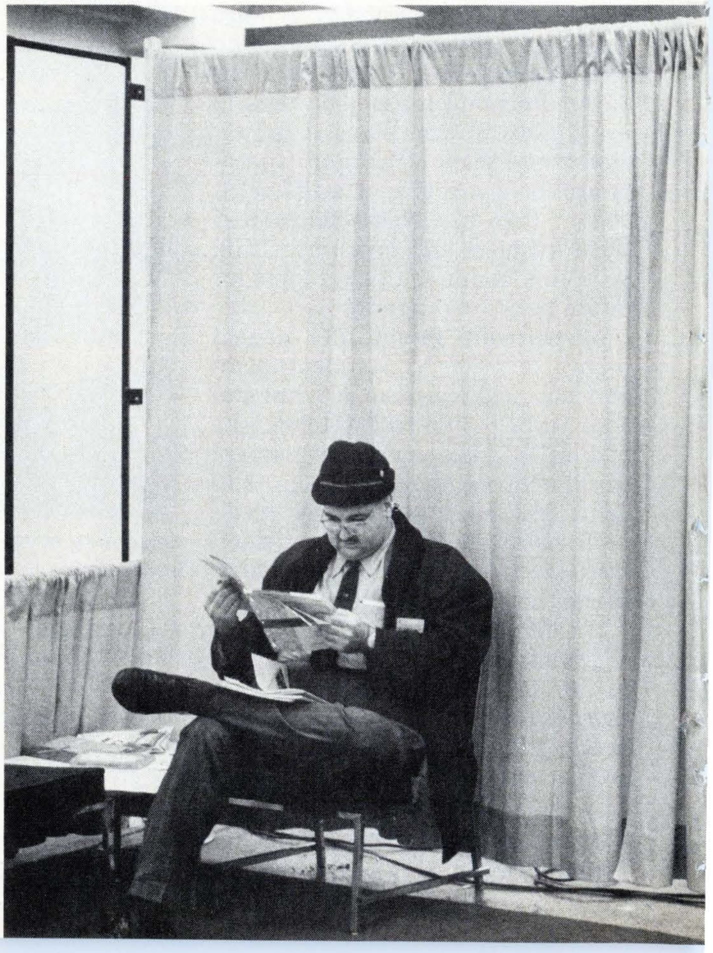
Problems to be discussed

Focusing on day-to-day engineering problems, a panel on "The Semiconductor Crunch," will emphasize delivery and price, and another will consider "Testability—the Key to Automation in Circuit Testing." Two sessions on the rapidly proliferating microprocessor will deal with architecture and applications.

The latest stand-by topic is "Solid State Systems for Automotive Electronics." "Solid State Systems for Consumer and Industrial Products," concerns a circuit for an electronic cash register from NS Electronics, Santa Clara, Calif., a data-acquisition device for industrial control from Analog Devices, Westwood, Maine, and a single-chip slide rule from Rockwell International, Anaheim, Calif.

"Investment plans for Engineers and Employers," mentioned earlier, will have four speakers—Frank Cummins, the IEEE counsel on Government affairs, who has worked on pension legislation in Washington; Richard Backe of Sperry Rand Corp., who is chairman of the IEEE Pension Committee; William Astrop, IEEE's investment counselor; and Thomas Sternau, the IEEE insurance-plan administrator.

Another session that is more or less on the professional-development level is entitled, "Technology As-



Alone again. Sparsity of crowds is also under attack by Intercon management by getting local IEEE sections involved in planning.

Down to business. With more booths filled by more exhibitors, Intercon 74 will try to live up to its theme and its goal of promoting sales.

sessment and the Engineer." Topics to be covered are the future of artificial intelligence, forecasting communications technology, tentative forecasts for ultrasonics, results of manufacturing-technology forecasting, an assessment of the SST's failure, and a discussion of the engineer's role in technology assessment. There were two sessions on this subject on the 1973 program, and both drew big crowds. And since technology assessment has become one of IEEE's ongoing tasks, this topic will probably become a fixture for future Intercon technical programs.

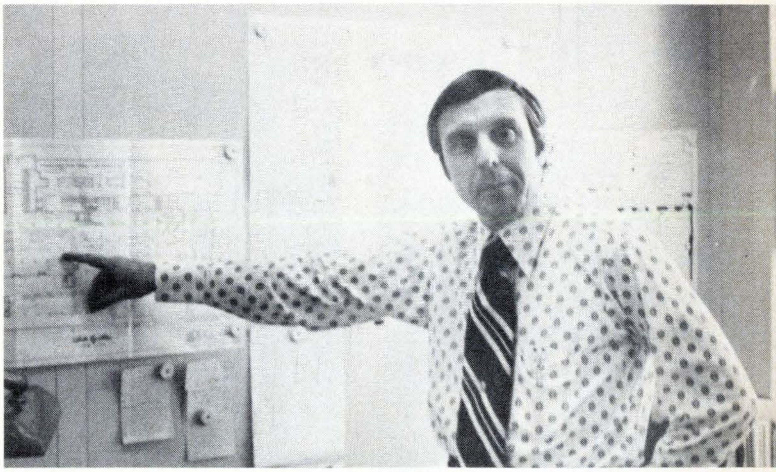
The most offbeat session this year undoubtedly is "New Advances in Parapsychology," reviewing research into extrasensory perception [*Electronics*, Feb. 7, p. 82]. Topics will cover mental telepathy, use of the subconscious mind in problem-solving, and the relation of bodily electrical fields to health.

These sessions should provide a good test for Raper's goal of establishing a distinct personality for the Intercon technical program. "We can ensure a loyal following by patterning the program to the following," Raper points out. "Before we could do this, the conference board spent some time reflecting on the question, 'What are we trying to do with this program?' The pattern was set when we decided that the program has got to match the specific audience, rather than trying to please everyone and doing none well."

The change in the meeting location downtown to the Statler-Hilton may counteract attendance falloff caused by the fuel shortage. Because the hotel is just across the street from Pennsylvania Station, EEs coming by rail from Long Island, Philadelphia, and New Jersey can register conveniently. As always, chartered buses will shuttle attendees to and from the Coliseum so that commuters can get into the Intercon loop without having to use any public transportation in Manhattan. On the other hand, if companies clamp a tight lid on travel budgets, the months of planning for Intercon could be rewarded by empty meeting rooms and a silent Coliseum.

In the meantime, things are not very quiet at the New York headquarters of IEEE. By the end of 1974, a special committee will probably name a successor to Donald

Want a booth? W. C. Weber, operations manager, says there's no reason that sales reps and distributors should not take show booths.



What's on Film Theatre?

In keeping with the Intercon theme of getting down to business, the program committee has arranged for a radical departure in the Film Theatre, normally run in the Coliseum exhibit area. This year, the films will include, not only the usual technical documentaries, but a series of highly rated management lectures produced by BNA Communications Co. and donated by RCA Corp.

Each day, starting on Monday afternoon, March 25, a different topic, encompassing a complete management course, will be screened. These films will not be repeated. The program consists of:

- "The Effective Executives" presented by famed management consultant Peter Drucker.
- "Motivation and Productivity" shown in two parts.
- "Managing Discontinuity," also in two parts.
- "Organization renewal," concerning coping with change.
- "Management by Objectives," including a case history.

Fink, executive director and general manager, who is retiring in 1976. To ensure what politicians call "an orderly transition," the new director will start several months before Fink retires. Since the general managership is a big job, with salary to match, the selection committee will be looking for a top-flight manager—someone who can handle an annual budget of $10 million to $14 million.

As Fink describes the position, it requires a manager with an engineering reputation. Because a career in engineering "is almost required," this would rule out a professional association manager and point to someone from the electronics industries. In addition, says Fink, "the new general manager will sit on top of a complex organization with nine bosses [the board of directors]."

During the year-long overlap, the incoming manager will first learn the ropes of the inside of IEEE, getting to know the staff and mastering the many, many committees that make up the organization. The second step will be to get a handle on the external issues—IEEE's career functions, the pension plans, engineering demands during the energy crisis, and the sometimes-touchy relations with the technical societies operating under the IEEE imprimatur.

For IEEE, it's Guarrera

While the search for a general manager goes on behind the scenes, highly visible out in front this year is IEEE president John Guarrera. Even though he's the head man of an electronics company, Guarrera feels he's still more of an engineer than a chief executive. He'll need both skills during this year, when the institute hopes to consolidate its professional-development activities, including its new, slightly higher profile in Washington.

But he's quick to point out that IEEE's technical activities will continue to be of prime importance. "It's dangerous to ignore the forefront role in technology IEEE enjoys," Guarrera cautions. "If not for the success and reputation of this organization as No. 1 in technology, we could not have accomplished any of our goals," he adds.

One important project that ties together IEEE's role is technology forecasting. By getting an honest evaluation of the future, engineers will have a chance to redirect their careers—to "tune up in areas where they are rusty," he states. "The step-function approach to careers creates a mess in the engineering community," Guarrera points out, in reference to the expansion and contraction of jobs that accompanies changes in technology and the electronics marketplace.

At the same time, the institute this year will emphasize information on product applications to assist members in the day-to-day needs of their present jobs. "Obviously, not all of engineering is state of the art," the president explains.

Among outside projects, Guarrera is strongly pushing a portable pension for engineers, passage of a meaningful congressional bill for research to develop alternate sources of energy, and renewed Government support of research and development—either by direct funding or through tax credits. All three are complex issues that require understanding of both engineering and economics, not to mention insight into political wheeling and dealing.

Guarrera states: "Engineers are used to making judgments only in the areas of their expertise and leaving the economics to others. But we have to get experts to help us separate the real from the baloney on these issues and try to avoid the baloney. We don't want headlines—just results."

Looking at the year ahead, the IEEE president confides, "I like to think I'm involved in making waves, and I'll continue to make waves in this organization when its necessary for the members' needs. In this job, you have to be responsive—responsibly." □


The leaders. "I don't believe in destroying an organization to change it," says IEEE president John Guarrera (left). "The changes we've made have demonstrated the flexibility of IEEE." Donald Fink, IEEE general manager (right), states, "IEEE has shown all other technical societies how much can be done in a short time by changing to career activities successfully without breaking apart."

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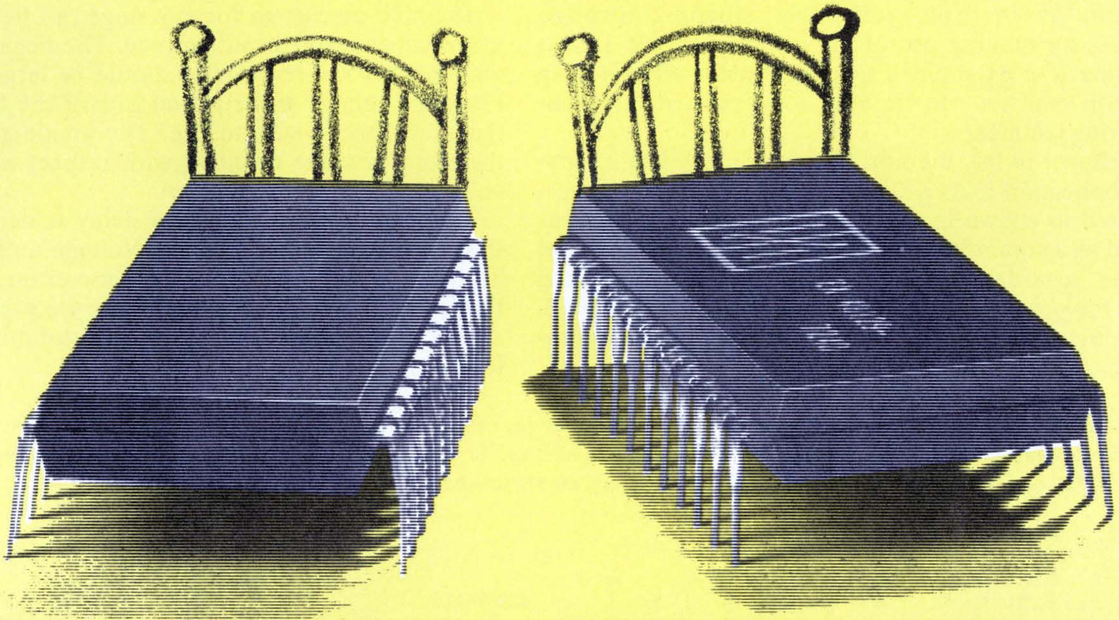

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Transistor array converts to fast-switching thyristors

by H.S. Kothari
Central Electronics Engineering Research Institute, Pilani, India

An ordinary monolithic transistor array can be wired to perform as multiple four-layer silicon-controlled switches by making use of the terminal to the array's substrate. For example, a seven-transistor array having common emitters can be used to implement a seven-stage ring counter.

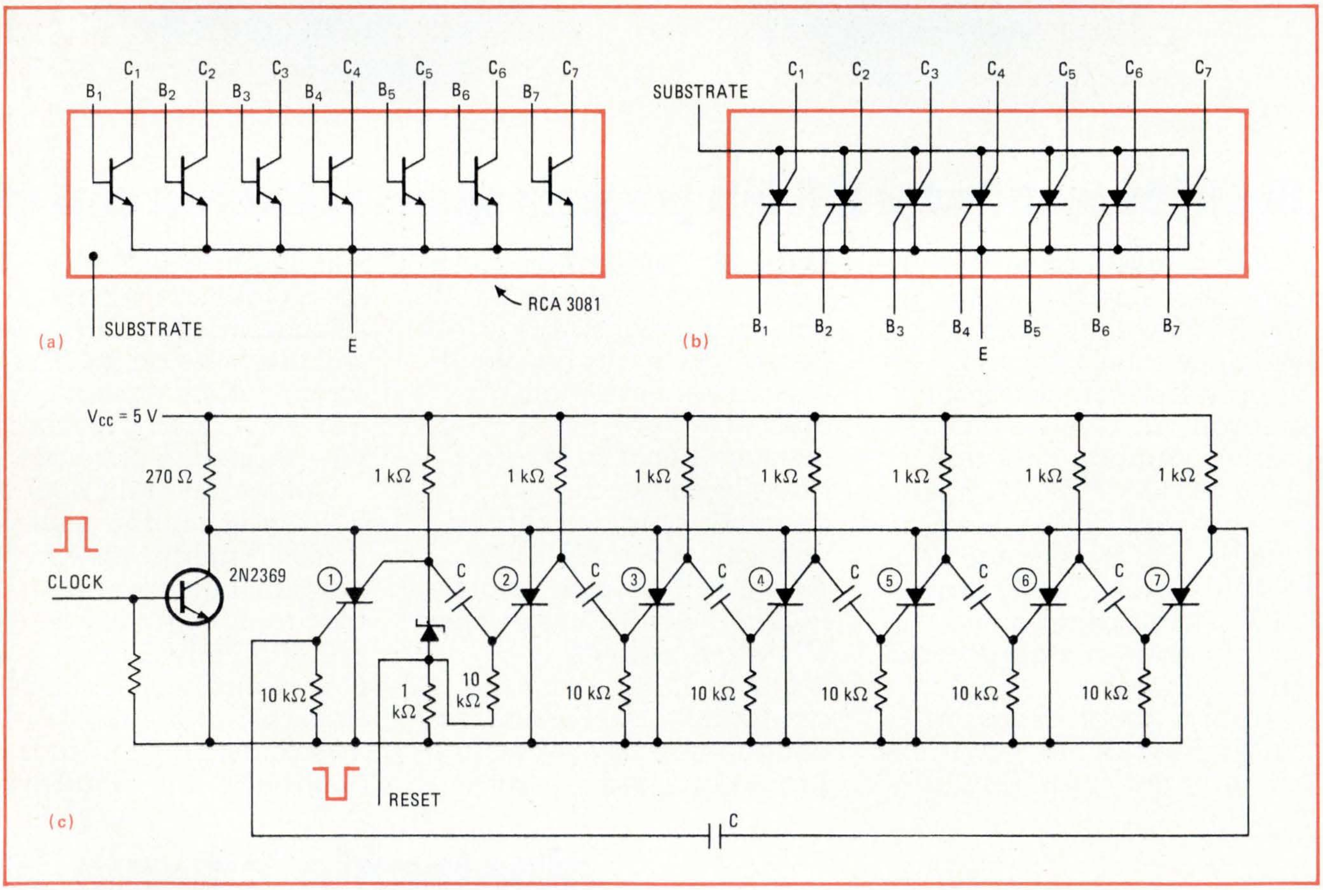
As shown in (a), the npn transistor array has a separate connection to its p-type substrate. The array is easily wired as shown in (b), with the substrate being employed as a common anode to form pnpn structures that can be regarded as silicon-controlled switches. And since the geometry of each transistor is very small, switching times can be on the order of a few nanoseconds.

The schematic of the ring counter is drawn in (c). The first stage is turned on by the trailing edge of the reset pulse. Now, when a clock pulse is applied to the input transistor, the voltage at this transistor's collector drops, and the other counter stages are turned off. In this way, a trigger pulse is transferred from the first stage to the second stage. The next clock pulse causes a trigger pulse to go from the second to the third stage. This process continues and repeats when the seventh counter stage triggers on the first counter stage.

The hold-on current for any stage can be between 50 microamperes and 1 milliampere. The negative voltage amplitude of the reset pulse should be large enough to lower the voltage of the anode gate of the first stage so that this stage is sure to fire. The anode-gate voltage, therefore, is made negative with respect to the anode voltage.

The length of the triggering delay is determined by the capacitance value selected. Voltage amplitudes can be made as large as the collector-emitter breakdown limit of each transistor by increasing the supply voltage, as well as the zener voltage, to some suitable maximum level. □

Wiring transistors as thyristors. Integrated seven-transistor array (a) can be wired as silicon-controlled switches by making use of their common substrate connection. The transistors can then be operated as four-layer devices (b) that have switching times on the order of a few nanoseconds. One application for the pnpn switch array is illustrated in (c)—a seven-stage ring counter.



C-MOS touch-switch array controls analog signals

by Max W. Hauser
Berkeley, Calif.

A few inexpensive complementary-MOS ICs can be used to create a bounceless buttonless touch-switch array. The resulting switching circuit takes advantage of the extremely high input impedance of C-MOS devices to detect the ambient signals (electrostatic charge and power-line hum) present on a person's finger. The circuit's outputs are solid-state switches that are capable of controlling audio or analog signals with negligible distortion and that, in many cases, are compatible with existing circuitry. Light-emitting diodes provide a visual display of the current state of these switches.

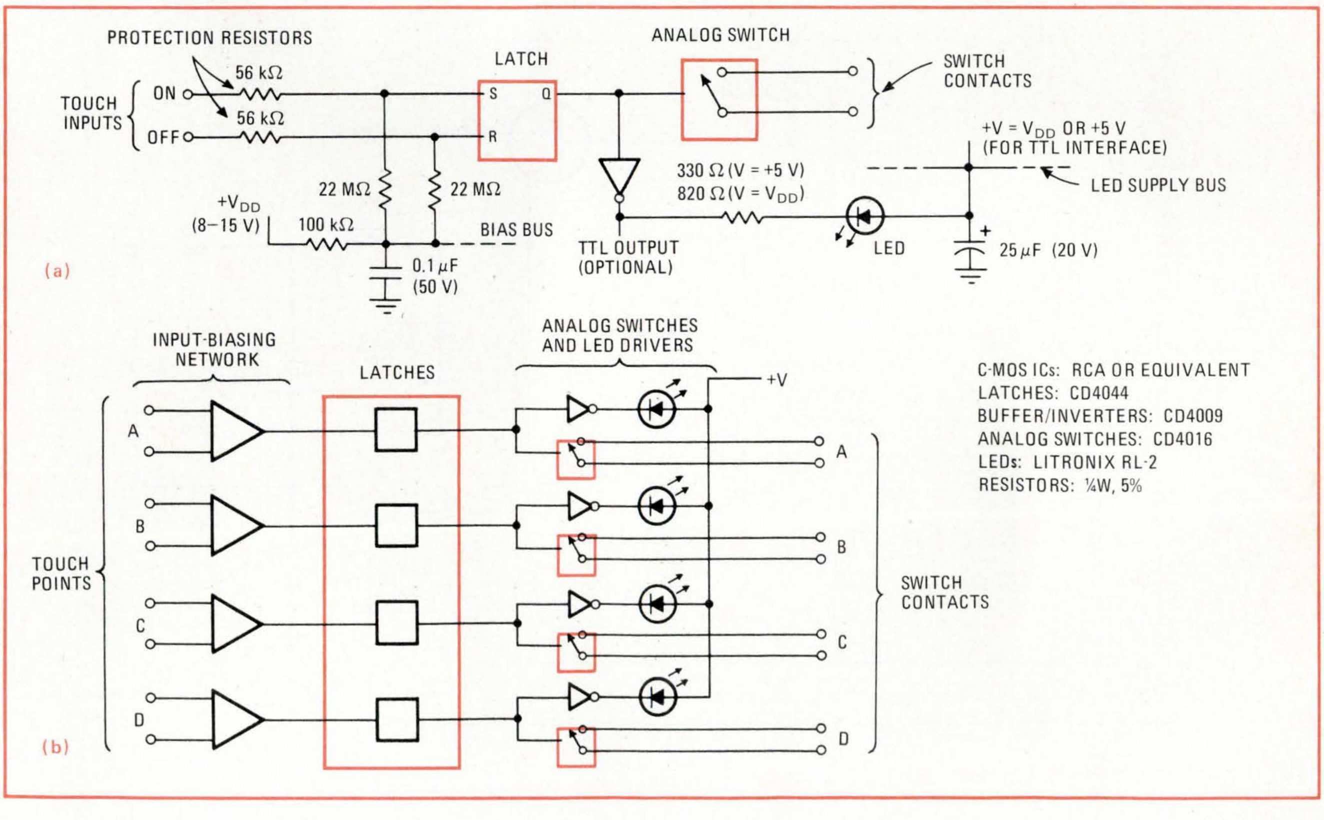
The heart of each touch-switch (a) is a set-reset flip-flop (one-quarter of a quad latch) whose inputs are biased to the V_{DD} supply through 22-megohm resistors. Under normal (resting) conditions, this renders the inputs inactive, and the flip-flop retains its last state. When a finger or large conductive object touches either the on or off input, a noise voltage appears across the bias resistor at that input and is amplified through the regenerative action of the flip-flop. This sets the flip-flop to the desired output state, where it remains until reset by touching the other input.

The flip-flop's output simultaneously controls an analog switch and a buffer/inverter that drives a panel-mounted LED. The output from the buffer can also be used to activate a TTL input, provided that the internal pull-up supply (V_{CC}) is made equal to the TTL power-supply voltage. The 100-kilohm resistor and the 0.1-microfarad capacitor serve to decouple the V_{DD} bias supply so that there is no interaction between the input and display portions of the circuit.

The block diagram (b) shows how a quadruple touch-switch array looks. The touch-sensors should be small metal plates—squares or disks having a side or diameter of 1 to 2 centimeters are best. A substantial increase in plate area results in a proportionate increase in the quiescent hum pickup, and can reduce circuit reliability unless the sensor is mounted very carefully. At the expense of added construction complexity, the LEDs or their mountings can be given a conductive coating, permitting them to serve as the solid-state equivalent of illuminated push-button switches.

Type-CD4016 analog switches work well for noncritical applications, for example, if the circuit is to be used as a source selector for an audio-mixing console. In more critical systems, however, it may be desirable to substitute lower-impedance devices, such as type-CD4066 units. Of course, each flip-flop output can drive many analog switches, and a complex switching arrangement can be created that might be difficult or uneconomical to implement with mechanical devices. Normally closed switching is possible by driving the analog switches with the buffer/inverter outputs, but the cir-

Touch-actuated switching. A simple touch-switch (a) can be built with complementary-MOS ICs. The high input impedance of the C-MOS latch permits the ambient signals of a fingertip to be sensed. The latch's output then controls a C-MOS analog switch, which implements the desired switching function. The LED indicates whether this analog switch is on or off. A quadruple touch-switch array is shown in (b).



cuit's TTL interface must be sacrificed.

In remote locations, where power lines or other major electromagnetic-field sources are not available, it is advisable to install a second contact (at ground potential) on each sensor, so that a slight conduction between the two contacts will assure triggering. Also, to eliminate any chance of damage to the flip-flop inputs from an external power source, the inputs should be protected against excessive current flow with 56-kilohm resistors, as shown. □

Switching regulator produces constant-current output

by Steven E. Summer
Hauppauge, N.Y.

The high efficiency that can be achieved with switching regulators need not be restricted solely to voltage regulators. By taking advantage of the convenience of a monolithic voltage regulator, a free-running constant-current switching regulator having a 1-ampere output can be built for applications like battery charging.

A 723-type IC regulator acts as the circuit's reference and comparator. The IC's 7.15-volt internal reference is scaled to approximately 3 V by the voltage divider formed by resistors R_1 and R_2. These resistors also feed the IC's noninverting input, while resistors R_3 and R_4 drive the IC's inverting input. The lower end of resistor R_4 is connected to shunt resistor R_5, and approximately 1 V appears across this shunt when the IC's comparator terminals are nearly balanced.

A hysteresis voltage of around 28 millivolts is applied to the IC's noninverting input through resistor R_6. This sets the minimum output ripple of the circuit at 28 milliamperes peak to peak. But if the storage time of output transistor Q_1 is significant, the ripple current will be higher.

When the circuit's feedback loop calls for a current increase, the output stage of the IC regulator conducts and a current pulse of 12 mA flows into the V_C terminal. (The size of the current pulse is determined by resistor R_7.) This current pulse drives transistor Q_1.

The zener diode (D_1) is used to bias the output stage of the IC regulator, while the junction diode (D_2) operates as a freewheeling diode. Inductor L_1 and capacitor C_1 filter the switched waveform. The circuit's maximum operating frequency depends on the size of the load and is typically 20 kilohertz. □

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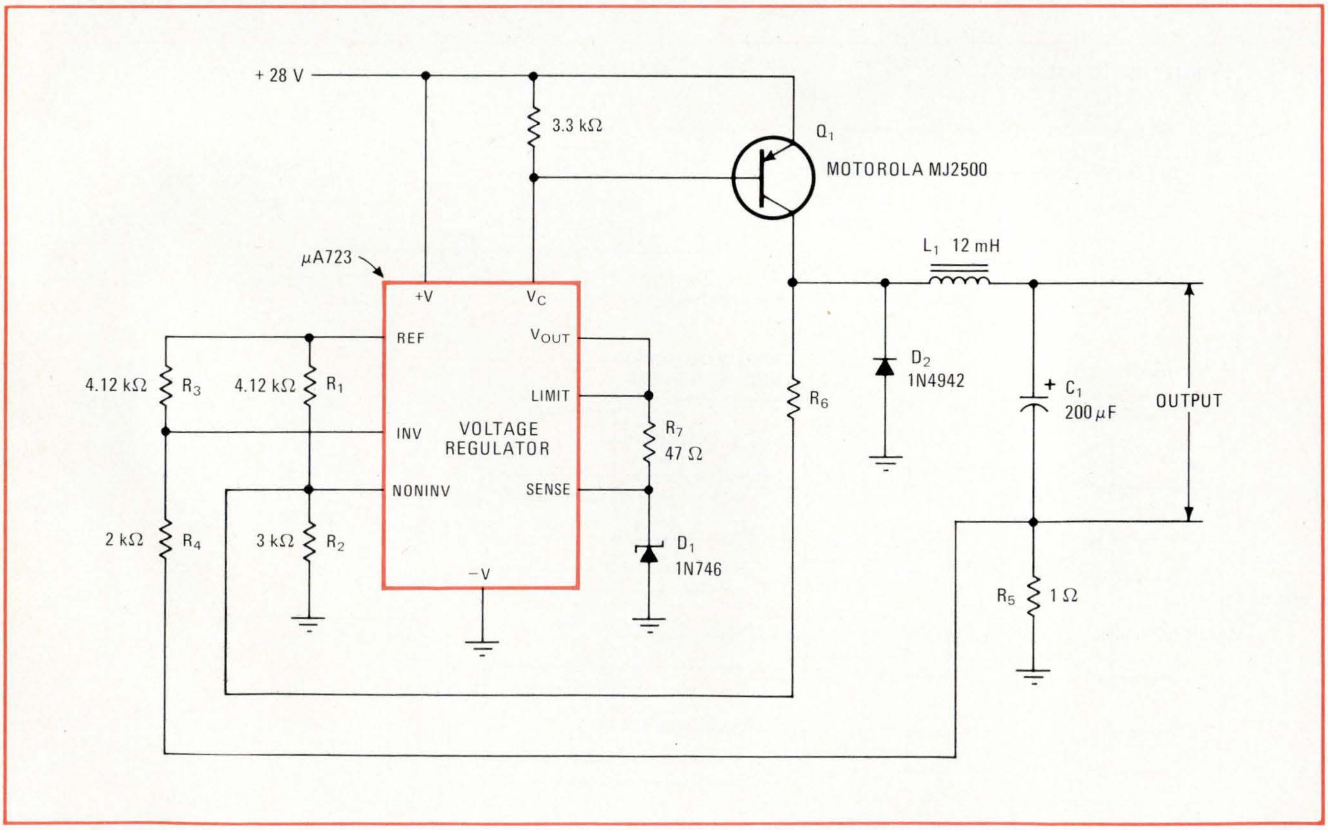
Constant-current source. Switching regulator circuit provides a 1-ampere constant-current output that has a peak-to-peak ripple of 28 milliamperes. The integrated 723-type voltage regulator functions as a reference source and a comparator. Transistor Q_1 is a current booster, while inductor L_1 and capacitor C_1 filter the switched waveform. The circuit's operating frequency can be as high as 20 kilohertz.



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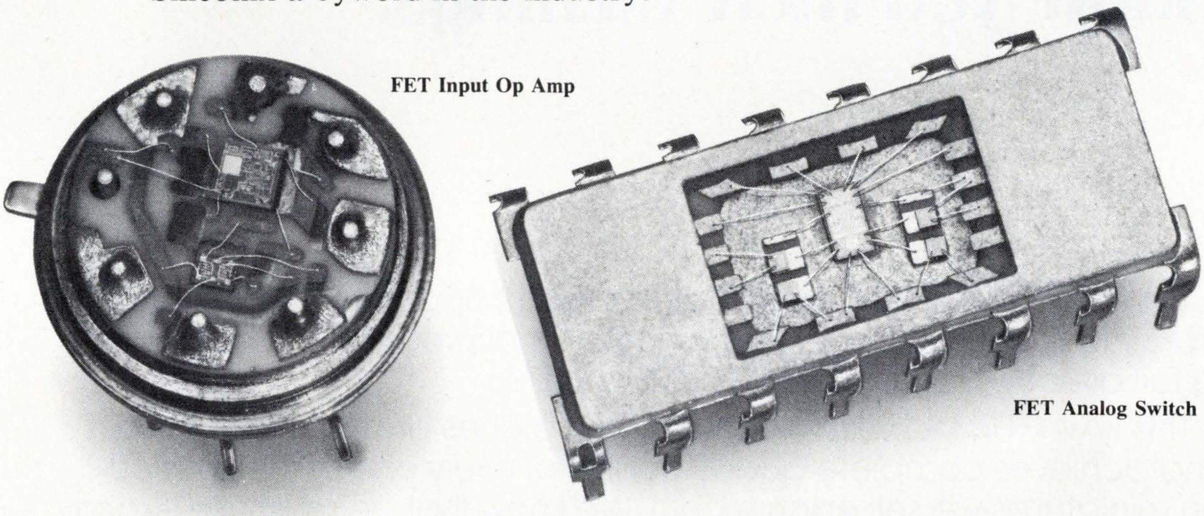

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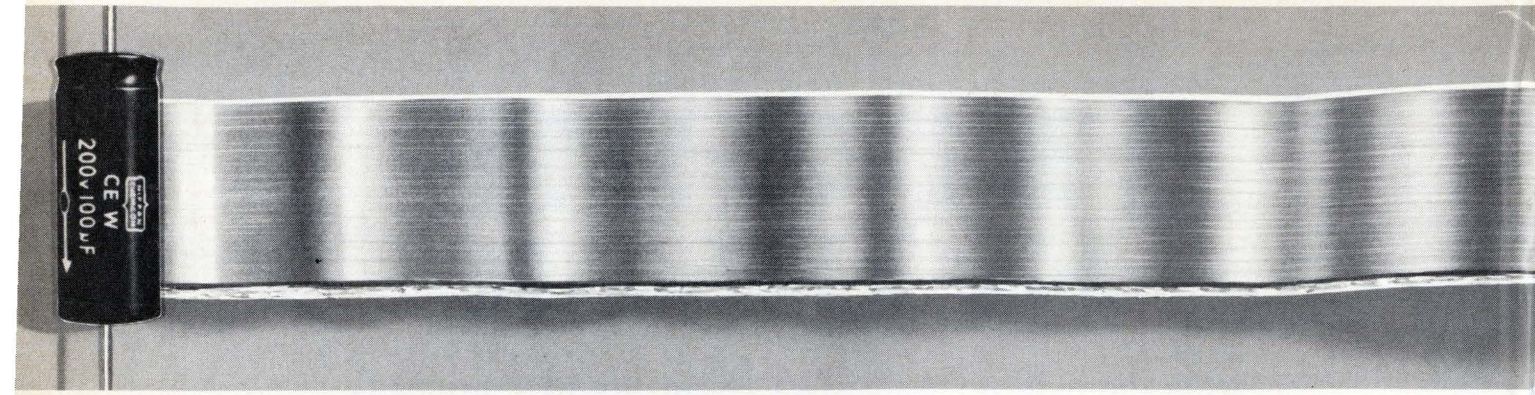

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Simplified n-channel process achieves high performance

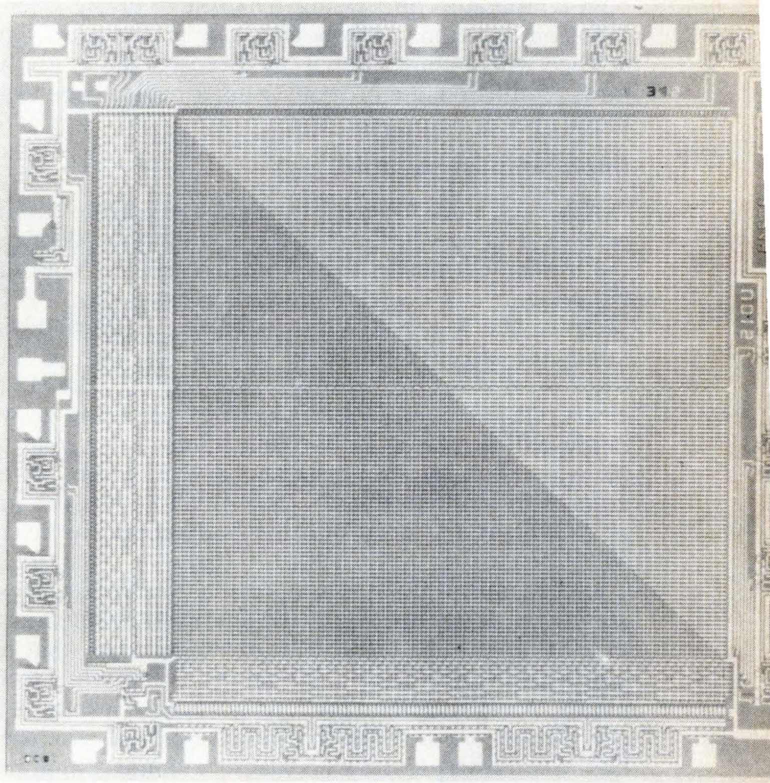
Ion-implanted metal-gate process, cheaper than silicon-gate technology, has the same advantages, operating on +5 volts for TTL compatibility; high-speed static memory has 350-ns access time and draws only 250 mW

by R. J. Huber, K. F. Smith, D. R. Hill, J. N. Fordemwalt, J. W. Hanson, and W. H. Dobelle, *University of Utah*

□ To satisfy demands for a single MOS process that can accommodate today's increasingly complex digital systems, such as medical prostheses and instrumentation systems[1], an ion-implantation n-channel metal-gate process has been developed. It achieves high operational performance in fully TTL-compatible large-scale integrated circuits. The process, which was developed under a contract funded by General Instrument Corp., Hicksville, N.Y., is significantly simpler and cheaper to implement than silicon-gate technology or other published n-channel metal-gate processes. Production economies are achieved by high yields, which are, in turn, attained through a reduction in the number of steps necessary in processing.

Their ability to operate from a single +5-volt power supply enables the new ICs to provide both the memory and processing requirements of the more conventional data-processing and calculator equipment, as well as to provide new microcircuit capabilities for a growing number of telecommunications, industrial, and biomedical systems.

The range of MOS performance has already been extended by these new ICs in memory and processor circuits. A 5,120-bit read-only memory has an access time of 500 nanoseconds and typical power dissipation of only 100 milliwatts. A 1,024-bit (quad 256) static random-access memory, which has a read time of 450 ns and write cycle time of 500 ns, draws a low 250 milliwatts of power when operating and less than 40 mW when standing by. The size of the ROM chip is only 121 by 126 mils, and the RAM chip is 160 by 164 mils. What's more, the process has been used to fabricate a 16,384-bit ROM containing nearly 19,000 transistors (Fig. 1).



1. Big ROM. This 16,384-bit read-only memory, typical of products being built with new n-channel MOS processes, teams ion implantation with metal-gate structures for maximum simplicity.

The process is simple

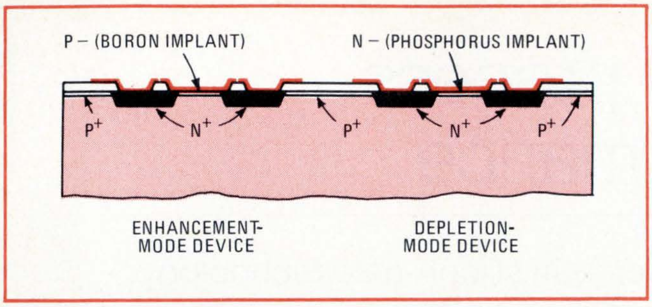
Like all of today's functional n-channel processes, this one uses ion-implantation techniques to do three things: control enhancement thresholds of the n-type gate regions, increase field-inversion voltage for better isolation between devices, and produce depletion-load devices.

But, unlike other ion-implanted n-channel processes, the main objective of this metal-gate process is simplicity. Indeed, this process produces LSI circuits more easily and more cost-effectively than others because of the reduction in the number of critical process steps and the use of conventional oxide masks, rather than polysilicon or silicon-nitride masks.

The process requires only two ion-implantation steps and eliminates the need for silicon nitride and the attendant complex etching procedures. Simple metal gates are used, even though they normally result in larger geometries than silicon gates, but the simplicity of the process offsets this disadvantage.

Getting rid of the silicon-nitride masks was a major boost to yield. True, the use of a silicon-nitride layer to mask against reoxidation is a technique successfully employed in a number of ion-implantation processes[2], but silicon nitride requires specialized equipment for deposition and more complex yield-killing etching techniques.

Finally, arsenic is used as a diffusant to still further



2. Careful control. The depth of implanted ions must be carefully controlled in the channels of both the enhancement- and depletion-mode devices. Oxide thickness is 5,000 Å.

simplify the process. Arsenic-diffused junctions are less mobile than phosphorus junctions during subsequent high-temperature processing. The source of the arsenic diffusion is a commercially available arseno-silica film, applied with a conventional photoresist spinner. But, in mass production, a more conventional sealed-tube technique may be employed.

Importance of controls

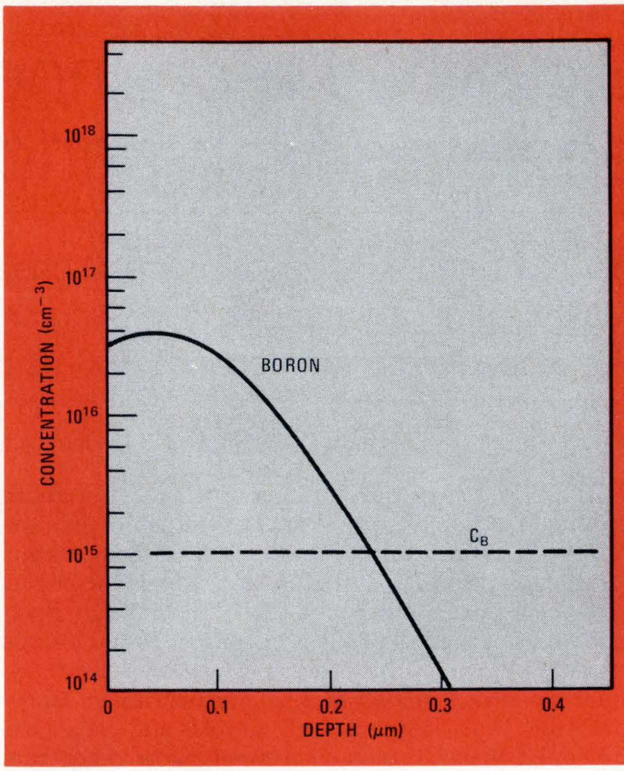
However, some aspects of this process require careful control. The most critical of these is the total depth of the implanted ions in the channel regions of both enhancement- and depletion-mode transistors (Fig. 2). To preserve the low body-effect coefficient (which determines the effective threshold voltage for a given substrate bias) of the high-resistivity starting material (15 to 25 ohm-centimeters), the thickness of the oxide grown in these devices must be carefully controlled. If the oxide is too thick, an insufficient portion of the implanted atoms will reside in the silicon. If it is too thin, the implant will be too deep and the body-effect coefficient will suffer.

Indeed, at this point, it is necessary to control the oxide thickness through which the ions must be implanted to 5,000 angstroms ±50 Å, a degree of accuracy that requires some unconventional process-monitoring techniques. A rapid method for control of this thickness is to compare the color of the interference pattern produced by the wafer in process with that of a standard that has been accurately calibrated.

With this technique, the boron atoms implanted through 5,000 Å of silicon dioxide at about 150 kiloelectronvolts gives an impurity distribution in the silicon shown in Fig. 3. With this distribution and the subsequent minimal heat cycles of the wafer, the body-effect coefficients do not change from those of the starting material.

The usefulness of this ion-implantation process to fabricate low-voltage circuits is confirmed by the electrical characteristics of individual depletion- and enhancement-mode devices:

- Enhancement-mode threshold: $V_{TE_0} = +0.85 \pm 0.3$ V.
- Depletion thresholds, $V_{TD_0} = -2.5 \pm 0.3$ V.
- Field-inversion voltage, V_{TF_0} greater than 30 V (thick-oxide threshold).
- Enhancement-gain factor, $\beta_E = 25$ to $30\ \mu A/V^2$
- Depletion-gain factor, $\beta_D = 35$ to $40\ \mu A/V^2$
- Drain breakdown voltage, BV_{DSS}, approximately 35 V.



3. Preventing changes. This impurity distribution and some minimal heat cycling of the wafers after implantation assure that the body effect of the starting material remains unchanged in processing.

The thresholds of both enhancement- and depletion-mode devices are kept well below 3 V, underlining the low-voltage TTL-compatibility of the process. Moreover, device stability is assured by the large (5 times threshold) field-inversion voltage and the high (35-V) junction-breakdown voltage.

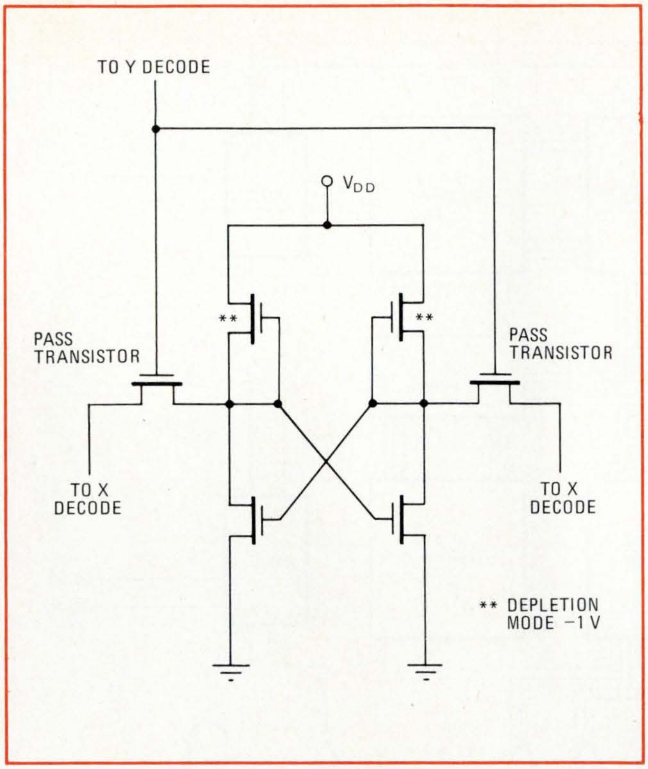
Designing tighter circuits

A key advantage of this n-channel ion-implanted metal-gate approach is that small-geometry devices can be produced in tighter LSI configurations than ever before achieved with metal-gate processes. Arsenic diffusion allows close control of diffusion depths, which, in turn, guards against spreading of the diffusion regions. On the other hand, ion implantation eliminates field-inversion problems so that relatively thin-field oxide can be used.

The RAM and ROM circuits already built clearly show the virtues of this process. The 1,024-bit static RAM fits on a chip measuring 165 by 160 mils (it has a static cell area of only 12.2 mils^2, while the 5,120-bit ROM fits on a chip 121 by 126 mils.

The RAM circuit actually uses three different transistor thresholds, which can be tailored to their most convenient values for low-voltage circuit design. The enhancement-mode threshold of +0.85 V is set by the boron implant, and the depletion threshold of -2.5 V is set up by the phosphorus implant.

If a transistor is given the full dose of both implants, the threshold will be approximately -1 V; thus, all three thresholds are obtained with no increases in processing steps. The -2.5-V depletion and the +0.85-V enhancement transistors are used in the peripheral circuits and



4. Conventional. Although the process is new, the RAM cell is based on the conventional bistable flip-flop. The loads are depletion-mode transistors, and the others are enhancement-mode devices.

the -1-v and the +0.85-v thresholds are used in the memory cells themselves.

A schematic of the static-RAM cell is shown in Fig. 4. Each memory cell is composed of six transistors in a conventional bistable flip-flop. The load transistors are depletion-mode transistors with thresholds of -1 v. The bottom transistors in the flip-flop and the pass transistors are enhancement-mode devices with 0.85-v thresholds. All other depletion-mode transistors in the remainder of the circuit and in the peripheral circuits have thresholds of -2.5 v.

The -1-v threshold in the load transistors of the memory cell results in a better design than a cell that uses enhancement-load devices or depletion devices with -2.5-v thresholds as loads. With enhancement-load devices, V_{CC}, minus some threshold voltage, appears at the gate of the bottom transistors, whereas the depletion-mode transistors used as a load allows the full V_{CC} power-supply voltage to be applied. Thus, the bottom transistors can be smaller for the same current drive when using depletion, rather than enhancement-load devices. However, a -2.5-v depletion transistor, rather than a -1.0-v transistor of the same size used as a load device actually degrades the performance of the cell, since the bottom transistors must sink the transistor-load current, as well as drive the outboard pull-up transistors and the capacitance load. An additional and perhaps more significant advantage of the -1-v threshold over the -2.5-v threshold is the lower power consumption for a given geometry.

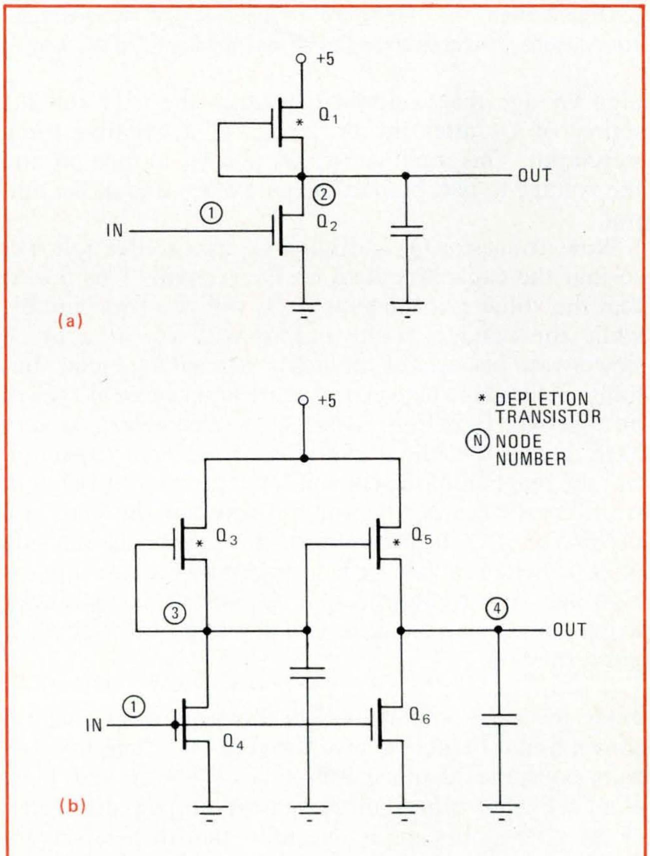
On the other hand, the use of a depletion transistor with a -1-v threshold in the peripheral circuits would make the design extremely difficult because these circuits are designed for high speed, while size and power are of secondary importance. The body-effect reduces the -1-v threshold to nearly zero as the source voltage of the load transistor approaches the potential of the power supply.

These circuits, using only depletion transistors with -1-v thresholds as loads, would be too slow, especially where high-voltage-output drives are required. Moreover, since the power supply is only 5 v, it is absolutely necessary to have drivers in the peripheral circuits that can drive hard to the power supply, a condition suitable for depletion transistors with -2.5-v thresholds. Enhancement-load devices won't work because their outputs can only swing to within a threshold of the power supply, and bootstrapping their voltages requires too much space.

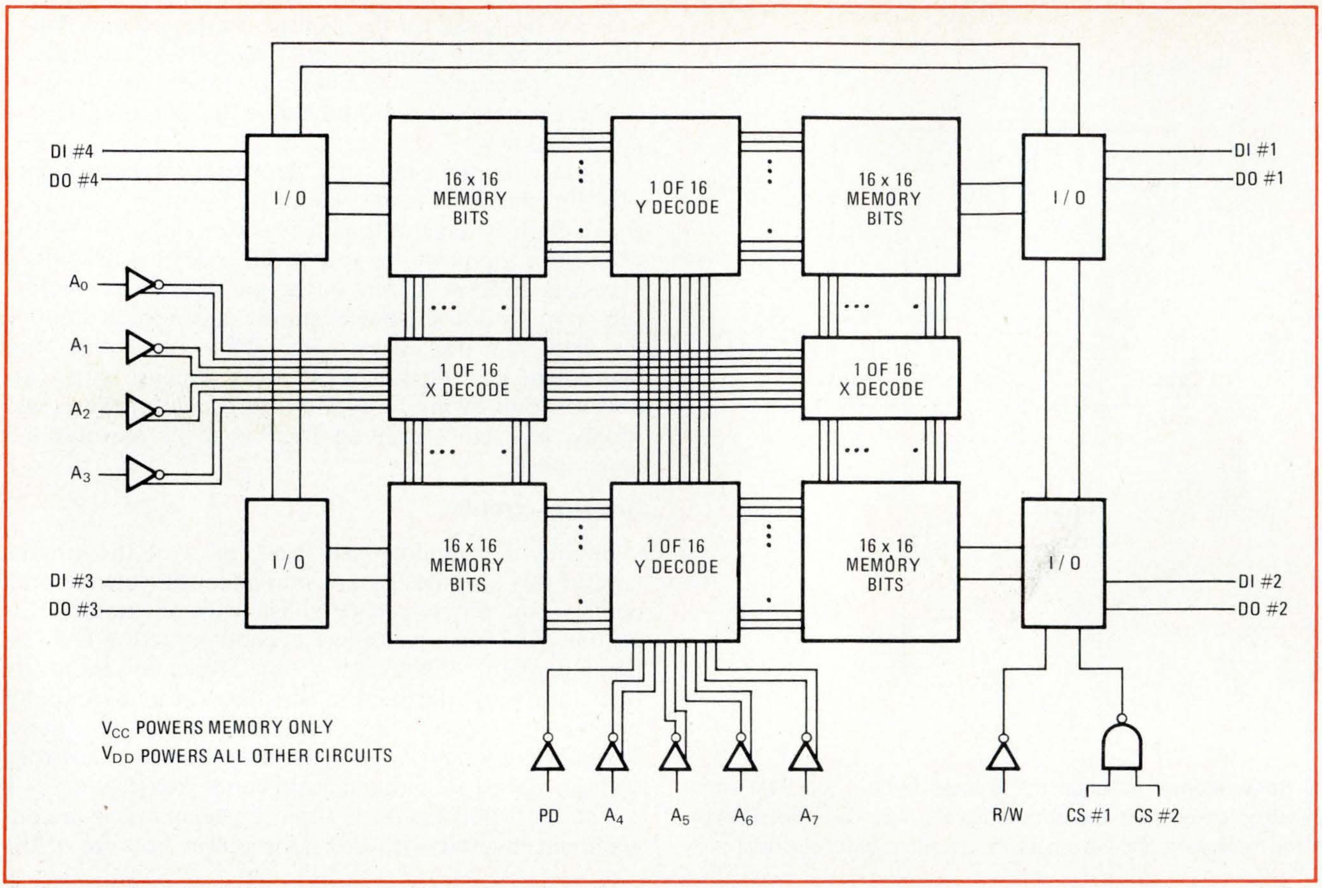
Unusual circuit

Besides the memory cell itself, most of the circuits used in this RAM design are similar to the conventional depletion-mode inverter (Fig. 5a), with one notable exception. The push-pull stage is coupled with a conventional depletion inverter (Fig. 5b). This circuit is used in the address inverters and in the input/output section of the memory where large capacitive loads are driven. Transistors Q_3 and Q_5 are depletion-mode transistors, and Q_4 and Q_6 are enhancement-mode transistors.

The push-pull circuit is three times as fast as a conventional inverter with the same power because of the



5. Similar but different. In the input/output section, the design is similar to that of a conventional depletion-mode inverter (a), except that push-pull stage is coupled by a depletion inverter (b).



6. Organization. The RAM employs altogether eight address lines for decoding a memory segment containing 256 bits. The decoding circuits are designed to be shared by all four quadrants, so that addresses are either read or written into simultaneously.

high voltage that is applied between the gate and the source of Q_5 after the beginning of a negative-going step input. This input causes Q_4 and Q_6 to turn off and the voltage to rise, both at the gate of Q_5 and at the output.

Now, transistor Q_3 is driving Q_5 as a source follower so that the capacitive load on Q_3 is small. This means that the voltage at the gate of Q_5 will rise very rapidly, while the voltage at the output will rise at a much slower rate because of the heavy capacitance load. Initially, the voltage between the gate and source at Q_5 will be approximately V_{CC}; hence, Q_5 will be driven on very hard during the initial charging of the load capacitor. But the reaction of the conventional inverter of Fig. 5(a) is different because the voltage between the gate and the source of Q_1 is always zero. However, since the gate of Q_5 is held at a voltage near ground when the input is high, the dc current flowing in Q_3 and Q_5 is equivalent to the current in a conventional depletion-inverter when it is turned on.

It is interesting to compare the speed of a depletion-mode push-pull circuit used in this RAM design with a conventional depletion inverter (Fig. 5b). The two circuits consume identical amounts of power and have identical input capacitances, but the propagation delay of the push-pull stage is one third that of the conventional inverter, which is 120 ns. These calculations are based on typical parameters for the process being used to build the RAMs.

The block diagram of the entire RAM configuration is shown Fig. 6. The TTL-compatible inputs can accommodate a minimum high voltage of 2.2 V and a maximum low voltage of 0.8 V, while the actual trip point is nominally at 1.5 V, near the center band of the TTL range. Leakage current at any input will be less than $10\mu A$.

Using the RAM

The outputs can drive a single TTL load with a parallel 100-pF capacitor. The output will sink 1.6 mA at 0.4 V and source 0.2 mA at 2.6 V. The required power is typically 100 mW for the memory cells and 150 mW for the peripheral circuitry, which results in the total operating power of 250 mW and a standby rating of 100 mW. A standby rating at 40 mW can be obtained with substrate bias and/or lowering of the cell power-supply voltage.

As shown in the block diagram, eight address lines are provided to decode a 256-bit segment of the memory in each of the four quadrants. These X and Y decoding circuits are shared by all four quadrants. Thus, all four addresses are independently but simultaneously either being read from or being written into.

The circuit has two chip-select inputs, which activate the circuit only if both inputs are low. If either chip-select is high, the chip is not selected. And, since the outputs of the chip have three states, an unselected chip is completely disconnected from the data bus.

A power-down signal, which drives the Y decoders, completely disconnects the memory cells in all four quadrants from the peripheral circuits. In a typical power-down sequence, first a power-down signal is applied, the cells are disconnected when the power-down line goes low, and then all power is removed from the peripheral circuits. The power-down signal can also be tied to the peripheral-power supply, which has the effect of automatically disconnecting the cells.

A problem could develop during the automatic power-down mode by changing the data in a cell already being addressed or in some other cell that may be inadvertently addressed as power goes down. Normally, a memory system provides a signal to anticipate a power-down condition, and this signal can be used to initiate the power-down cycle.

But, since the chip has two power supplies, V_{CC} and V_{DD}, which supply the peripheral circuits and the memory cells, respectively, the power can be maintained on the memory, even though the periphery is not powered.

Although RAMs are normally operated from 5-V TTL supplies, Fig. 7 illustrates an excellent method for connecting the circuit for battery operation in a standby mode. V_{CC} supplies power to the memory cells via diode D_2 and the battery, V_{BB} is trickle-charged via D_1 and R_1, and D_3 is normally off. When V_{CC} goes to ground, D_2 and D_1 turn off, D_3 turns on, and V_{BB} supplies power to the cells. This circuit approach permits data to be stored indefinitely so long as V_{DD} is held to 4 V or more.

The read-only memory (Fig. 8) is organized as a 512-by-10 array. Its entire circuit was designed with only five basic cells, which are repeated as required; hence, it is possible to use the same cells and change the ROM configuration with little change in chip size or appearance. Indeed, a 16,384-bit ROM (Fig. 1) has been fabricated by means of the standard layout techniques. The array is organized 4,096 by 4 bits and has a chip size of 169 by 174 mils.

What's ahead?

For still larger ROMs, a new technique reduces the silicon area required for a transistor so that circuits can be laid out in a much more compact arrangement than ever before. This technique involves elimination of the usual dimensional tolerances along the width of the gate electrode.

The factors that limit minimum device sizes are photolithographic resolution and imperfect mask alignment. The design rules for circuit layout take this into account by providing overlap between layers. Elimination of this overlap would significantly reduce the circuit area, but, in most instances, no misalignment between layers can be tolerated. In fact, if misalignment occurs at metal delineation so that the gate oxide is exposed, transistor performance is impaired because electrical charges can migrate from the gate electrode onto the exposed gate oxide, causing an unwanted channel. This results in a shunt-current path from source to drain when the MOS transistor is turned off.

Since absolute alignment without overlap is impossible, the only previous solution had been to completely cover the gate oxide with gate electrodes that are significantly wider than the gate oxide. Applied to a ROM, this enlargement of the gate electrode can easily double the area required for each storage transistor. However, an additional ion-implant step can inhibit this unwanted channel formation.

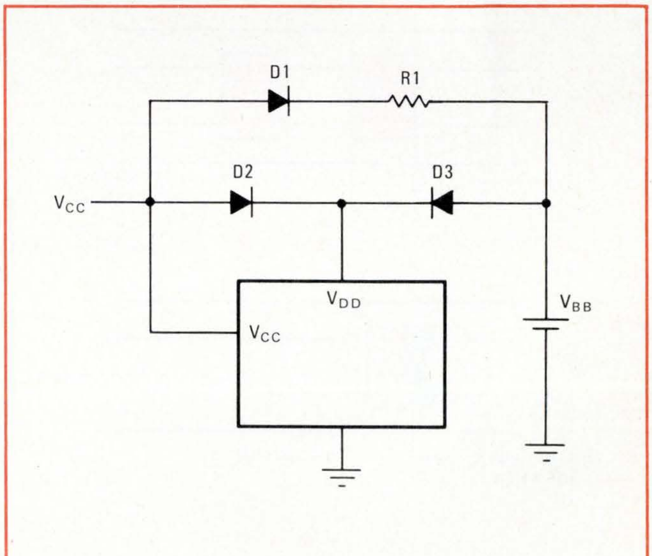
A typical layout of a standard ROM element is shown in Fig. 9(a). In the new ROM layout (Fig. 9b), the gate metal is made the same width as the channel. The exposed gate oxide, which results from the inevitable misalignment of the metal mask, would normally degrade ROM performance.

However, the formation of a conducting channel below the exposed gate oxide is prevented by implanting ions of the same conductivity type as the original substrate. In the n-channel process used for ROM fabrication, a boron implant is used. No additional masking is needed because the metal forms the mask of the implant.

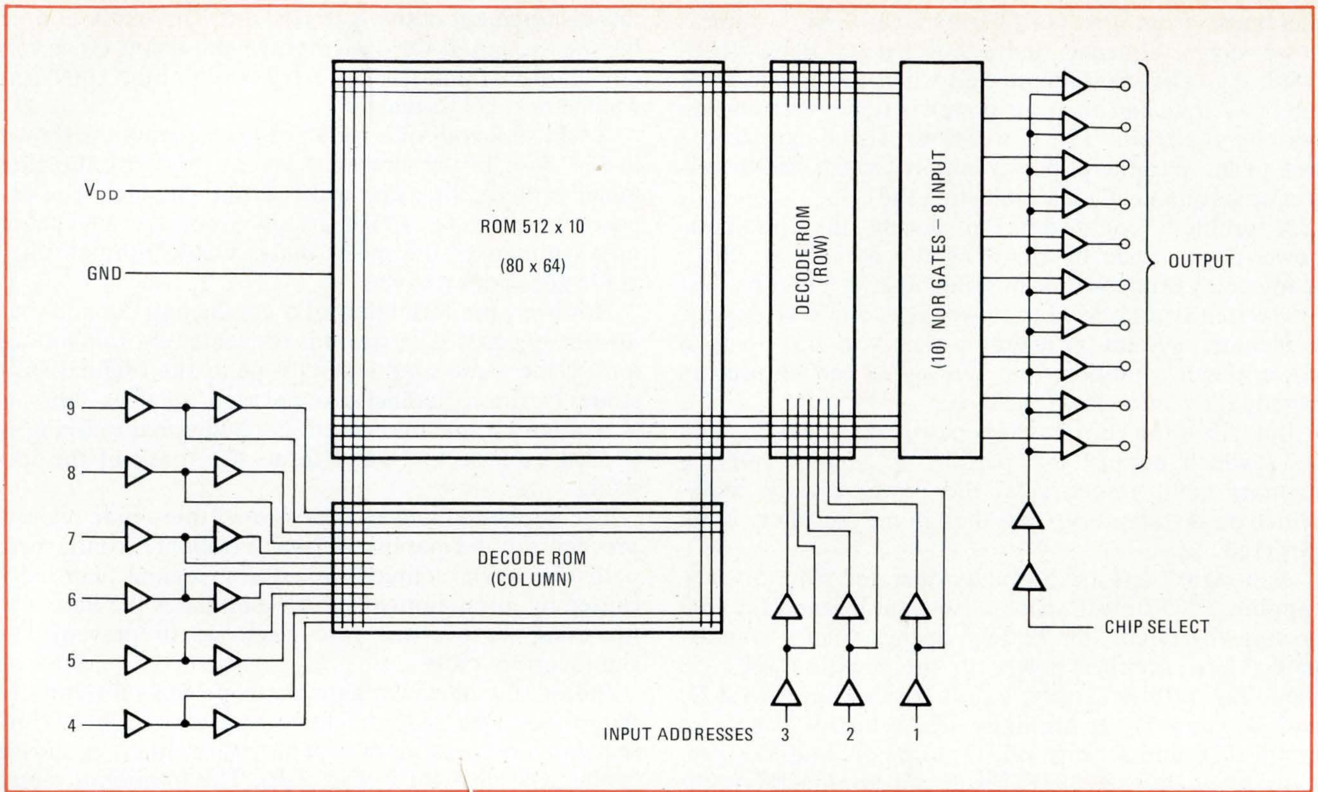
The implanted ions in the exposed thin-oxide regions prevent the formation of uncontrollable conducting paths between source and drain regions normally caused by misalignment, which eliminates the necessity for using an oversize gate electrode to prevent the shunt-current paths.

Indeed, the narrower gate electrode can substantially reduce the area required for a transistor, which, consequently, reduces the size of an entire circuit as shown in the ROM element in Fig. 9(b). The minimum metal width considered practical in processing such a ROM is 0.3 mil. Allowing for misalignment, the active gate width would be 0.2 mil, which is equivalent to the standard drawn device; however, the area required for the minimum-size zero-overlapped device, like the new ROM, is one half that of a minimum-size standard ROM device, even though the two devices are electrically equivalent. Fig. 9(c) shows a misaligned device and the area affected by ion implantation.

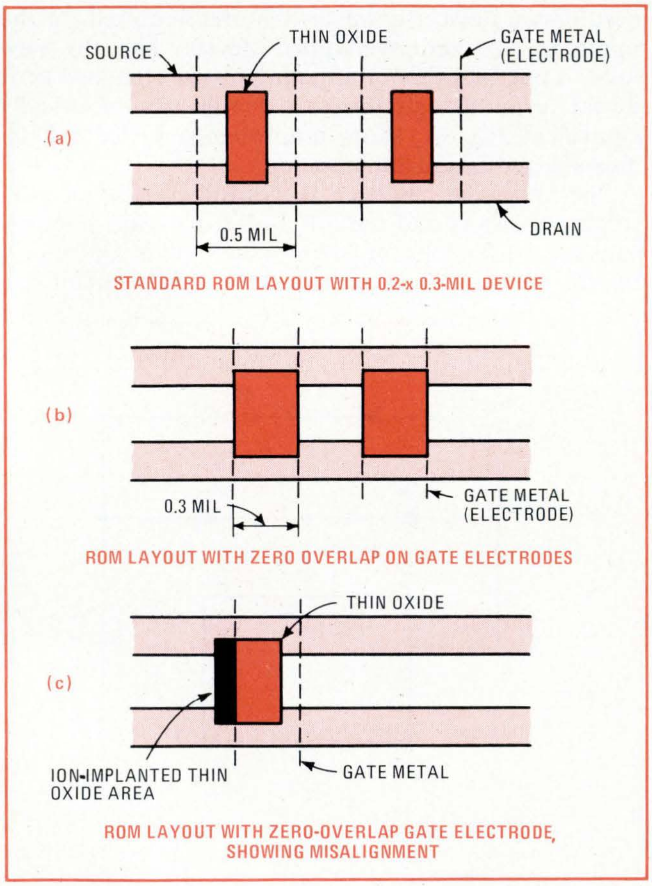
The technique has been successfully tested on both single transistors and the 5,120-bit ROM. And since results are satisfactory for performance, yield, and stability, this technique can considerably reduce circuit size



7. Power-down. For battery operation, V_{CC} powers the cells via D_2, while battery voltage V_{BB} is trickle-charged through D_1 and R_1. D_3 turns on when V_{CC} goes to ground, passing voltage to the cells.



8. ROM layout. The 512-by-10 array, which is constructed around only five basic cell designs, allows various different read-only memories to be configured with little change in chip size or design. The 16,384-bit RAM has same basic layout.



9. Evolution. By using a narrower gate electrode and a boron implant, a ROM cell can be fabricated that is much smaller (b) than a standard cell (a). In (c), a misaligned device is shown.

without sacrificing performance for ROMs as large as to 64 kilobits, and the technique is being investigated for application to other circuit types, as well.

A still simpler n-channel enhancement/depletion-mode process can be designed by using (111)-orientation silicon instead of the usual (100)-oriented material. Here, it's possible to take advantage of the natural surface-state change Q_{SS} of the (111) crystal face to give better depletion-mode load transistors without a phosphorous implant. On high-resistivity material, depletion-mode thresholds of nominally –1-V can be obtained from Q_{SS} alone, so that the need for this second implant is eliminated. An adjustment of the size of the boron-implant dose compensates for the greater Q_{SS} in the enhancement devices.

The principal difference in the electrical characteristics of circuits manufactured by this modified process on (111) silicon is a substantially lower gain factor because of lower charge-carrier mobilities[3]. With a gate oxide 1,200 Å thick, an enhancement-mode gain fact or of $\beta' = 12 \pm 2$ and a depletion-mode gain factor of $\beta' = 22 \pm 2$ are observed. Because the reduced gain factors degrade circuit speed, this technique can only be used in moderate-performance devices. With this in mind, this laboratory has designed and built a simple 8-bit dynamic shift register using the modified-(111) process. This device also operates from a single 5-V power supply and TTL-logic levels at a clock frequency of 5 MHz. □

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Part 5: Shift register

Multiple J-K master/slave flip-flop models duplicate the performance of serial-in/parallel-out 4-bit shift register

By John R. Greenbaum, *General Electric Co., Syracuse, N.Y.*

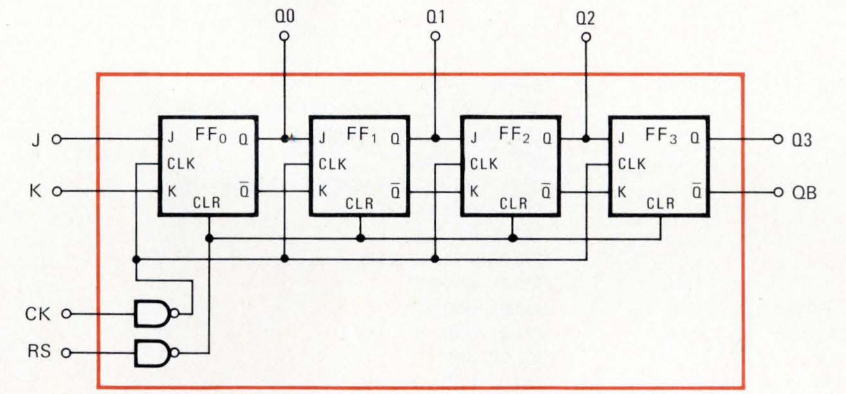
☐ In this series of articles, computer models have been developed for several basic digital-IC functions. Now these basic functions can be combined to realize more complex digital functions or to simulate complete digital circuits.

Such is the case for the type 9780 4-bit shift register, which consists of a bank of four J-K master/slave flip-flops. The J-K flip-flop model described in Part 2 can be used here to simulate the operation of a shift register.

The type 9780 shift register is a serial-in/parallel-out synchronous device. As shown in Fig. 1, it provides a Q output (Q0, Q1, Q2, and Q3) for each of its four stages, as well as a $\bar{Q}$ output (QB) at its last stage. Besides a clock input and J and K inputs, there is an overriding asynchronous master reset input. Data entry is synchronous, with an input change of stage after each low-to-high transition of the clock. The asynchronous master reset overrides all other input conditions and clears the register.

Logic information present on the J and K inputs of

FIG. 1 SHIFT REGISTER DATA



TRUTH TABLE FOR EACH STAGE

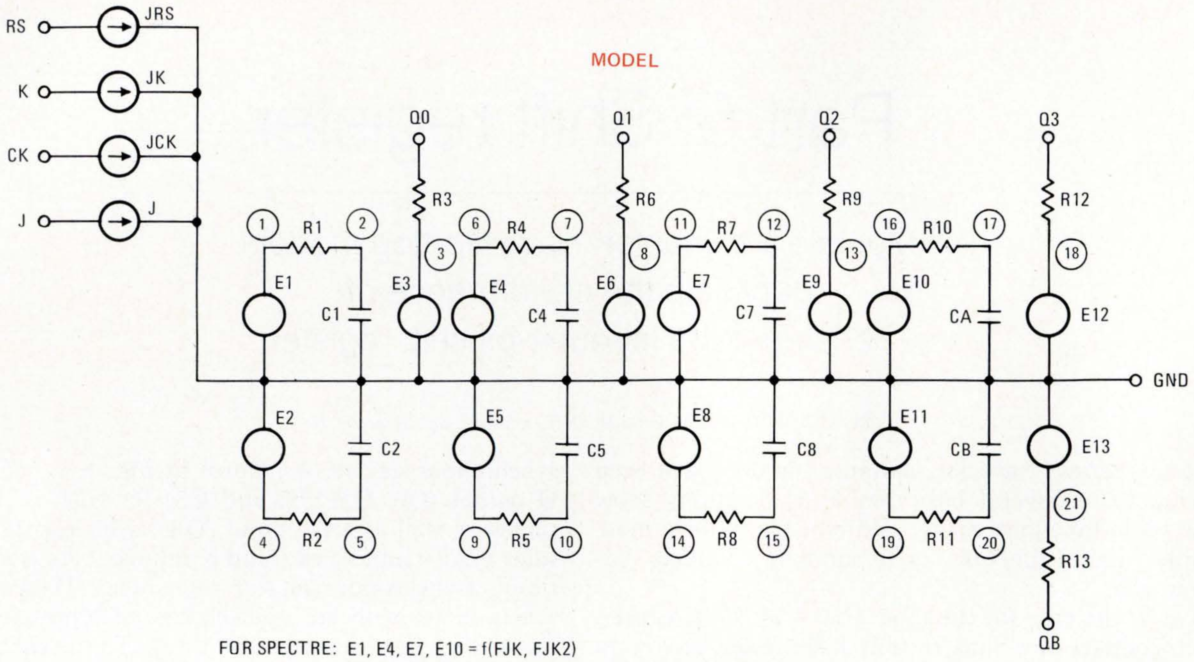
t_n		t_{n+1}	
Input		Output	
J	K	Q	$\bar{Q}$
0	0	Q_{th}	$\bar{Q}_{th}$
0	1	0	1
1	0	1	0
1	1	$\bar{Q}_{th}$	Q_{th}

t_n = bit time before clock pulse
t_{n+1} = bit time after clock pulse

ELECTRICAL CHARACTERISTICS

	Parameter	Conditions	Minimum	Typical	Maximum
V_{OH}	Output high voltage	V_{CC} = 4.5 V, I_{OH} = −1.2 mA	2.40 V	3.0 V	
V_{OL}	Output low voltage	V_{CC} = 5.5 V, I_{OL} = 16 mA		0.25 V	0.40 V
V_{IH}	Input high voltage		1.70 V		
V_{IL}	Input low voltage				0.90 V
I_F	Input load current	V_{CC} = 5.5 V, V_F = 0.4 V		−1.1 mA	−1.6 mA
I_R	Input leakage current	V_{CC} = 5.5 V, V_R = 4.5 V		20 μA	60 μA
I_{PD}	Power-supply current	V_{CC} = 5.0 V		55 mA	80 mA

FIG. 2 MODELING THE SHIFT REGISTER



FOR SPECTRE: E1, E4, E7, E10 = f(FJK, FJK2)
E2, E5, E8, E11 = f(FJK1, FJK3)
C1, C2, C4, C5, C7, C8, CA, CB = f(FCAP1)
E3 = f(VC1), E6 = f(VC4), E9 = f(VC7), E12 = f(VCA), E13 = f(VCB)

FOR CIRCUS-2: V1, V4, V7, V10 = f(FJK, FJK2) V2, V5, V8, V11 = f(FJK1, FJK3)
R1, R2, R4, R5, R7, R8, R10, R11 = f(RR72)
V3 = f(V.C1), V6 = f(V.C4), V9 = f(V.C7), V12 = f(V.CA), V13 = f(V.CB)

SCEPTRE DESCRIPTION

```
MODEL 9780 (RS-CK-J-K-Q0-Q1-Q2-Q3-QB-GND)
4-BIT SHIFT-REGISTER
ELEMENTS
JRS,RS-GND = 0.
JCK,CK-GND = 0.
J, J-GND = 0.
JK,K-GND = 0.
E1,GND-1 = Q1(VC2,P11,VJCK)
R1,1-2 = 100.
C1,2-GND = Q2(E1,VC1,75.E-12,300.E-12)
E2,GND-4 = Q3(VC1,VJRS,P12,VJCK)
R2,4-5 = 100.
C2,5-GND = Q2(E2,VC2,75.E-12,300.E=12)
E3,GND-3 = X1(VC1)
R3,3-Q0 = 100.
E4,GND-6 = Q1(VC5,P21,VJCK)
R4,6-7 = 100.
C4,7-GND = Q2(E4,VC4,75.E-12,300.E-12)
E5,GND-9 = Q3(VC4,VJRS,P22,VJCK)
R5,9-10 = 100.
C5,10-GND = Q2(E5,VC5,75.E-12,300.E-12)
E6,GND-8 = X2(VC4)
R6,8-Q1 = 100.
E7,GND-11 = Q1(VC8,P31,VJCK)
R7,11-12 = 100.
C7,12-GND = Q2(E7,VC7,75.E-12,300.E-12)
E8,GND-14 = Q3(VC7,VJRS,P32,VJCK)
R8,14-15 = 100.
C8,15-GND = Q2(E8,VC8,75.E-12,300.E-12)
E9,GND-13 = X3(VC7)
R9,13-Q2 = 100.
E10,GND-16 = Q1(VCB,P41,VJCK)
R10,16-17 = 100.
CA,17-GND = Q2(E10,VCA,75.E-12,300.E-12)
E11,GND-19 = Q3(VCA,VJRS,P42,VJCK)
R11,19-20 = 100.
CB,20-GND = Q2(E11,VCB,75.E-12,300.E-12)
E12,GND-18 = X4(VCA)
R12,18-Q3 = 100.
E13,GND-21 = X5(VCB)
R13,21-QB = 100.
JQ0,Q0-GND = 0.
JQ1,Q1-GND = 0.
JQ2,Q2-GND = 0.
JQ3,Q3-GND = 0.
JQB,QB-GND = 0.
DEFINED PARAMETERS
P11 = Q4(P12,VJRS,VJ,VC2,VJCK)
P12 = Q5(P11,VJK,VC1,VJCK)
P21 = Q4(P22,VJRS,E3,VC5,VJCK)
P22 = Q5(P21,VC2,VC4,VJCK)
P31 = Q4(P32,VJRS,E6,VC8,VJCK)
P32 = Q5(P31,VC5,VC7,VJCK)
P41 = Q4(P42,VJRS,E9,E13,VJCK)
P42 = Q5(P41,VC8,E12,VJCK)
FUNCTIONS
Q1(A,B,C) = (FJK(A,B,C))
Q2(A,B,C,D) = (FCAP1(A,B,C,D))
Q3(A,B,C,D) = (FJK1(A,B,C,D))
Q4(A,B,C,D,E) = (FJK2(A,B,C,D,E))
Q5(A,B,C,D) = (FJK3(A,B,C,D))
OUTPUTS
VJQ0,VJQ1,VJQ2,VJQ3,VJQB,PLOT
```

FIG. 2 CONTINUED

CIRCUS-2 DESCRIPTION

```
MODELS
MODEL NAME = 4-BIT SHIFT REGISTER
EXTERNAL NODES = (RS,CK,J,K,Q0,Q1,Q2,Q3,QB,GND)
TOPOLOGY
JRS,RS,GND
JCK,CK,GND
J,J,GND
JK,K,GND
V1,1,GND
R1,1,2
C1,2,GND
V2,4,GND
R2,4,5
C2,5,GND
V3,3,GND
R3,3,Q0
V4,6,GND
R4,6,7
C4,7,GND
V5,9,GND
R5,9,10
C5,10,GND
V6,8,GND
R6,8,Q1
V7,11,GND
R7,11,12
C7,12,GND
V8,14,GND
R8,14,15
C8,15,GND
V9,13,GND
R9,13,Q2
V10,16,GND
R10,16,17
CA,17,GND
V11,19,GND
R11,19,20
CB,20,GND
V12,18,GND
R12,18,Q3
V13,21,GND
R13,21,QB
   EQUATIONS
   P11=FJK2(P12,V.JRS,V.J,V.C2,V.JCK)
   P12=FJK3(P11,V.JK,V.C1,V.JCK)
   P21=FJK2(P22,V.JRS,V3,V.C5,V. JCK)
   P22=FJK3(P21,V.C2,V.C4,V.JCK)
   P31=FJK2(P32,V.JRS,V6,V.C8,V.JCK)
   P32=FJK3(P31,V.C5,V.C7,V.JCK)
   P41=FJK2(P42,V.JRS,V9,V13,V.JCK)
   V1=FJK(V.C2,P11,V.JCK)
   D(V1,T)=0.
   R1=RR72(V1,V.C1,75,300)
   V2=FJK1(V.C1,V.JRS,P12,V.JCK)
   D(V2,T)=0.
   R2=RR72(V2,V.C2,75,300)
   V3=V.C1
   D(V3,T)=1.
   V4=FJK(V.C5,P21,V.JCK)
   D(V4,T)=0.
   R4=RR72(V4,V.C4,75,300)
   V5=FJK1(V.C4,V.JRS,P22,V.JCK)
   D(V5,T)=0.
   R5=RR72(V5,V.C5,75,300)
   V6=V.C4
   D(V6,T)=1.
   V7=FJK(V.C8,P31,V.JCK)
   D(V7,T)=0.
   R7=RR72(V7,V.C7,75,300)
   V8=FJK1(V.C7,V.JRS,P32,V.JCK)
   D(V8,T)=0.
   R8=RR72(V8,V.C8,75,300)
   V9=V.C7
   D(V9,T)=1.
   V10=FJK(V.CB,P41,V.JCK)
   D(V10,T)=0.
   R10=RR72(V10,V.CA,75,300)
   V11=FJK1(V.CA,V.JRS,P42,V.JCK)
   D(V11,T)=0.
   R11=RR72(V11,V.CB,75,300)
   V12=V.CA
   D(V12,T)=1.
   V13=V.CB
   D(V13,T)=1.
   RETURN
   END
END OF INPUT
DEVICES
DEVICE NAME = 9780,MODEL NAME = 4-BIT SHIFT REGISTER
SINGLE-VALUED PARAMETERS
JRS = 0, JCK = 0, J = 0, JK = 0,
C1 = 100E-12,C2 = 100E-12,C4 = 100.E-12,
C5 = 100E-12,C7 = 100E-12,C8 = 100E-12,
CA = 100E- 12,CB=100E-12,
R1 = 100,R2 = 100,R3 = 100,R4 = 100,
R5 = 100,R6 = 100,R7 = 100,R8 = 100,
R9 = 100,R10 = 100,R11 = 100,R12 = 100, R13 = 100
END OF INPUT
```

any stage, plus information fed back from that stage's Q and $\bar{Q}$ outputs, sets the master section of that flip-flop. When the clock input is logic 1, the master section of a given stage is isolated from the slave section. As soon as the clock pulse falls to the clock-threshold level (approximately 0.8 volt), the data on the J and K inputs is entered into the master section.

When the clock is logic 0, the master section is again isolated from the slave section. As the clock pulse begins to rise, the master section is disabled, and, as soon as the clock pulse reaches the threshold level, the logic information at the output of the master section is transferred to the slave section, which controls the flip-flop's output.

If the data on the J and K inputs of each stage remains stable while the clock is logic 0, that stage's output will correspond to the truth table shown in Fig. 1 when the clock makes a low-to-high transition. This truth table is for a single stage and applies when the reset signal is logic 0. The electrical characteristics for the entire shift register are also shown in Fig. 1.

The computer model for the type 9780 shift register is drawn in Fig. 2, which also shows the program listings that describe the model. There are two model descriptions—one for the Sceptre (System for Circuit Evaluation and Prediction of Transient Radiation Effects) analysis program, and the other for the Circus-2 (CIRCUit Simulator) analysis program. The model subprograms shown in the figure, which are applicable to both model descriptions, establish the shift register's output-signal levels and delay characteristics.

Doing the simulation

The model's signal-input impedances (J, JK, JRS, and JCK) are represented as zero-valued current sources, implying that the impedance of the register's input-signal terminals is infinite. This is a reasonable first-order approximation, although the inputs of an actual type 9780 device do have measurable varying impedance values that depend on the applied signal level. For greater accuracy in the analysis, the current sources can be modeled as tables of functions of current vs applied voltage.

Each section of the shift register can be considered as an independent flip-flop whenever the correct input signals are applied to any particular stage. The inputs to

FIG. 2 CONTINUED

MODEL SUBPROGRAMS

```
CFFJK              FOR USE WITH SHIFT-REGISTER
          FUNCTION FJK(A,B,C)
C
C         REGISTER TO TRIGGER ON POSITIVE CLOCK SLOPE
C         REGISTER TO RESET FOR HIGH AT RS INPUT
          N1=1
          IF(A.GE.1.5.AND.B.GE.1.5) N1=2
          N2=1
          IF(A.GE.1.5.AND.C.LE.2.0) N2=2
        1 FJK=0.1
          IF(N1.EQ.1.AND.N2.EQ.1) FJK=3.0
          RETURN
          END
```

```
CFJK1              FOR USE WITH SHIFT-REGISTER
          FUNCTION FJK1(A,B,C,D)
          N1=1
          IF(A.GE.1.5.AND.B.LE.1.5.AND.C.GE.1.5) N1=2
          N2=1
          IF(A.GE.1.5.AND.D.LE.2.0.AND.B.LE.1.5) N2=2
          FJK1=0.1
          IF(N1.EQ.1.AND.N2.EQ.1) FJK=3.0
          RETURN
          END
```

```
CFJK2              FOR USE WITH SHIFT-REGISTER
          FUNCTION FJK2(A,B,C,D,E)
          N1=1
          IF(C.GE.1.5.AND.D.GE.1.5.AND.E.LE.0.8) N1=2
          N2=1
          IF(A.GE.1.5.AND.B.LE.1.5) N2=2
          FJK2=0.1
          IF(N1.EQ.1.AND.N2.EQ.1) FJK2=3.0
          RETURN
          END
```

```
CFJK3              FOR USE WITH SHIFT-REGISTER
          FUNCTION FJK3(A,B,C,D)
          N1=1
          IF(A.GE.1.5) N1=2
          N2=1
          IF(B.GE.1.5.AND.C.GE.1.5.AND.D.LE.0.8) N2=2
          FJK3=0.1
          IF(N1.EQ.1.AND.N2.EQ.1) FJK3=3.0
          RETURN
          END
```

```
CFCAP1             DIGITAL-IC CAPACITOR-SELECT
          FUNCTION FCAP1(A,B,C,D)
C FCAP1   TO ESTABLISH CAPACITOR VALUE OF DIGITAL IC
          FCAP1 = C
          IF(A.GE.B) FCAP1 = D
          RETURN
          END
```

the first stage are the signals on the J, K, CK, and RS terminals, while the inputs to the subsequent stages are the same CK and RS signals, but the J and K signals are the Q and $\bar{Q}$ outputs from the preceding stage.

Examining the model

Since every stage uses the same functions to generate its output signals, only the operation of the first stage needs to be examined. For the first flip-flop, then, the voltage levels associated with dependent voltage sources E1 and E2 are determined by subprogram functions FJK, FJK1, FJK2, and FJK3. These functions are interrelated to simulate the master and slave sections of the flip-flop.

Output signals from the master section are stored as DEFINED PARAMETERS to simplify the simulation because a number of flip-flops are being interconnected. DEFINED PARAMETERS P11 and P12 are determined by functions FJK2 and FJK3, respectively. These two functions determine the outputs of the master section, while functions FJK and FJK1 establish the outputs of the slave section, which are E1 and E2, respectively. Signals that are greater than or equal to 1.5 V are defined as logic 1, and signals that are less than 1.5 V are defined as logic 0.

Because the switching-delay times for a negative-going (t_{pd0}) transition and a positive-going (t_{pd1}) transition differ, two time constants are needed to establish the time delays for each stage. For the first flip-flop, time constants R1-C1 and R2-C2 are adjusted to get the right delay.

If the Sceptre analysis program is used, the time constants are adjusted by varying the capacitor values by means of subprogram FCAP1. The value of capacitance chosen depends on whether the flip-flop's output is logic 0 or logic 1. Capacitor C1, for instance, is set equal to 300 picofarads when voltage E1 is greater than or equal to capacitor voltage (VC1). If E1 is less than VC1, capacitor C1 becomes 75 pF. The value of capacitor C2 is established in a similar manner for the first flip-flop.

If the Circus-2 analysis program is used instead, the model's delay characteristics are adjusted by changing the resistor values, rather than the capacitor values. Subprogram RR72 does this, establishing the correct resistor value for a logic 0 or logic 1 signal at a stage's output.

The output voltage (E3, E6, E9, E12, or E13) of each stage is a function of capacitor voltage (VCL, VC4, VC7, VCA, or VCB, respectively), which is, in turn, related to input-signal conditions. This means that relationships are readily established between all input and output voltages.

The output impedance (R3, R6, R9, R12, or R13) of every stage is set equal to 100 ohms as a reasonable approximation of the register's output signal level. To simulate the output-impedance variations of an actual type 9780 device, the output resistors can be expressed as functions of the load voltages and load currents. □

This article concludes a five-part series on simplified, but accurate, computer models for common digital ICs. The models are based on device terminal behavior, instead of the classical method of modeling each transistor and diode junction in the IC. The NAND gate was covered in Part 1 in the Dec. 6 issue, the flip-flop in Part 2 in the Dec. 20 issue, the monostable multivibrator in Part 3 in the Jan. 24 issue, and the AND-OR-INVERT gate in Part 4 in the Feb. 7 issue.

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Pinch load resistors shrink bipolar memory cells

Simple flip-flop memory cell, for which narrow p channels provide high resistances, occupies as little as 9 mil² of chip surface, dissipates only microwatts of power, is basic to 1,024-bit RAMs in IBM 370 systems

by S. K. Wiedmann,
IBM Deutschland GmbH, Boeblingen, Germany

□ The 10- to 50-nanosecond access times of bipolar chips used to have little appeal to memory designers because those high speeds came along with low packing densities, high power dissipation, and high costs. At the time this cell was conceived, the high-impedance loads that would minimize power dissipation were not being realized in a small area. Space was also wasted by the need to isolate all active elements from each other, so as few active elements as possible seemed desirable.

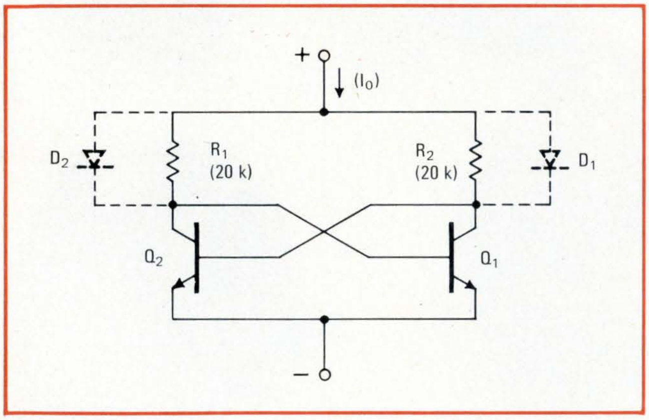
Advances in technology, however, made it practical to put pinch load resistors on a chip. This kind of resistor exploits the fact that a very narrow conducting channel has a high resistance. By merging two of these resistors with just two npn transistors,[1,2] it has proven possible and economical to produce a very small flip-flop storage cell that dissipates little power.

The silicon area of the complete memory cell is only slightly larger than the area of two normal npn transistors—about 9 mil² in the final product. The cell dc standby power is approximately 20 microwatts. These characteristics explain why the cell is the basic building block of the 1,024-bit random-access-memory chips used in IBM's Systems 370/145 and 370/135.[3]

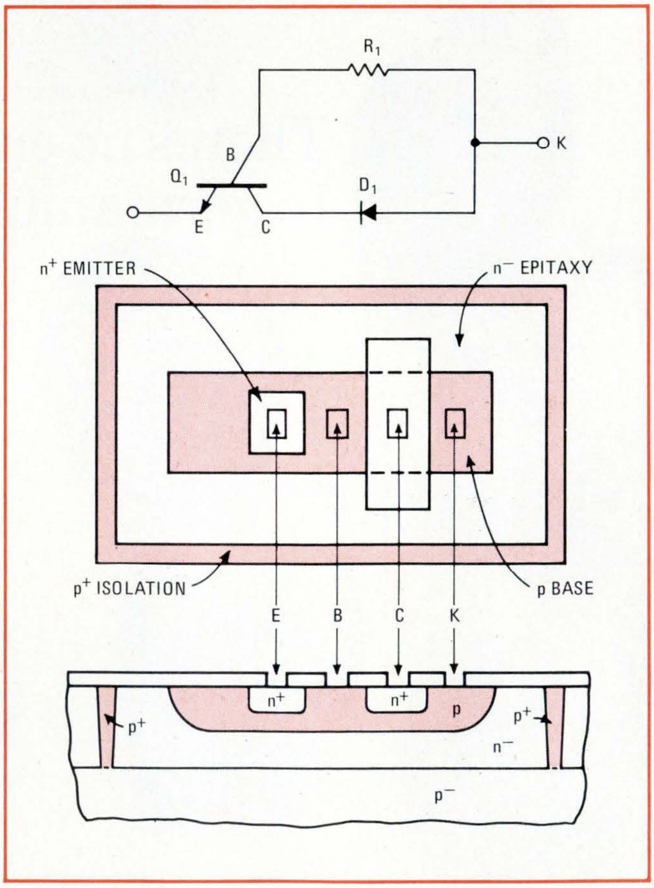
Basic cell design

The basic flip-flop circuit is very simple. It consists of directly cross-coupled npn transistors Q_1 and Q_2, ohmic load resistors R_1 and R_2, and parallel diodes D_2 and D_1 (Fig. 1). However, the sheet resistance of conventional diffused p-type resistors is only 150 to 300 ohms per square, and realizing large resistance values with this technology would make this memory cell unattractively large even though it would keep power dissipation attractively low.

The way out of this dilemma is to turn the shallow p base channel region of the vertical npn transistor into a pinch resistor. Since the resistance is inversely proportional to the thickness of the conducting channel, resis-



1. High tolerance. Flip-flop circuit basic to the memory cell has an output voltage that is highly insensitive to wide variations in resistor values, input supply current, and transistor saturation. Pinch load resistors provide high resistivity in small area. Broken lines indicate that diodes double as part of the npn transistors.



2. Twin halves. Each half of the circuit in Fig. 1 has an identical layout. Narrow path through p base from contact K to transistor base B forms the pinch load resistor, while diode is simply the pn junction between K and collector C. Not shown here are Schottky diode clamps and collector buried layers used in the actual memory.

tivities of 5 to 10 kilohms square can be achieved—30 times higher than standard diffused resistors.

The absolute resistance tolerances are fairly large but, fortunately, the voltage/current characteristic at the flip-flop terminals is relatively unaffected by large tolerances of the load resistors. Deep transistor saturation is avoided, even when Schottky diode clamps are not used at the base-collector junctions. This prevents the parasitic effects of stored base charge, caused by carrier injection into the forward-biased base-collector junction, from occurring and slowing down circuit speed.

The parallel diodes require no separate diffusion step but are identical with the pn junction between the contact for current source, I_o, and each transistor's collector. Since the diodes limit the voltage drop across the collector resistor of the on transistor, the voltage across the flip-flop supply terminals does not change much within a fairly large range of the supply current I_o. The supply current can therefore be readily increased from a small standby value to a larger value, so that pulse powered operation can be used to reduce average power dissipation still further.

Finally, more space can be saved if current can be supplied to the cell through a series resistor common to many other cells. At small cell currents, the voltage drop across the transistor base and a series resistance is relatively small, and the voltage across the cell is mainly given by the V_{BE} of the on transistor. Consequently, the voltage tracking of two adjacent cells is comparable with the V_{BE} tracking of two transistors, and good current sharing can be obtained with a common series resistor. Deviation from a nominal cell current of less than 100 microamperes is less than 10%.

Isolation at a minimum

Two isolation pockets are enough to accommodate the circuit in Fig. 1. That circuit can be split into two identical halves, one of which is shown at the top of Fig. 2. The rest of Fig. 2 explains how the elements of a half-circuit are accommodated within a single pocket of n^- epitaxy surrounded by p^+ isolation walls. The n^- epitaxy itself serves as the collector of transistor Q_1 (a low ohmic buried-layer resistance, which reduces the collector resistance, is not shown for the sake of simplicity). Within the n^- epitaxy is a homogeneous p-base diffusion partly covered by two n^+- type diffusions. The smaller n^+ area is transistor Q_1's emitter. The larger n^+ diffusion, which overlaps the p base, implements the pinch resistor R_1 between contact Q and base contact B.

The beauty of this cell structure lies in the fact that a single diffusion serves more than one circuit function. Thus the n^+ diffusion of the pinch resistor may be utilized for contacting the collector C. Also, diode D_1 between contact K and collector C is inherent in the pn junction formed by the p diffusion region contacted at K and the n^- epitaxy of the collector. Finally, Schottky-diode base-collector-junction clamps may be implemented simply by opening up the base contact B until it extends over the n^- epitaxial region.

Figure 3 shows how the two half-circuits are interconnected to form a complete flip-flop. As a result, the

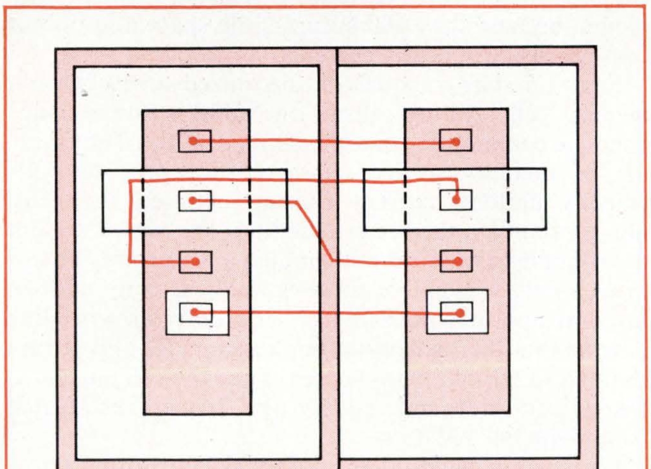
From cell to main memory

Structure of the memory used in the IBM 370/145 and 135 and based on the pinch-load-resistor memory cell will be described at the IEEE Intercon 74 by John Gersbach.

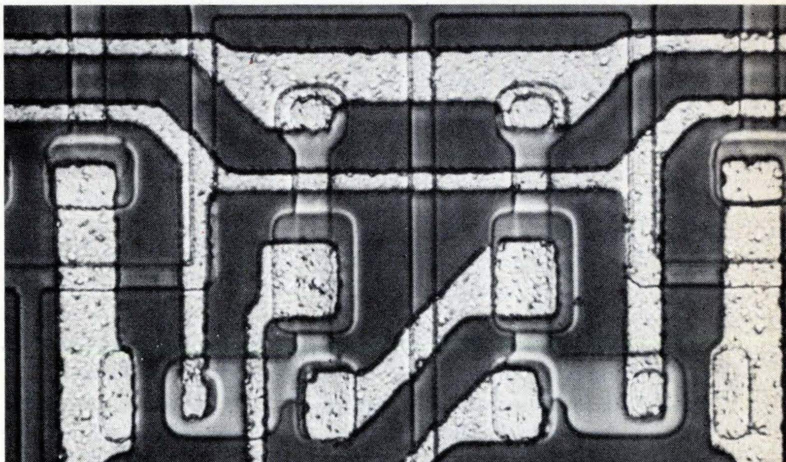
Each RAM chip has double-layer metalization and Schottky-diode base-collector gating. It packs 1,024 cells, organized as 32 words of 32 bits, into 117 by 149 mils.

In his article, Gersbach states that the chip dissipates 58 milliwatts in standby, 425 mW when selected. A stable 300-millivolt offset voltage is obtained by having a nominal cell standby current of 20 microamperes flowing through the 15-kilohm loads. Logic level inputs are typical ECL levels of ±400 mV.

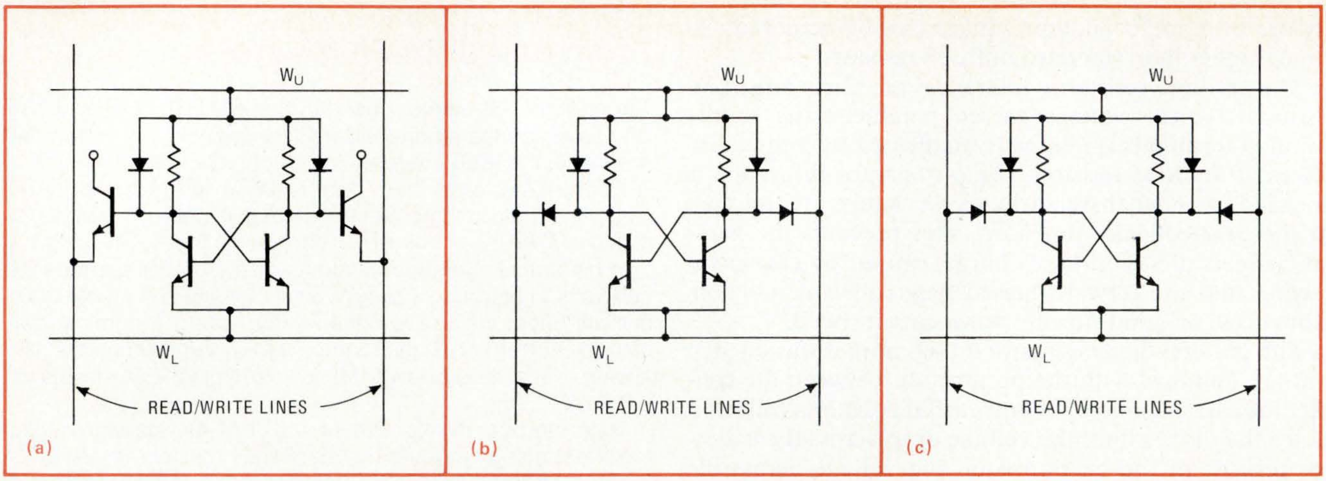
Main storage makes use of the IBM 4K standard solid logic technology module that packages four chips into a ½-in.-by-½-in. module. Chip selection within a large matrix of modules is facilitated by having row and column selects arranged in a two-by-two matrix. All other chip inputs and outputs are common. Typical cycle time is 50 ns.—Joel DuBow



3. Paired halves. The half cell of Fig. 2 is interconnected with an identical second section to realize a complete memory cell, which occupies little more area than two individual transistors.



4. Realization. Actual cell built with 3-micrometer epitaxy, 5-micrometer metal line widths, and single-layer metalization measures only 12 mil². Double-layer metalization improves that to 9 mil².



5. Making contact. To address cell, current can be fed into cell nodes (a, b) or taken out of them (c). The addition of Schottky diode clamps aids this process in all three cell versions but is essential only in (b). In (a), information may be transferred either via the collector or via the emitter path of the coupling transistor. Best tradeoff between read/write performance, cell area, and cell stability is given by (c).

whole device occupies little more space than two ordinary transistors would.

The photomicrograph in Fig. 4 displays an actual cell, which uses 5-micrometer line widths and a 3-μm epitaxy and occupies 12 mil^2 with single-layer metalization. With double-layer metalization, the cell as used in the final product occupies 9 mil^2.

Coupling options

To turn the flip-flop into a full memory cell, it must be coupled to data lines.[4]

There are two different ways of transferring data between storage cell and read/write data lines. For both reading and writing, currents can be either pulled out of the cell nodes (Fig. 5a and b) or fed into them (Fig. 5c). Of course, a combination of these two operating modes is also possible to optimize read and write performance at the expense of some circuit complexity—and some waste of space.

In each cell type shown in Fig. 5, however, the coupling elements can be realized in the n-type regions of the npn transistors, thus requiring only little silicon area. Note, too, that any of the cells may employ Schottky diode clamps at the input to the cross-coupled transistors. These clamps have several advantages:

- The cell switches faster, since less charge is stored at the flip-flop nodes.
- The address line drivers operate at a smaller voltage swing so that less power is needed/dissipated and speed is higher.
- The cell nodes are less sensitive to leakage, since the current reaching the base terminal of the on transistor is higher.

The transistor-coupled cell of Fig. 5a can be addressed in at least two ways, depending on whether the cell information is transferred via the collector or via the emitter of the coupling transistors. The first method has the disadvantage of requiring two additional area-consuming isolation pockets.[5]

In the second approach, on the other hand, the collector of the coupling transistor may be tied to the collector of the opposite flip-flop transistor, requiring only a second emitter to be added to the flip-flop transistor to implement the coupling transistors.[4,6] The disadvantage here is that parasitic current in the second emitter may occur unless the emitter-base junction is prevented from going into deep saturation by Schottky diodes, which turn on fully at a lower voltage than the transistor junctions.

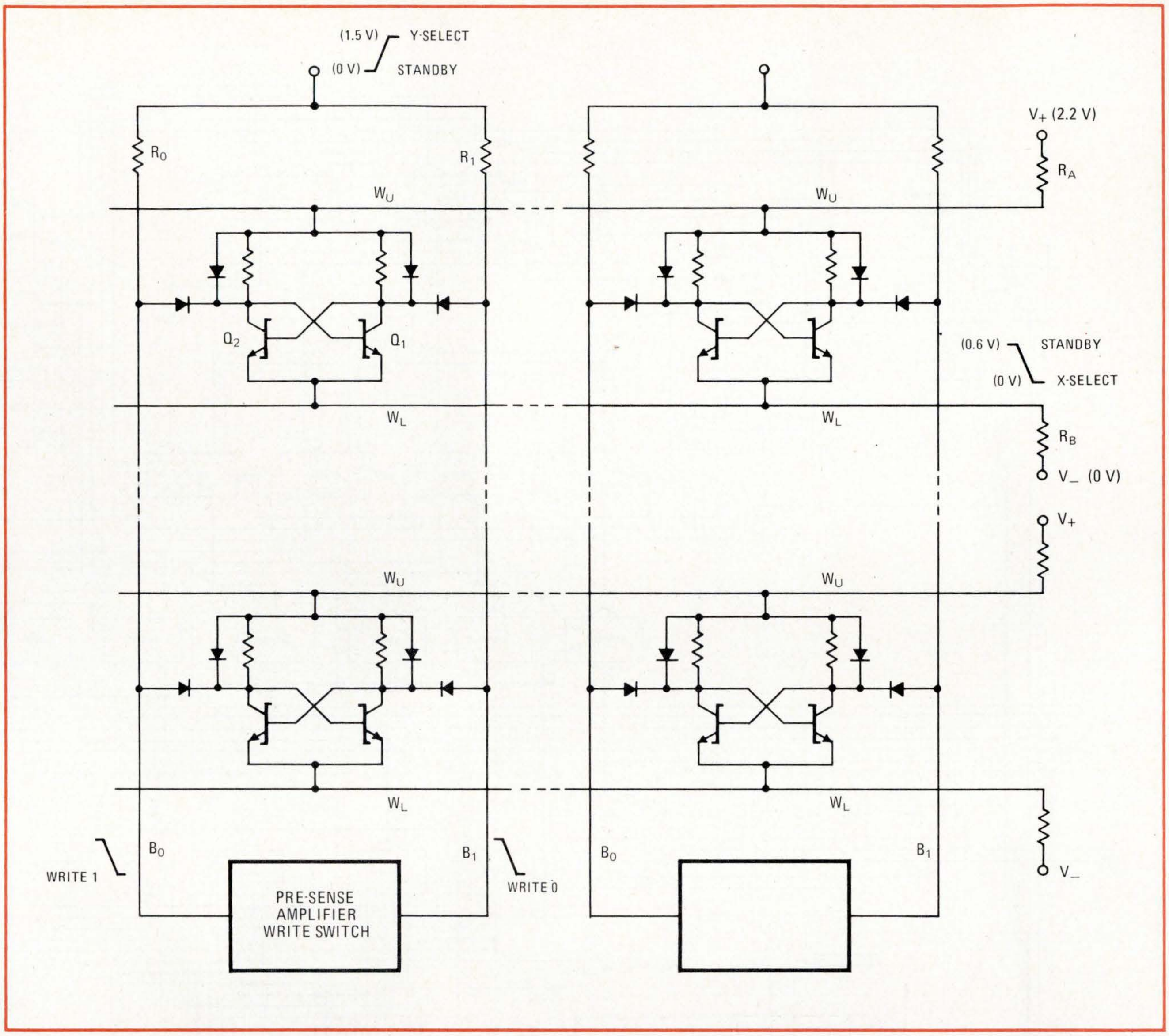
The cell circuit in Fig. 5b has practical advantages only with Schottky clamped transistors. Its operating characteristics are similar to those of the circuit in Fig. 5a, except that a smaller sense current is available and thus the cell stability is more critical. (For selecting a memory cell in a word-organized array, a positive pulse of about 1 volt is applied to the upper word line so that the coupling transistors of the selected cell alone conduct. Since current is pulled out of the cell during reading or writing instead of being fed to it, it is preferable if cell current be increased during addressing in order to improve performance stability.)

The addressing scheme shown in Fig. 5c offers a good tradeoff between cell area, stability, and read/write performance[2, 7] and was the approach finally adopted. The coupling diodes are preferably realized by Schottky diodes, because they will occupy little space and do not cause parasitic injection currents.

Figure 6 shows a quasi-bit-organized array of such memory cells. All the cells of one address line are supplied via common series resistors R_A and R_B. The tracking of memory device characteristics provides sufficiently uniform current sharing between the cells. During standby, the read/write lines are biased so that the coupling diodes do not conduct any current. To address a cell, a negative pulse is applied to its address line and a positive pulse to its Y-address read/write-line pair, so that the read/write-line resistors R_0 and R_1 are shunted to the cell load devices. Thus the cell current is essentially determined by the lower-resistance read/write line resistors.

For reading, the difference of the voltage drops across these resistors is sensed in the pre-sense amplifier. The delay time of the sense signal is negligibly small, since relatively large currents are chosen for the read/write lines.

For writing a logic 1, the B_0 is pulled down so that



6. Cells en masse. In this quasi-bit-organized array of cells, the write operation is one that limits speed, since the B_1 line current has to pull Q_1's collector out of saturation. Because of uniform current sharing, only one common series resistor is required for each X address line.

only the B_1 line delivers a current to the cell to charge up the corresponding cell node and thus to turn on transistor Q_2. The write operation is somewhat more critical than reading, since the B_1 line current has to be relatively large to pull the collector of Q_1 out of saturation. In fact, at dc conditions, this current has to be β times larger than the base current of Q_1. Moreover, if dynamic switching is used and fast switching is necessary, the read/write-line current will have to be considerably larger, particularly if the on transistor is heavily saturated. This is due to the well-known Miller effect, which entails that during the on-state the effective capacitance between a transistor's collector and emitter terminals is essentially given by the base-collector capacitance multiplied by the current gain β.

It should be mentioned that the write current can be reduced by inserting a small series resistor between collector and cross-coupling points, if necessary.[7]

Figure 7 shows a typical read/write operation sequence for a circuit utilizing the coupling scheme of Fig. 5a and adopting the common collector configuration (flip-flop and coupling transistors sharing a collector). Read time is fast since there are no resistors in series with the access path. As the oscilloscope shows, the cell can within 15 ns deliver 50 millivolts of different voltage into a 10-picofarad load at its read/write lines. The delay time for writing is also less than 15 ns. □

ACKNOWLEDGMENT

The author is indebted to Howard Leung and Steve Platt for the cell layout for the 3-micrometer epitaxy technology.

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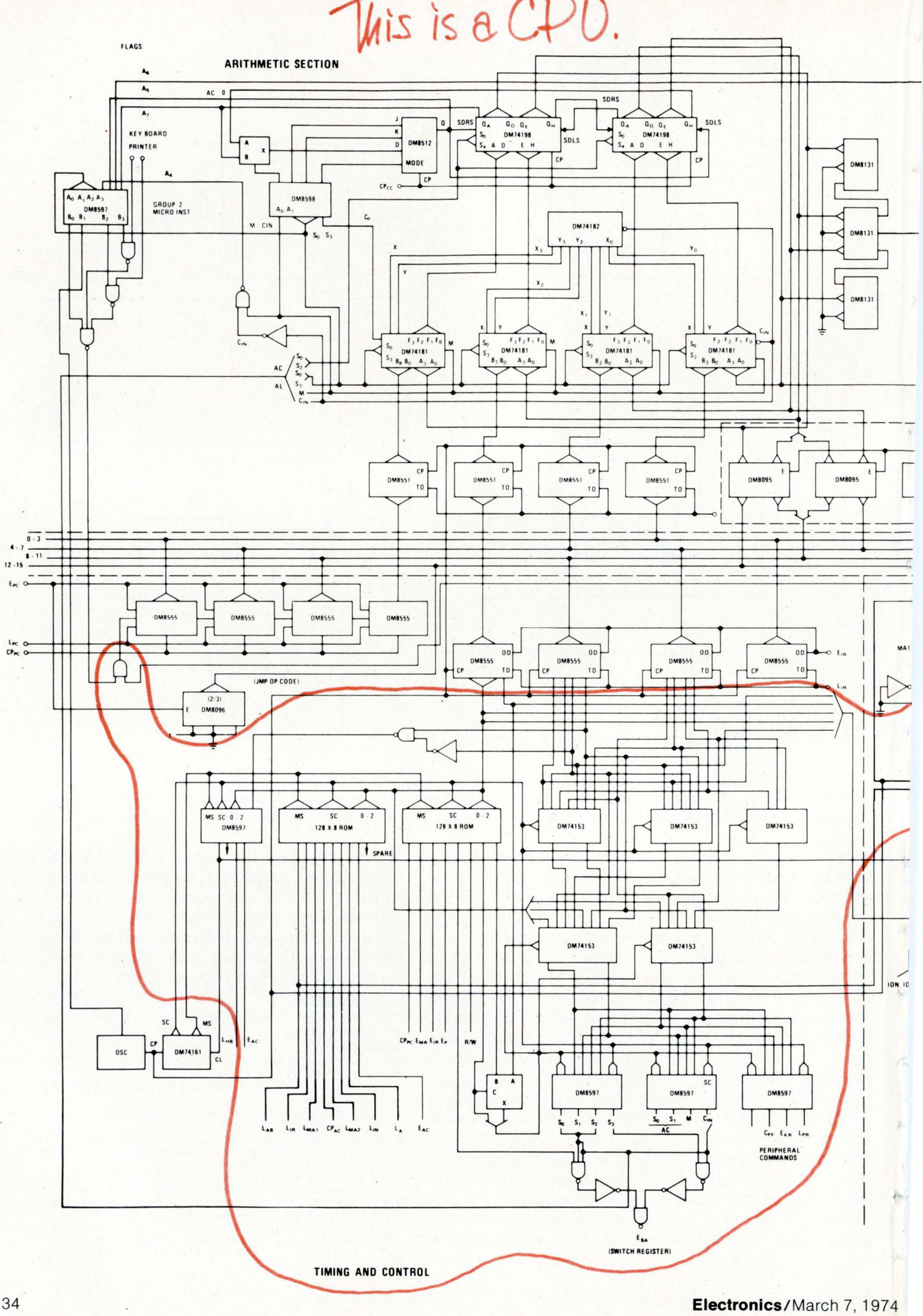
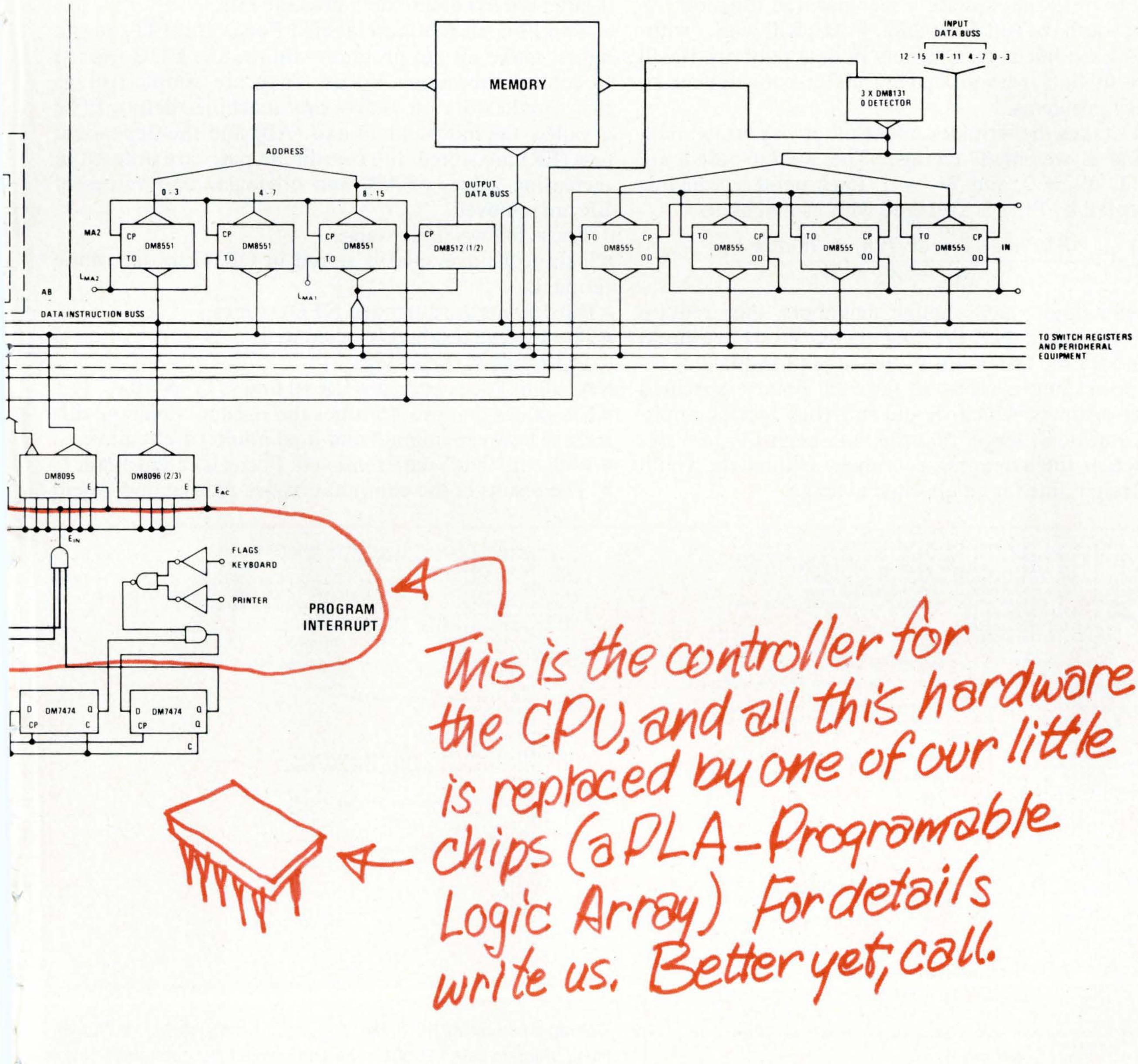

This is a CPU.
ARITHMETIC SECTION
FLAGS
KEY BOARD
PRINTER
GROUP 2 MICRO INST
DM8597
DM8598
DM8512
DM74198
DM74182
DM74181
DM8131
DM8551
DM8095
DM8555
DM8096
(JMP OP CODE)
DM74153
128 X 8 ROM
SPARE
OSC
DM74161
R/W
PERIPHERAL COMMANDS
(SWITCH REGISTER)
TIMING AND CONTROL


MEMORY
INPUT DATA BUSS
3 X DM8131 0 DETECTOR
ADDRESS
OUTPUT DATA BUSS
DM8551
DM8512 (1/2)
DM8555
DATA INSTRUCTION BUSS
TO SWITCH REGISTERS AND PERIOHERAL EQUIPMENT
DM8095
DM8096 (2/3)
FLAGS
KEYBOARD
PRINTER
PROGRAM INTERRUPT
DM7474
This is the controller for the CPU, and all this hardware is replaced by one of our little chips (a PLA-Programable Logic Array) For details write us. Better yet, call.

Weighted averaging simplifies curve fitting

by Richard E. Blake
Vast Inc., Waldoboro, Maine

A program called Focus considerably eases the job of curve fitting, especially if you are working with data that does not approximate a recognizable function. As long as you have sufficient data, Focus will work—without being modified—on a variety of data patterns. It will quickly fit data without having either convergence or accuracy problems.

Focus takes the wrinkles out of otherwise erratic data by using a weighted average. The weights used are $W_1 = 1$, $W_2 = 2$, and $W_3 = 1$. Each point n, which is represented by P(n), is averaged with its neighbors:

$$P(n) = \frac{W_1P(n-1) + W_2P(n) + W_3P(n+1)}{W_1 + W_2 + W_3}$$

Since end points lack enough neighbors, they require special attention. For the first point, W_1 is set equal to 0; and for the last point, W_3 is also set to equal 0.

The averaging is repeated for each point a specified number of times, which should suit your specific application. But don't forget that the data begins to lose significance as the averaging continues. Ultimately, you'll get a straight line for an absolute average.

When using Focus, you are faced only with basic decisions. First, establish which axis should be used to order the points. This decision determines the neighbors that are the heart of the method. Next determine if the data from the remaining axis can be used as a reference, or should the data from both axes be averaged?

After you determine these answers, you can then decide how many times the averaging should take place. It is easy enough to change this number, and perhaps the best solution is to try a few different numbers. And finally, you have the option to remove data through some desired criteria and to do a possible refit.

Two Fortran routines, labeled Focus and FIT2 in the figure, make up the program—subroutine FIT2 is used to control subroutine Focus. They are simple listings that should work on almost any machine. Before FIT2 is called, the independent axis (AB) and the dependent axis (ER) are stored, the coordinate pairs are ordered in increasing values of AB, and obviously bad values of ER are removed.

Focus follows these steps:

- Data to be averaged is stored in ORIG to determine residuals.
- Data points are averaged NFOC times.
- The average residual is calculated.

FIT2 follows these steps:

- A call to Focus averages ER 10 times (IY = 10).
- ER values that are 2.5 times the residual (average difference between original and final points) are removed.
- With this "bad" data removed, Focus is called again.
- The results of the computation are plotted and key fit

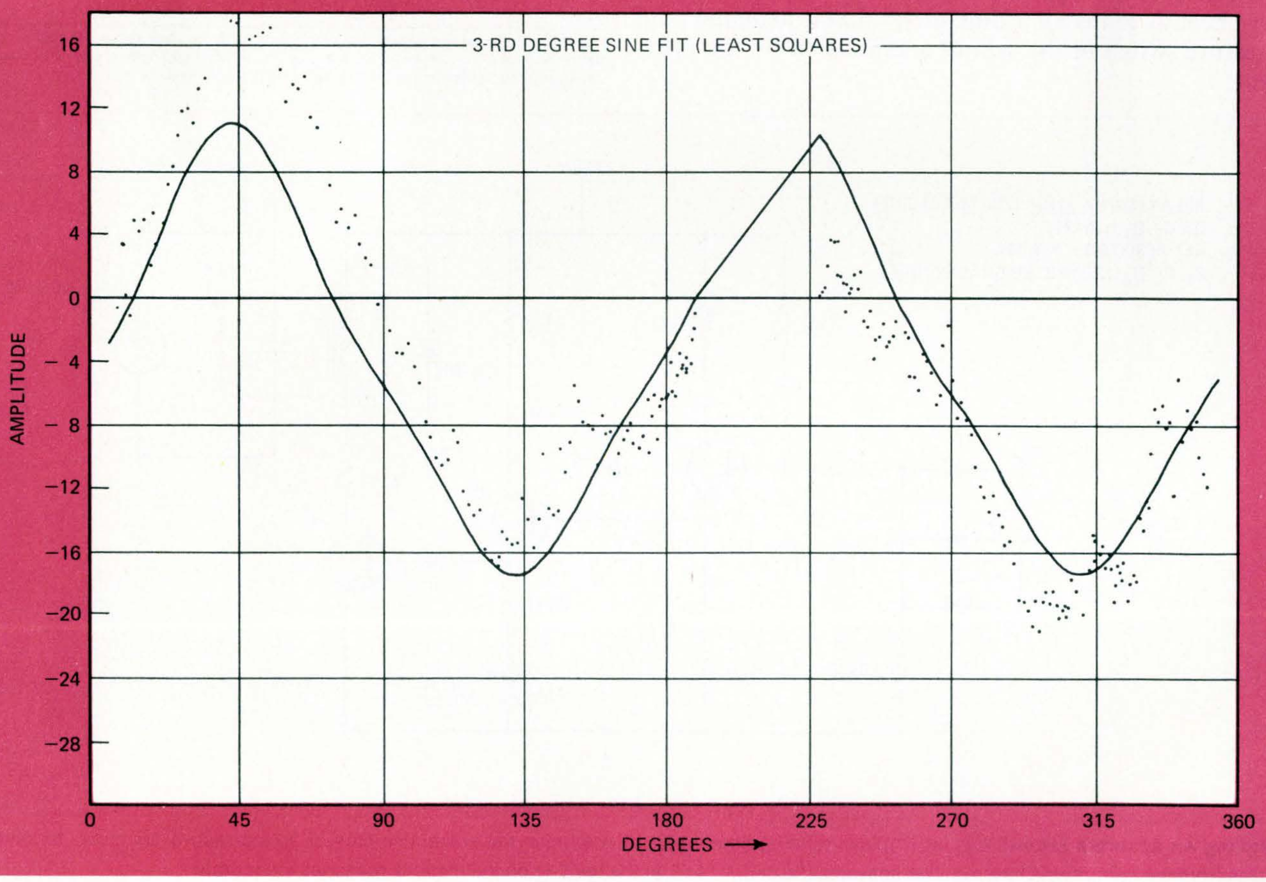
```
      SUBROUTINE FIT2(AVE1,AVE,DELT1,DELT2)
C AVE1  IS THE AVERAGE RESIDUAL FROM THE FIRST PASS AT FOCUS
C AVE   IS THE AVERAGE RESIDUAL FROM THE SECOND PASS AT FOCUS
C DELT1 IS THE WORST RESIDUAL FROM THE FIRST PASS
C DELT2 IS THE WORST RESIDUAL FROM THE SECOND PASS
C NOTE THAT .1 APPEARS OFTEN ON PRINTED VARIABLES, SINCE THEY
C  WERE 10 TIMES REAL SCALE
      DIMENSION ORIG(1000)
      COMMON AB(1000),ER(1000),NTPS
      IY=10
      CALL FOCUS(NTPS,ER,IY,AVE1,ORIG,DELT1)
      AVE=AVE1*2.5
C 2.5 TIMES THE AVERAGE RESIDUAL WILL NOW BE USED TO ELIMINATE DATA
      WRITE(6,1410)
 1410 FORMAT(////"  DATA REMOVED BETWEEN PASS ONE AND TWO",//,
     *"   BEARING      DATA       FIT DIFFERENCE (10X REAL VALUES)")
      DO 42 I=1,NTPS
      DIF=ABS(ORIG(I)-ER(I))
      IF(DIF-AVE)42,42,41
   41 CONTINUE
      WRITE(6,411) AB(I),ORIG(I),ER(I),DIF
  411 FORMAT(4F10.3)
      DO 415 J=I,NTPS
      AB(J)=AB(J+1)
      ORIG(J)=ORIG(J+1)
  415 ER(J)=ER(J+1)
      NTPS=NTPS-1
      I=I-1
   42 CONTINUE
C NOTICE THAT THE CALLING SEQUENCE HAS BEEN CHANGED!
C THE NEXT FOCUS WILL BE ON THE ORIGINAL DATA STORED IN ORIG NOW.
      CALL FOCUS(NTPS,ORIG,IY,AVE,ER,DELT2)
C THE FOLLOWING CODE PLOTS THE FITTED DATA ON A H.P.7210A
   50 CONX=100.
      CONY=320.
      IPC=0
      DO 55 I=1,NTPS
C 2.63 AND 20. ARE SCALE FACTORS FOR THE PLOTTER
      IX=(AB(I)+CONX)*2.63
      IY=(ORIG(I)+CONY)*20.
      WRITE(7) IPC,1,IX,IY
   55 IPC=1
C THE FOLLOWING CODE PRINTS ANGLES AND ERRORS FOR FURTHER PROCESSING
      WRITE(6,156)
  156 FORMAT("1  ANGLE  ERROR")
      DO 56 I=1,74
      ANG=(I-1)*50
      DO 57 J=1,NTPS
      IF(ANG-AB(J)) 58,57,57
   57 CONTINUE
   58 ANG=ANG*.1
      ERROR=ORIG(J)*.1+.05
      WRITE(6,157) ANG,ERROR
   56 CONTINUE
  157 FORMAT(F7.0,F7.1)
   60 RETURN
      END
```

```
      SUBROUTINE FOCUS(NDATA,DATA,NFOC,AVE,ORIG,DELT1)
C NDATA IS THE NUMBER OF DATA POINTS TO BE FIT
C DATA  IS THE DATA ARRAY
C NFOC  IS THE NUMBER OF TIMES THE DATA IS TO BE AVERAGED
C AVE   IS THE AVERAGE RESIDUAL ( DIFFERENCE BETWEEN ORIGINAL & FIT)
C ORIG  IS THE ORIGINAL DATA (STORED TO CALCULATE RESIDUALS)
C DELT1 IS THE WORST RESIDUAL
      DIMENSION DATA(1),ORIG(1)
      DO 20 I=1,NDATA
   20 ORIG(I)=DATA(I)
C THE FOLLOWING CODE (TO STATEMENT 30) IS THE ACTUAL FOCUSING
      DO 30 I=1,NFOC
      D1=DATA(1)
      DATA(1)=(D1*2.+DATA(2))*.33333
      NUM1=NDATA-1
      DO 25 J=2,NUM1
      D2=D1
      D1=DATA(J)
   25 DATA(J)=(D2+DATA(J)*2.+DATA(J+1))*.25
   30 DATA(NDATA)=(D2+DATA(NDATA)*2.)*.33333
      AVE=0.
      DELT1=0.
C CALCULATE RUNNING ERROR FOR AVERAGE ERROR
      DO 250 I=1,NDATA
      DIF=ABS(DATA(I)-ORIG(I))
      AVE=AVE+DIF
      IF(DIF-DELT1) 250,250,245
  245 DELT1=DIF
  250 CONTINUE
      X=NDATA
      AVE=AVE/X
      RETURN
      END
```

Getting an accurate fit. These two Fortran listings make up a curve-fitting program called Focus. (The subroutine FIT2 controls the subroutine Focus.) The program, which fits data by using a weighted average, is fast, as well as accurate. The solid line in Graph 1 shows how accurately Focus can generate a function to fit the data points (dots). If the averaging is repeated too many times, the fitted curve (dashed line) loses accuracy. Graph 2 shows the best fit that can be obtained for the same data points with a least-squares technique.

GRAPH 1

GRAPH 2



values are printed as the output.

The two graphs compare the accuracy of Focus with that of the popular least-squares curve-fitting technique. Both graphs represent an instrument calibration.

Graph 1 shows the results of Focus' weighted-average approach. The data points are represented as dots, while the solid line is the best average fit. The averaging was repeated 10 times, and it required only 5.34 seconds to run. The average difference between the data points and the best-fit curve is 1.076 units. If the averaging is repeated 50 times, the data becomes over-averaged, and the dashed line results.

Graph 2 shows the same data points being fitted by using a least-squares approach. This plot is the best of a series of runs. It required 49.3 seconds on the computer, and the difference error is 3.568 units. □

Measuring the use time of interactive terminals

by Thomas A. Lutke
Bunker Ramo Corp., Falls Church, Va.

If you've ever tried to determine the actual use time of an interactive computer terminal, you already know what a troublesome task this can be. But, it's sometimes necessary to know, with reasonable accuracy, how long the terminal is actually being used to assess the load or amount of traffic on the terminal.

Generally, the terminal's use time is greater than the time recorded by the computer's central processing unit, but smaller than the total time that the terminal in on-line with the computer. One way for you to determine this figure is to keep a log sheet by the terminal and hope that it's filled in, rather than forgotten. Another way, one that eliminates the policing required by the log sheet, is to install a time meter that is actuated by a pressure switch in the seat of a chair used by the operator.

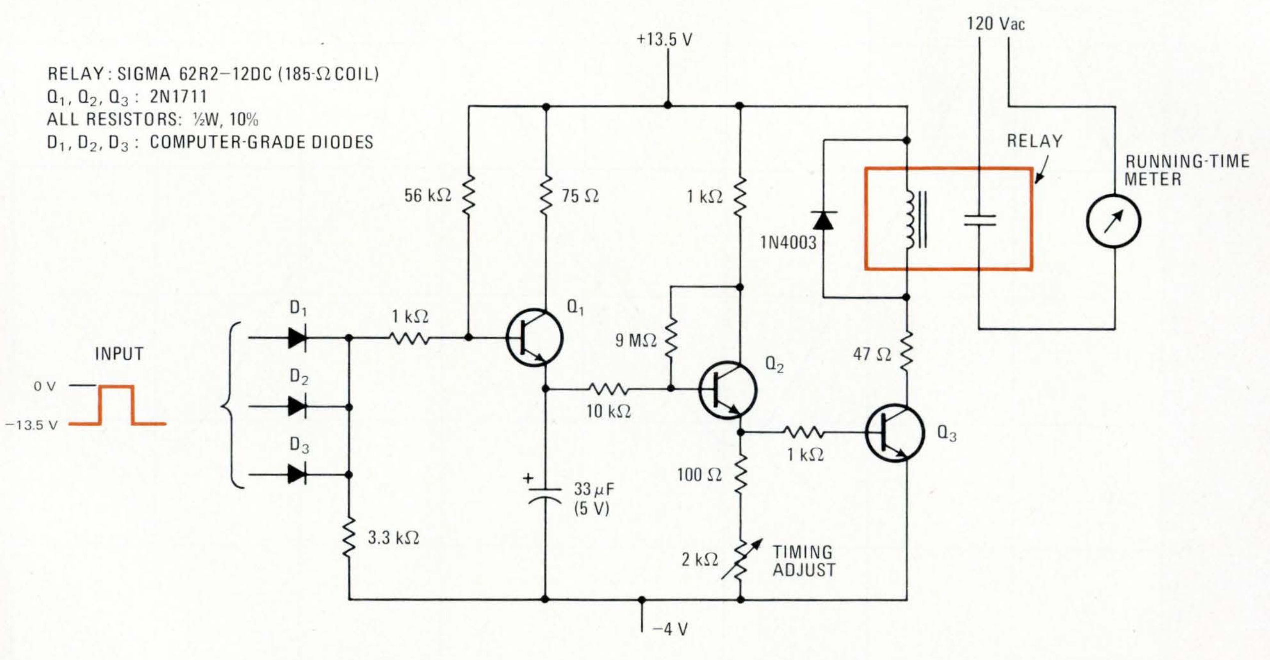
An even better method is to use the circuit in the diagram to drive a running-time meter. This circuit is conveniently activated by a 1-millisecond communications pulse or pulse train, which can be taken from the computer's interrupt line.

There is a delay between the time the input to the circuit resets and the time the meter is deactivated. This delay lets the meter run continuously all the while the operator is using the terminal, provided that he interrupts the computer often enough to keep the circuit from resetting.

An input pulse at either diode D_1, D_2, or D_3 turns on transistor Q_1, which in turn charges the timing capacitor. Now transistors Q_2 and Q_3 also conduct so that current is supplied to the relay coil, energizing the relay and running the meter.

When the input resets, transistor Q_1 turns off, and the timing capacitor discharges through the base of transistor Q_2. This reduces the base current to transistor Q_3 so that the relay is eventually de-energized. The circuit's timing, which can be varied from 1 to 50 seconds, is controlled by the 2-kilohm potentiometer. □

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.



Making an accurate record. Circuit employs running-time meter to determine the actual use time of an interactive computer terminal. A pulse from the computer's interrupt line activates the circuit, so that the reading on the meter is reasonably accurate.

Engineer's newsletter

It's easy to turn an IC timer into an R-S flip-flop

The versatile 555-type IC timer can also be used as an R-S flip-flop, says D.E. Hokanson, a physicist at the Veterans Administration Hospital in Seattle, Wash. **The device makes a handy bistable because of its low cost, wide operating voltage range, and an output power large enough to drive indicators or relays.**

Wiring the unit is simple—just omit the timing capacitor. The set input pulse is capacitively coupled (1,000 picofarads) into the unit's trigger input, which is also connected to the supply voltage through a 27-kilohm resistor. **The reset input pulse is applied through a switch (push button) that runs from ground to the timer's reset input.** The timer's threshold and ground terminals are also wired to the grounded side of the switch. (The V_{CC} supply and output connections are normal.)

The timer flip-flop will be set by the negative-going edge of a pulse applied to its trigger input. Grounding its reset input or momentarily raising its threshold input above ⅔ V_{CC} will reset it. If a positive pulse is applied to the threshold input for resetting, the reset input should be tied to the supply to prevent the timer from resetting prematurely. Conversely, if a negative pulse is applied to the reset input to reset the device, the threshold input should be grounded.

Plain sailing over rough spots

Checking out the surface of wafers or thin or thick films is a tough job with most surface-profile measuring systems. The Dektak system from Sloan Technology Corp., however, is easy to use and **can plot microscopic step differences as small as 25 angstroms or as large as a million angstroms.** Chart speed of the strip recorder can be varied to attain horizontal magnifications ranging from 2× to 5,000×. Accuracy is ±2%, and total traverse capability is 6 cm. Sloan's address is 535 East Montecito St., Santa Barbara, Calif. 93101.

Where to go for extra training in electronics

Now that electronics is spreading into the automotive, medical, and other industries, many companies are discovering a need to give their own already highly expert and very busy personnel additional training in electronics. One source of this training is the Center for Technical Development Inc., a subsidiary of Kurz-Kasch Inc., which offers **five in-depth home-study courses in the design of digital circuits, power supplies, IC logic, MOSFET and JFET circuits, and MOS circuits.**

The center's clients are often corporations, not individuals, and student caliber is high—average age is 36 years, 43% are engineers with degrees, and 57% are technicians with 10 to 12 years of experience. Course completion rate is also very high. Address of the center is 2876 Culver Ave., Dayton, Ohio, 45429; phone number is (513) 296-1020.

Getting a grip on emi control requirements

If you've suddenly developed a need to meet Mil Std 461 requirements for controlling electromagnetic interference, a new publication from an emi consulting firm may help. The 130-page book contains complete guides and checklists for the engineer, project and quality control manager, and draftsmen, typists, and others faced with the complex problem. "Simplified emi Control Plan Report 1546, Vol. 1" costs $60 from Hish Associates, 9710 Cozycroft Ave., Chatsworth, Calif., 19311.

Data General introduces the first stereo computer system.

This computer not only looks like a music system. It works in stereo.

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And as it turns out, every Dual Nova computer has a foreground to do one thing. And a background to do something else.

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909	1803	5444	54165	54H78	9H50	9N30	9S133	9321	93164	93S10	710	7805
910	1804	5445	54166	54H87	9H51	9N32	9S134	9322	93165	93S12	711	7806
911	1805	5447	54174	54H101	9H52	9N37	9000	9324	93166	93S16	715	7808
912	1806	5448	54175	54H102	9H54	9N38	9001	9328	93174	93S41	723	7812
913	1807	5449	54178	54H103	9H60	9N40	9002	9334	93175	93S42	725	7815
921	1808	5450	54179	54H106	9H61	9N50	9003	9338	93178	93S43	726	7818
930	1809	5451	54180	54H183	9H71	9N51	9004	9340	93179	93S46	727	7824
931	1810	5453	54181	54S00	9H72	9N53	9005	9341	93180	93S47	730	9614
932	1811	5454	54182	54S03	9H73	9N54	9006	9342	93190	93S62	733	9615
933	1812	5460	54190	54S04	9H74	9N60	9007	9344	93191	93S137	734	9620
935	1813	5470	54191	54S05	9H76	9N70	9008	9345	93198	93S138	740	9621
936	1814	5472	54198	54S10	9H78	9N72	9009	9348	93199	93S139	741	9622
937	5400	5473	54199	54S11	9H81	9N73	9012	9352	93H00	93S153	747	9624
941	5401	5474	54H00	54S15	9H82	9N74	9014	9353	93H72	93S157	748	9625
944	5402	5475	54H01	54S20	9H101	9N76	9015	9354	93H87	93S158	760	9650
945	5403	5476	54H04	54S22	9H102	9N86	9016	9357B	93H183	93S174	776	
946	5404	5477	54H05	54S40	9H103	9N107	9017	9358	93407B	93S175	777	
948	5405	5480	54H08	54S64	9H106	9N122	9020	9359	93410	93S194	791	
949	5406	5482	54H10	54S65	9H108	9N123	9022	9375	93411	93S253	LM101	
950	5407	5483	54H11	54S74	9N00	9S00	9024	9377	93415	93S257	LM101A	
951	5408	5486	54H20	54S109	9N01	9S03	9300	9380	93433B	93S258	LM102	
961	5409	5490	54H21	54S112	9N02	9S04	9301	9382	93434	9600	LM104	
962	5410	5491	54H22	54S113	9N03	9S05	9302	9383	93435	9601	LM105	
963	5411	5492	54H30	54S114	9N04	9S10	9304	9386	93L00	9602	LM107	
9093	5413	5493	54H40	54S133	9N05	9S11	9305	9390	93L01	9603	LM108	
9094	5416	5494	54H50	54S134	9N06	9S15	9307	9391	93L08	96L02	LM110	
9097	5417	5495	54H51	9H00	9N07	9S20	9308	9392	93L09		CA3018A	
9099	5420	5496	54H52	9H01	9N08	9S22	9309	9393	93L10		CA3018	
9109	5425	54107	54H54	9H04	9N09	9S40	9310	9394	93L11		CA3019	
9110	5426	54121	54H55	9H05	9N10	9S41	9311	9395	93L12		CA3026	
9111	5427	54145	54H60	9H08	9N11	9S42	9312	9396	93L14		CA3036	
9112	5430	54150	54H61	9H10	9N13	9S64	9313	93145	93L16		CA3039	
9135	5432	54151	54H62	9H11	9N16	9S65	9314	93150	93L18		CA3045	
9157	5437	54152	54H71	9H20	9N17	9S74	9315	93151	93L21		MC1558	
9158	5438	54153	54H72	9H21	9N20	9S109	9316	93152	93L22		SN55107	

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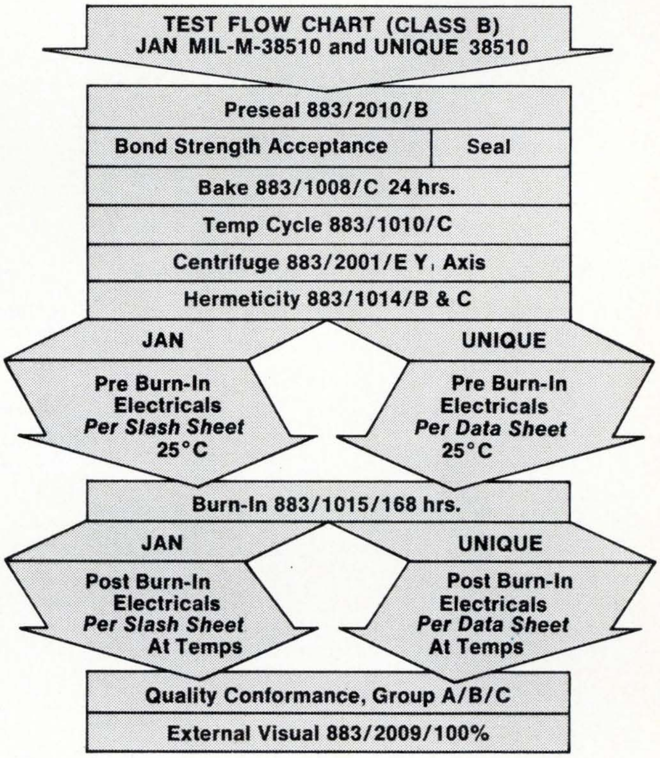

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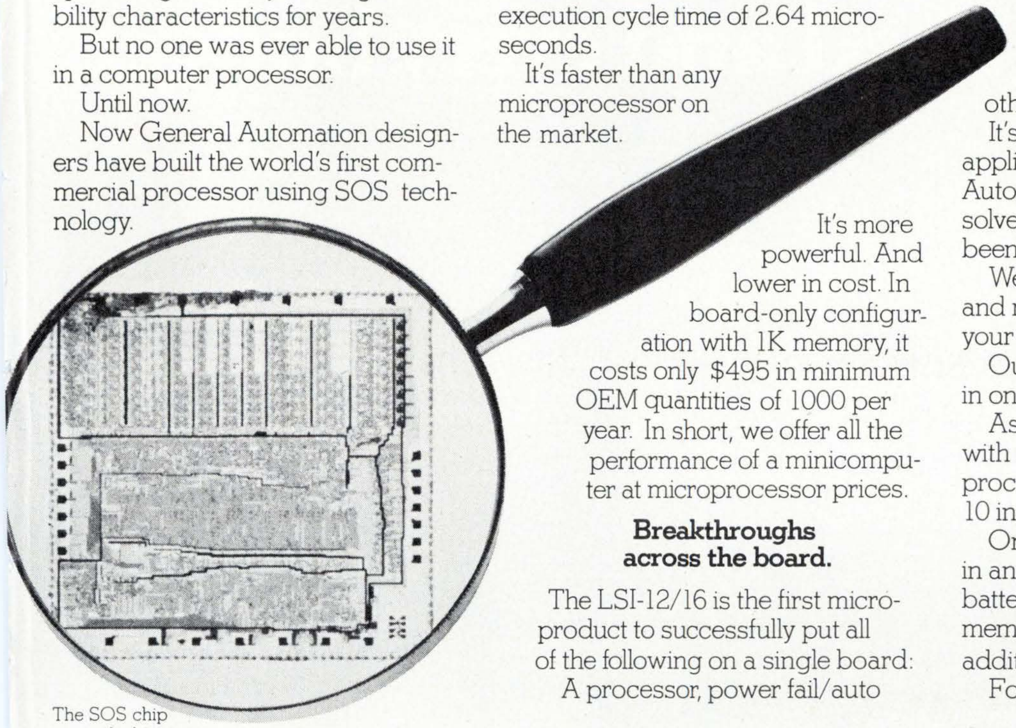

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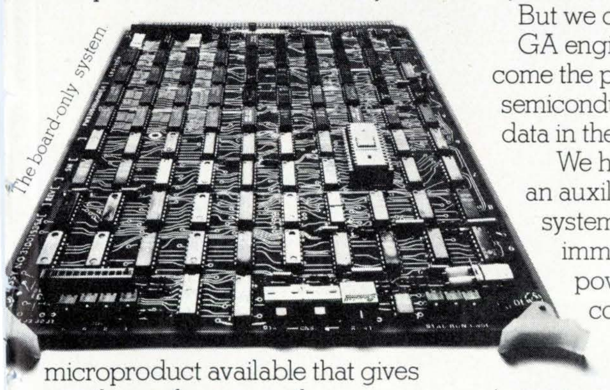

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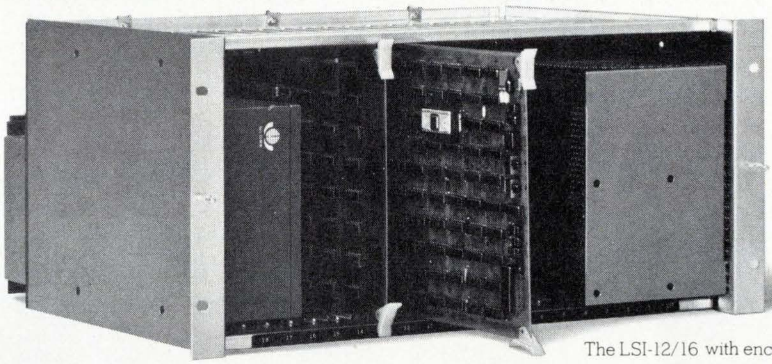

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Exhibitors stress hard-sell at IEEE Intercon 74

Instrument-dominated show, March 26–29 at New York Coliseum, to focus on applications-oriented equipment available now for automatic testing, exercising high-speed logic families, checking communications links and terminals, and servicing industrial, commercial, and consumer systems. Following are some of the significant products to be introduced at Intercon 74

Digital meters use new a-d conversion technique

In a major assault on the instrumentation market, United Systems Corp., Dayton, Ohio, will be loosing more than 20 new products on the IEEE show. Called the HT (for high-technology) Series, the line includes counters, printers, digital multimeters, digital panel meters, comparators, and precision calibrators.

Technologically, perhaps the most significant are the company's model 2780 DPM and its model 2210 DMM. Both are 4½-digit (20,000-count) machines, and both are built around the same LSI circuit, which performs analog-to-digital conversions by means of a patented new technique. The major advantages of the new integrating conversion scheme are high input impedance and low bias current, low cost, and minimized digitizing error, through the use of synchronized data transfer. The single reference voltage source eliminates up to half the adjustments that might otherwise be needed in a bipolar machine, and also does away with special drift problems around zero—to the new meters, zero is just another number.

In their standard form, both meters are supplied with Monsanto MAN-72 LED readouts. These red digits are 0.3 in. high. For OEM buyers, however, the meters can be supplied with Monsanto's amber or green versions of the MAN-72 at no additional cost to the purchaser.

Price of the model 2780 panel meter, which United Systems is marketing under its Digitec tradename, is $219. An additional $40 buys a TTL-compatible parallel BCD output. The meter comes in four dc voltage ranges and five dc current ranges. The former include full-scale values of 1.9999 V, 19.999 V, 199.99 V, and 1,000.0 V. The 2-V scale is electronically protected against overloads of up to ±200 V; all other ranges can withstand up to ±1.2 kV. Input resistance exceeds 1,000 megohms on the lowest range, and equals 10 megohms on all others. Polarity is automatically detected and displayed on all ranges.

In designing the new meter, efforts were clearly made to keep accuracy commensurate with resolution. Maximum error on the dc voltage ranges is specified as ±(0.01% of reading + 1 count) at an ambient temperature of 23°C ±1°C. For the current ranges the 0.01% figure becomes 0.05%.

The meter's worst-case temperature coefficient is ±0.001% of full scale per degree centigrade for the zero offset, and 0.002% for the full-scale offset. In addition, the external multiplier (or shunt) resistors supplied by United Systems cause a maximum temperature-related error of ±0.0025% of reading/°C. Alternatively, the user can supply his own external resistors.

The 2780 is designed to fit into the 3.75-by-1.72-in. panel cutout that seems to be becoming an industry standard. It can run off standard line voltages or a 5-V supply. The line-voltage model can take either 115 or 230 Vac at any frequency

from 50 to 400 Hz, and it has a maximum power consumption of 4 volt-amps. The 5-V version draws a maximum of 750 mA. Price for both types is the same $219.

The model 2210 DMM has the same dc voltage ranges as the panel meter; in addition, it measures ac voltage and resistance. Current measurement cannot be made.

Ac voltage measurements can be made over the same span as dc measurements, covering the frequency range from 45 Hz to 20 kHz. Input impedance on ac is 10 megohms in parallel with 40 pF, and maximum error is ±(0.25% of reading + 5 counts). The temperature coefficient for ac is ±(0.025% of reading + 0.001% of full scale)/°C.

Maximum response time for the multimeter to come to its rated accuracy is 1 second for dc volts, and 5 seconds for ac volts and ohms. The 2210 is line-operated only and consumes a maximum of 5 W. Price is $525.

United Systems Corp., 918 Woodley Road, Dayton, Ohio 45403[381]

Tektronix launches calculator-based instrument line

In a move that most industry observers have expected ever since the company's introduction of its models 21 and 31 calculators, Tektronix Inc., Beaverton, Ore., has entered the field of calculator-based instrumentation systems. Called the models 21/53 and 31/53, depending upon which calculators they use, the new systems make extensive use of the company's TM500 line of modular measuring instruments.

Unlike many other automatic test systems that have been designed to exercise units under test by detecting and diagnosing their faults, the two new systems are aimed primarily at applications involving data acquisition and analysis. Only measurement modules—not signal-producing modules—from the TM500 line are meant to be used with the new systems.

Not counting the measurement modules themselves, which are selected by the user for the particular task he has to perform, the basic systems carry price tags of $2,895 for the 21/53, and $3,995 for the 31/53. These prices include a calculator, a mainframe power supply, a plug-in interface unit for connecting the calculator with the instrument modules, an interface cable, and two software packages for data acquisition and reduction.

The attractiveness of these new systems is in their relatively low cost, their flexibility, and their considerable data-reduction power. The software packages are supplied as tape cartridges. One contains routines for the simple acquisition of data. With these routines, the user decides how often a measurement should be made, what limits it must fall between, how many measurements should be made before the testing is stopped, and so on. The acquired data itself is stored in the calculator's registers, or may be listed by an optional printer.

The second software package contains some much more powerful routines. Instead of saving the original raw data, it processes it as the data is acquired and stores the results of its analyses. Some of the results it can provide are calculations of the mean, variance, and standard deviation of a single input variable. It can also look at two input variables—such as two voltages or a voltage and a time interval—and calculate their covariance and correlation coefficient.

Further, the routines can calculate the best-fit straight line for a collection of data and can also provide the outputs needed to construct a histogram. For obtaining a graphical presentation of the data automatically, the model 4661 digital plotter is available.

The new systems will be available after March 15.

Tektronix, Inc., P. O. Box 500, Beaverton, Ore. 97005[382]

GR network analyzer runs 200 tests a second

Up to 200 tests a second—each of 5 milliseconds duration—can be conducted by an automatic network analyzer, the model 2260 developed by General Radio. The versatile rf test system includes a digitally swept frequency synthesizer, GR's model 1062, which provides a frequency range of 200 kilohertz to 500 megahertz, with 0.1-hertz resolution.

Since the synthesizer is accurate to one part per million, a spokesman says the operator knows what frequency he is getting down to 10 digits, an important feature in testing filters used in communications applications. Phase noise of the synthesizer is 60 decibels down, low enough to test very-narrow-band devices. Also, when testing narrowband devices, the 2260 can be programed to wait for the device to settle after each frequency change. Dynamic range is greater than 100 decibels; interface is provided by kits that determine operating im-

pedance, which can be 50 ohms, 75 ohms, or 50 and 75 ohms mixed.

A programable attenuator associated with the synthesizer provides the 1-decibel-level output steps, and an offset generator provides the local-oscillator signal, 80 kilohertz from the test frequency. Dc bias up to ±20 volts in 40-millivolt steps for additional tests is supplied by a dual programable power supply.

Transmission and reflection measurements are made by an rf module that amplifies the synthesizer output, splits it into two channels, and switches it to and from the device under test and the measuring circuits.

The test sequence, equipment-control settings, and port interconnections are all controlled by the processor, a Digital Equipment Corp. PDP-8/E with 20,000 12-bit words of core memory. A teletypewriter provides control via instructions punched on paper tape and loaded into the processor by a high-speed tape reader. Instruction sets, one for each type of device test, are written in a simple language developed by GR. Once the instruction set is written, the push of a button initiates the measurements and tests, and the routine can be modified by changing instructions. Instruction sets are stored in a dual magnetic-tape unit.

Test results are displayed on an 8.5-by-11-inch oscilloscope, which can plot up to four characteristics simultaneously. Digital, hard copy, and bright-light outputs are also provided, giving anything from a simple go or no-go indication to a detailed account of each test.

Nearly any active or passive one- or two-port device can be tested, including amplifiers, filters, couplers, relays, and antennas. Characteristics tested include transmission, reflection, magnitude, gain, and bandwidth.

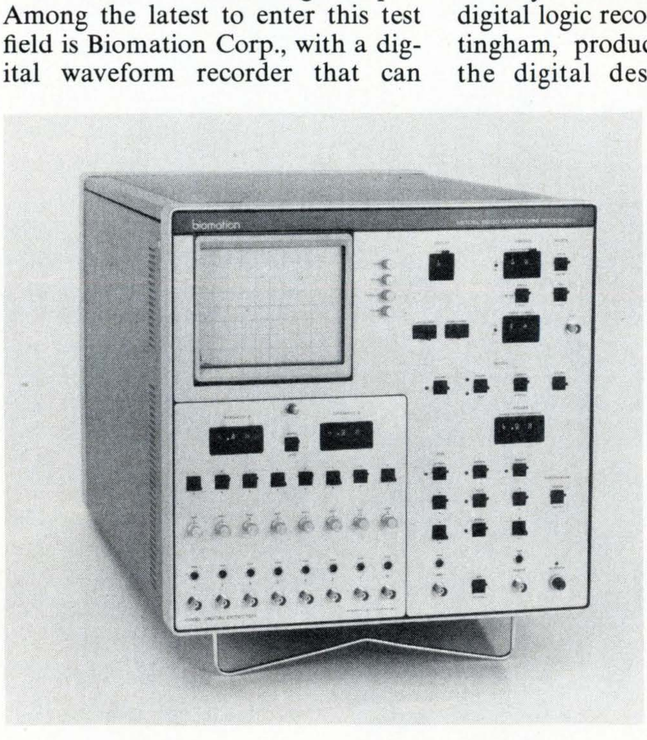
GR says the 2260 can be used both in the laboratory and on the

production line, and it can be operated by semi-skilled personnel. A typical configuration including display scope, processor, storage, teletypewriter, and line printer will cost about $100,000. Delivery time for the system is four to six months.

General Radio, 300 Baker Ave., Concord, Mass. 01742 [383]

Logic scope records at 200 megahertz

As the speed-power performance of logic families swings upward, so does the need for faster logic scopes. Among the latest to enter this test field is Biomation Corp., with a digital waveform recorder that can handle ECL speeds while displaying eight channels of input simultaneously. The $15,000 model 8200 digital logic recorder, says Roy Tottingham, product manager, "is to the digital designer or troubleshooter what the large-bandwidth oscillator is to the analog designer."



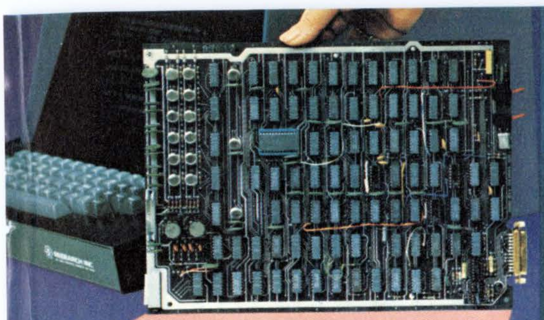
The complex test requirements of such technologies as MSI, LSI, and high-speed ECL, require a faster means of testing, says Tottingham. The 8200, which can accept and display eight input signals simultaneously, compares the digital signals against two threshold levels. When the instrument is in a sample mode, it displays a 0 if the sample is below the threshold level and a 1 if it is above.

The second mode of comparison is called latch, which detects noise pulses that may occur on a signal between clock pulses. The 8200 records at 200 megahertz, storing the binary signals at the rate of one digit every 5 nanoseconds, and it is capable of storing 2,048 words in each of the eight channels.

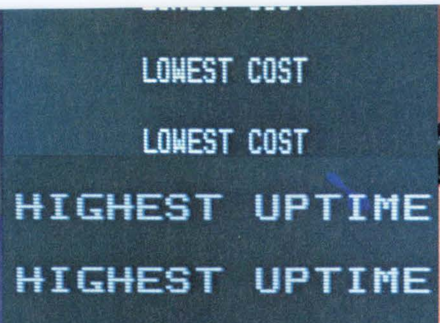
The solid-state recorder, says Tottingham, "looks like an oscilloscope and acts like one, but stores in digital form and displays digital information." The display, using a conventional cathode-ray tube, provides a timing diagram, and each signal is represented as a square-type wave line that shows the high and low states with respect to time from left to right.

The 8200 will allow designers to test ICs, components and systems. Production will begin this spring.

At Intercon 74, Biomation will



The whole works on one single PC board with every chip a plug-in!



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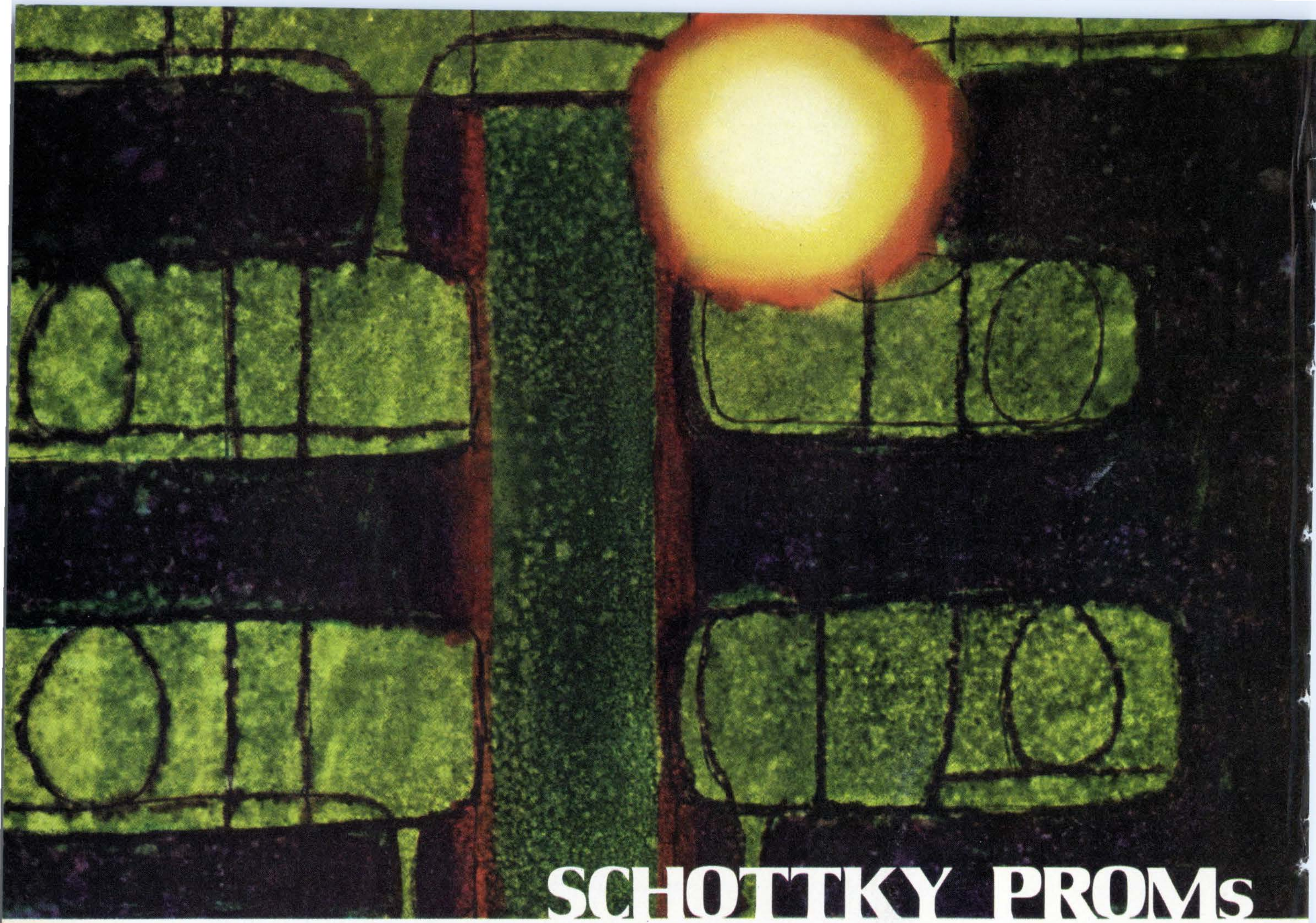

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For a copy of a new 28-page brochure *Designing with TI TTL PROMs and ROMs*, Bulletin CB-162, write: Texas Instruments Incorporated, P.O. Box 5012, M/S 308, Dallas, Texas 75222

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*Texas Instruments U.S. Patent Number 3,463,975

83022

also introduce two other products: the model 805 waveform recorder and the model 815 A/D, a video analog-to-digital converter.

Biomation Corp., 10411 Bubb Rd., Cupertino, Calif. 94301 [384]

Lab-grade scope is priced at $425

Joining the recent spate of laboratory-grade scopes aimed at servicing industrial and consumer electronics gear [*Electronics*, Oct. 25, 1973, p. 220] is a new 15-megahertz triggered-sweep scope with a vertical sensitivity of 10 millivolts per division from Simpson Electric Co.

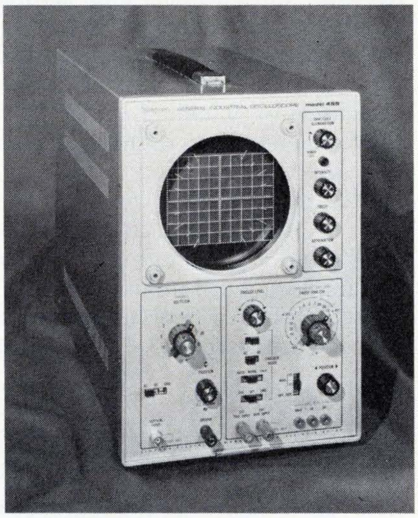
Tagged at $425, the Simpson model 459 features a wide range of sweep speeds adjustable from 0.5 second/centimeter to 0.2 microsecond/cm in 20 calibrated steps, and a 5-power magnifier can be used to extend sweep speed to 40 nanoseconds/cm. Automatic, normal, or free-running sweep modes can be selected, and special TV-horizontal and TV-vertical settings allow users to lock on to a television's line- or frame-synchronizing signals.

Vertical sensitivity ranges from 10 mV/cm to 20 mV/cm in 11 calibrated steps. Input impedance is 1 megohm ±5% in parallel with 35 picofarads, and an optional 15-pF probe is available at $15.

X- and Y-vector inputs are on the front panel, and Z-axis modulation input is on the rear. Also accessible from the front of the unit are three separate calibration signals—1-kilohertz square-wave signals of 5 V, 0.5 V, and 50 mV peak to peak—for vertical calibration. The low-level signal outputs are useful for external circuit testing and calibrating the optional probe.

Power-supply voltages, including high voltages, are regulated to ensure that trace amplitude, time base, brightness, and focus are stable with line-voltage variations of ±10%. The 115-V ac, 50/60-Hz scope is also available in a 230-V ac model at $435.

Simpson Electric Co., 853 Dundee Ave., Elgin, Ill. 60120. [385]



Counter operates up to 18 GHz

As any engineer who's ever made a precision X-band frequency measurement knows, it's not easy. As frequency increases, noise goes up and power goes down for any given signal-generating technology. Unfortunately, microwave frequency counters of the transfer-oscillator type, which can deal well with low-power signals, tend to be intolerant of fm noise. On the other hand, heterodyne-type counters, which can tolerate a lot of residual fm, are not noteworthy for their sensitivity.

Recent progress in counter technology has largely overcome this dilemma for frequencies up to 4 gigahertz. Above that, however, no solution has been available until EIP Inc.'s introduction of its 350D series Autohet frequency counters. These counters, which will be exhibited at the IEEE Show at the Weinschel Engineering Co. booth, have a worst-case fm tolerance specification of 40 megahertz peak to peak, and a worst-case sensitivity of −20 dBm. Frequency coverage is either

20 hertz to 12.4 gigahertz, for the model 350D, or 20 Hz to 18 GHz, for the model 351D. Prices for the two units are $4,700 and $5,100, respectively.

Since the 40-MHz fm-tolerance figure is cited as a worst-case specification regardless of rf frequency, signal level, or modulation rate, best-case conditions are considerably better. And in fact, peak-to-peak deviations of over 200 MHz can be tolerated under ideal conditions. Similarly, sensitivity is actually –25 dBm over the broad frequency range from 1.1 GHz to 12.4 GHz, with a typical figure closer to –30 dBm over most of that range. A $100 option guarantees –30 dBm sensitivity from 1.1 to 6.5 GHz.

Both instruments employ 11-digit LED readouts grouped into four sections—GHz, MHz, kHz, and Hz. The need for annunciators and decimal points is thus eliminated. When full 1-Hz resolution is not required, reading speed can be considerably increased by blanking up to six of the least significant digits in the display. As the resolution is decreased in decade steps, the counter's gate time is also decreased in decade steps from a maximum of 1 second to a minimum of 1 millisecond.

Accuracy of the counters is ±(time-base stability + 1 count). The standard time base supplied with the units has an aging rate of less than 3 parts in 10^7 per month, and a short-term maximum drift of less than 1 part in 10^9 rms for a one-second averaging time. Temperature-induced variations are less than 2 parts in 10^6 over the range 0°C to 50°C.

Three time-base options are offered for the 350D counters. The most expensive of these costs $600 and has an aging rate of less than 5 parts in 10^{10} over a 24-hour period after a 72-hour warmup. Short-term stability is better than 1 part in 10^{10}, and temperature stability over the 0 to 50°C range is better than 3 parts in 10^8.

Many other options, including BCD output, remote programing, i-f offset, and YIG preset are also available. The YIG preset option allows the user to set the frequency at which the counter's YIG-tuned filter will begin its sweep. This shortens the measurement process for applications in which the user knows that the frequency to be measured is above a definite number.

The counters require 80 watts of operating power at either 115 or 230 Vac. Line frequency may be anywhere from 50 to 60 Hz.

EIP Inc., Subsidiary of Danalab, 3130 Alfred St., Santa Clara, Calif. 95050 [386]

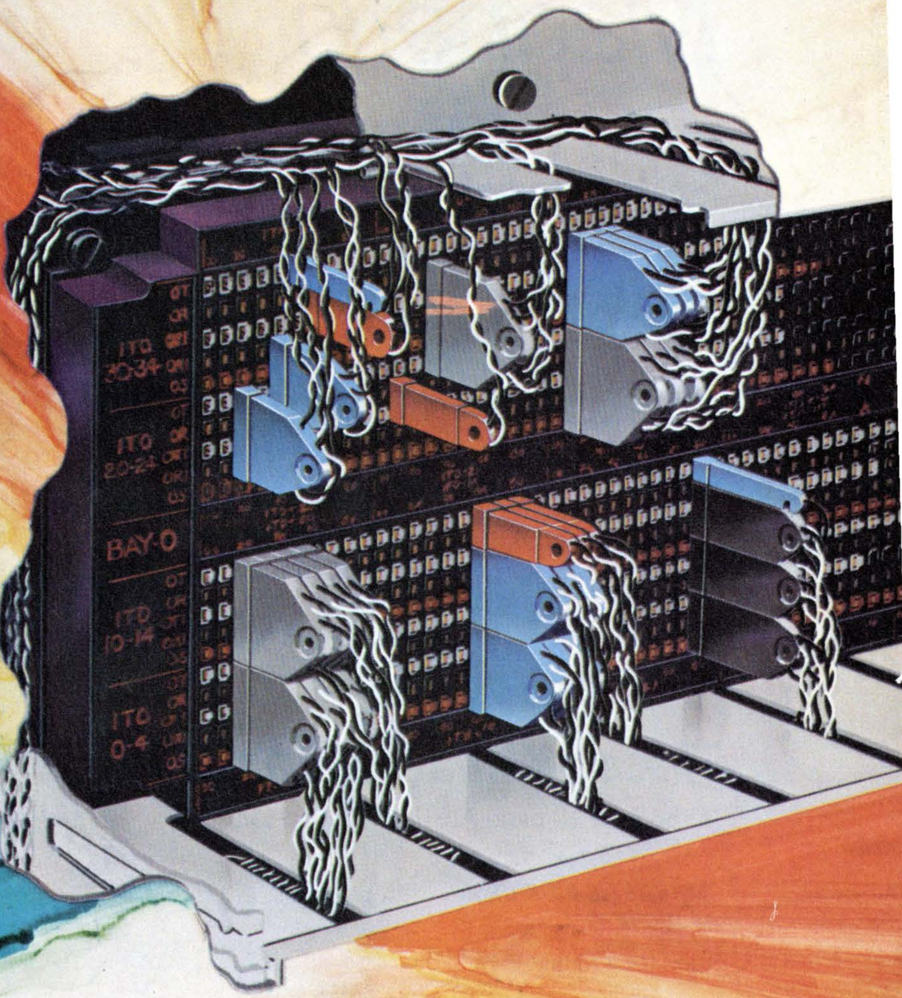
12-bit converter uses little power

Hybrid Systems' contribution to this year's IEEE show is the ADC-575-12, a low-power analog-to-digital converter that operates from a single power supply. The 12-bit a-d device is packaged in a small module 2 by 0.4 inches with a pinout compatible with dual in-line packages.

Designed specifically to need little power, the ADC-575 uses a single source of +12 volts to +15 V and consumes only 30 milliwatts of power. Hybrid claims this is significantly lower than most 12-bit a-d

New from Cinch: compact, easy interconnection

for switching and test panels, programming boards, and other patch cord systems



Originally developed and successfully used for telecommunications applications, this Cinch CCB circuit concentration system may now be the answer to *your* complex interconnection problems.

One side of the panel assembly is wirewrappable, for automatic, semi-automatic or hand wiring. The other side accepts polarized, positive detent, single through six-pin, color-coded patch cord plugs for rapid circuit changes.

Color coded panels have raised, high-visibility, replaceable marker strips. Contacts are on 0.200" centers and individual contact modules can be replaced in seconds. The compact CCB system is remarkably easy to install, modify and maintain.

For detailed information call TRW/Cinch Connectors at (312) 439-8800 or write TRW/Cinch Connectors, an Electronic Components Division of TRW Inc., 1501 Morse Ave., Elk Grove Village, Ill. 60007.

CM-7310

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Circle 155 on reader service card

converters which may consume as much as 10 times that much power. A Hybrid spokesman notes that some a-d converters reduce their average power drain by shutting off the analog section when the device is not in use; the ADC-575 is never shut off.

The heart of the ADC-575-12 and the key to the minimal power drain is the use of delta-sigma modulation, which is provided by the Deltaverta, a product recently introduced by Hybrid Systems. The Deltaverta converts its input to an output pulse rate by maintaining a charge balance across an integrating capacitor. The pulse rate, in turn, controls the amount of charge that is applied to achieve balance. The Deltaverta eliminates the need for a power- and space-hungry ladder network through high-quality integration, even though this raises the conversion time of the device to 100 milliseconds.

By a simple change in its pin-interconnections, the ADC-575 can be made to convert either unipolar (0 to +10 v) or bipolar (−10 to +10 v) input signals. The unit can also provide corresponding C-MOS-level binary or offset binary output codes to within ±½ count linearity (0.02%). The device contains an internal dc-to-dc converter that provides the necessary bipolar offset.

The minimum input impedance is 10 milliohms for unipolar signals and 400 kilohms for bipolar signals.

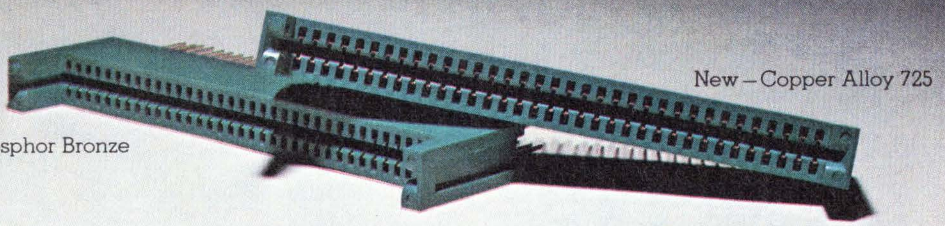
The gain stability in relation to temperature is 30 parts per million per °C, and offset drift is 5 ppm/°C. Specified temperature range is 0 to 70°C.

Hybrid Systems' ADC-575-12 is designed for such battery-powered applications as portable instrumentation and for point-of-measurement conversion of remote transducer outputs. It is also suitable for measuring many geophysical and oceanographic parameters.

The ADC-575-12 converter is priced at $199 each in quantities of one to nine.

Delivery time for the unit is two weeks.

Hybrid Systems Corp., 87 Second Ave., Burlington, Mass. 01803. [387]



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This allowed Honeywell to get more gold where it is needed – at the contact point. More gold at the contact point increased connector life ten times; made possible by CA 725.

Honeywell's connector manufacturer, Winchester Electronics, knows that CA 725 has a lot to offer in the way of good mechanical properties and excellent fabricability. CA 725 is a standard material available from many copper and brass sources.

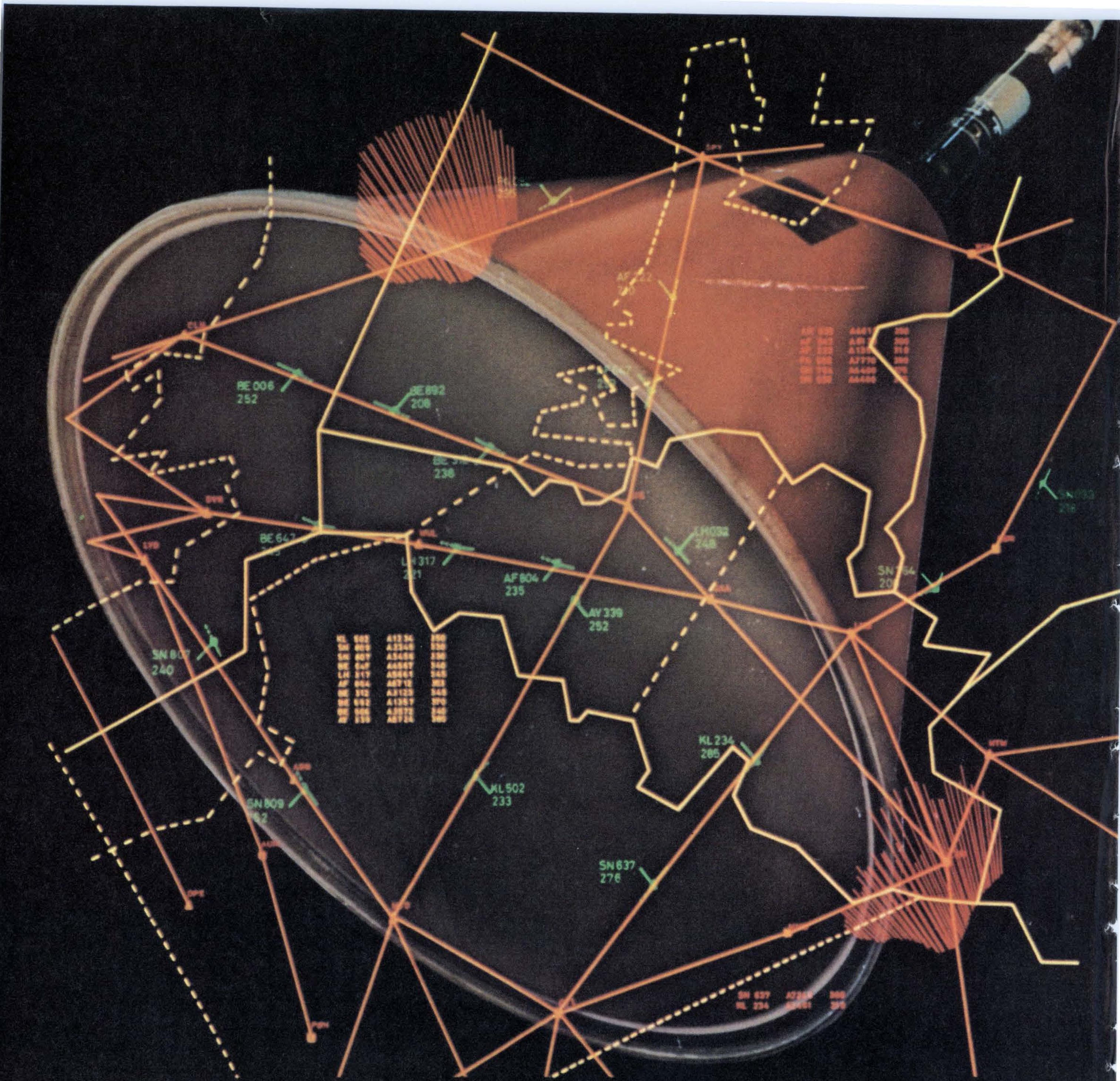
Why don't you consider a change for the better? For more detailed facts about CA 725, write The International Nickel Company, Inc., Dept. 3373, One New York Plaza, New York, New York 10004.

Honeywell's new main frame connectors are manufactured by Winchester Electronics.

INCO

THE INTERNATIONAL NICKEL COMPANY, INC.

Circle 157 on reader service card



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Schottky-TTL controller put on a chip

Four-bit microcontroller can do job of 24 TTL MSI packages and uses less power; it emulates midicomputer systems with a fraction of the DIP count

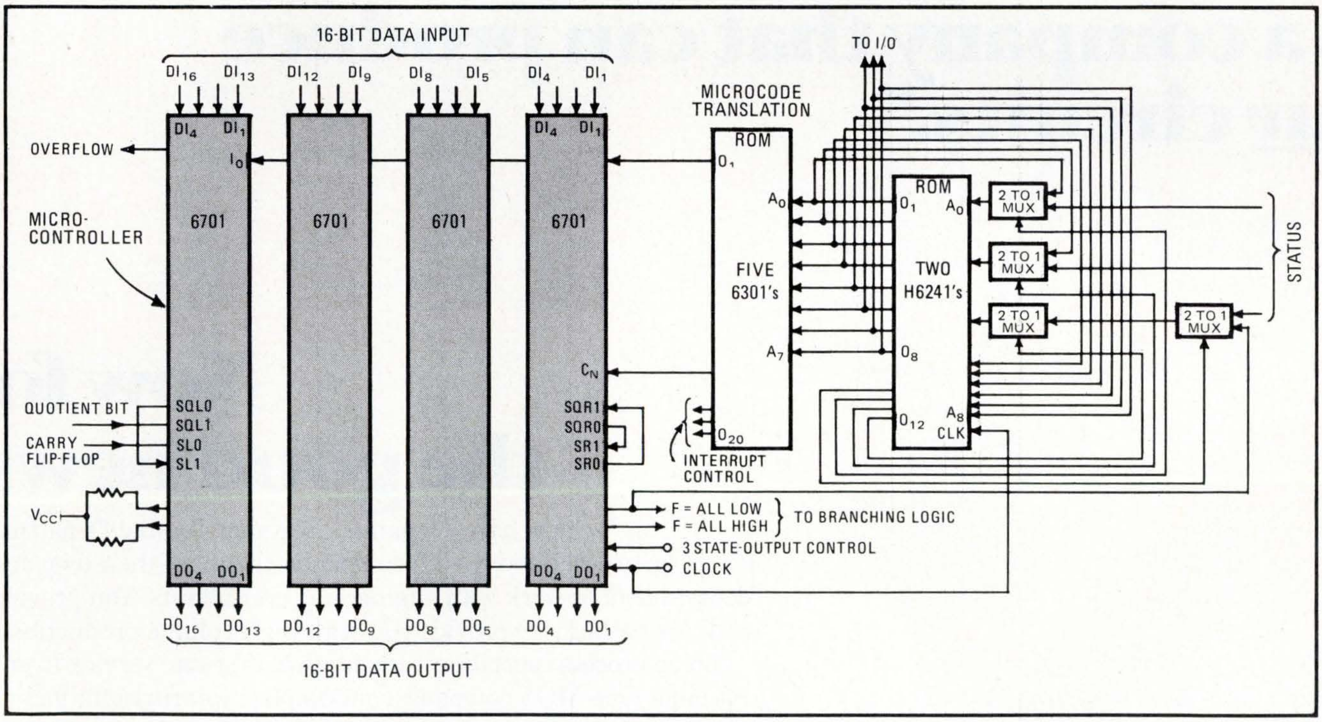
by Laurence Altman, Solid State Editor

Large-scale integration, until recently a technology of benefit only to MOS-circuit manufacturers, has been adapted to bipolar data-processing circuitry—with significant results. Monolithic Memories, Sunnyvale, Calif., has built a bipolar microcontroller—a complete 4-bit Schottky LSI processor slice on a single chip. It can do the job of 24 TTL MSI packages and save 6 watts of power in the process. Indeed, with a gate complexity of 1,000 (the largest bipolar processor chip available), the 5701/6701 microcontroller with only 28 packages can emulate a Nova-level computer, whereas a typical Nova's CPU board requires 175 packages.

Dale Williams, marketing manager, claims that the 6701 is "ideal for upgrading or replacing existing computers because no new software is needed, and it's extremely flexible. Since the microcontroller is 4-bit expandable, machines in all classes can be emulated with a minimum number of packages—from 8-bit single-chip MOS processors, such as Intel's 8080, to the higher-performing 8-bit multichip minicomputers, right up through the 16-bit midimachines. Even the 32-bit maxis, such as the IBM-360 types, are in the 6701 range."

The 6701 microcontroller contains an impressive array of circuitry; bit shifters, a multiport 16-by-4 RAM, control registers, multiplexers, arithmetic/logic unit, and 352 bits of ROM, in addition to clocks and output-control drivers. A total of 256 instructions is possible, providing full arithmetic, logic, and shifting capabilities. There are 16 directly addressable two-port general-purpose accumulators, and a separate accumulator-extension register.

The two-address capability of the 6701 (ability to work on two accumulators simultaneously) and the powerful microinstructions permit design of hard-wired central processors having sub-microsecond cycle times or the efficient emulation of conventional machines through use of read-only memories for microprograming. The microcontroller will handle the data-flow section of



Low count. Typical special-purpose microprocessor has four 4-bit controllers, five 6301 ROMs, two H6241 ROMs, four TTL shift registers

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"What we need is a company that can produce our circuits."

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AMERICAN MICROSYSTEMS, INC.

Circle 160 on reader service card

most computers, since it is expandable to handle any word length in increments of 4 bits without significant speed degradation (look-ahead outputs are available). The 16 on-chip general-purpose accumulators give the microcontroller the type of central processor usually found only in high-performance 16-bit minicomputers and 24- or 32-bit computers.

The microcontroller can be thought of as a general-purpose 4-bit register and arithmetic/logic unit with separate A operand, B operand, and data-in and data-out ports. Additional accumulators or registers can be added by tying off-chip packages to the microcontroller's data-in pins.

When compared with its TTL MSI equivalent, the single-chip microcontroller has 350 fewer input-output pins and 19 are replaced—14 16-pin packages and five 24-pin packages. In board area, this saves about 40 square inches. To emulate the Nova-class minicomputer, for example, would require only four 6701 controllers, 14 ROMs or programable ROMs, say of the 5301/6301 type, four or five registers, three gates, and two multiplexers—a total package count of only 27 or 28.

Besides package reductions, instruction times in 6701 systems are reduced, as well—following from the 6701's speedy 150-ns cycle time. A jump, for example, is done in two microcycles that take 400 ns, compared to Nova 800's 800-ns jump time. Jump-to-subroutine takes 3 microcycles or a total of 600 ns, compared to Nova's 800 ns, Monolithic Memories says.

"Aside from emulating existing machines," asserts Williams, "the 6701 will also be useful in new applications, such as tape and disk controllers, point-of-sale terminals, process-machine control, word-processing and navigation systems, intelligent terminals, game machines, and traffic-control systems—anywhere high computer performance is required in small space using a minimal number of packages." Deliveries will begin in July.

Monolithic Memories Inc., 1165 East Arques Ave., Sunnyvale, Calif. 94086 [339]

Nickel-boron plating may replace gold

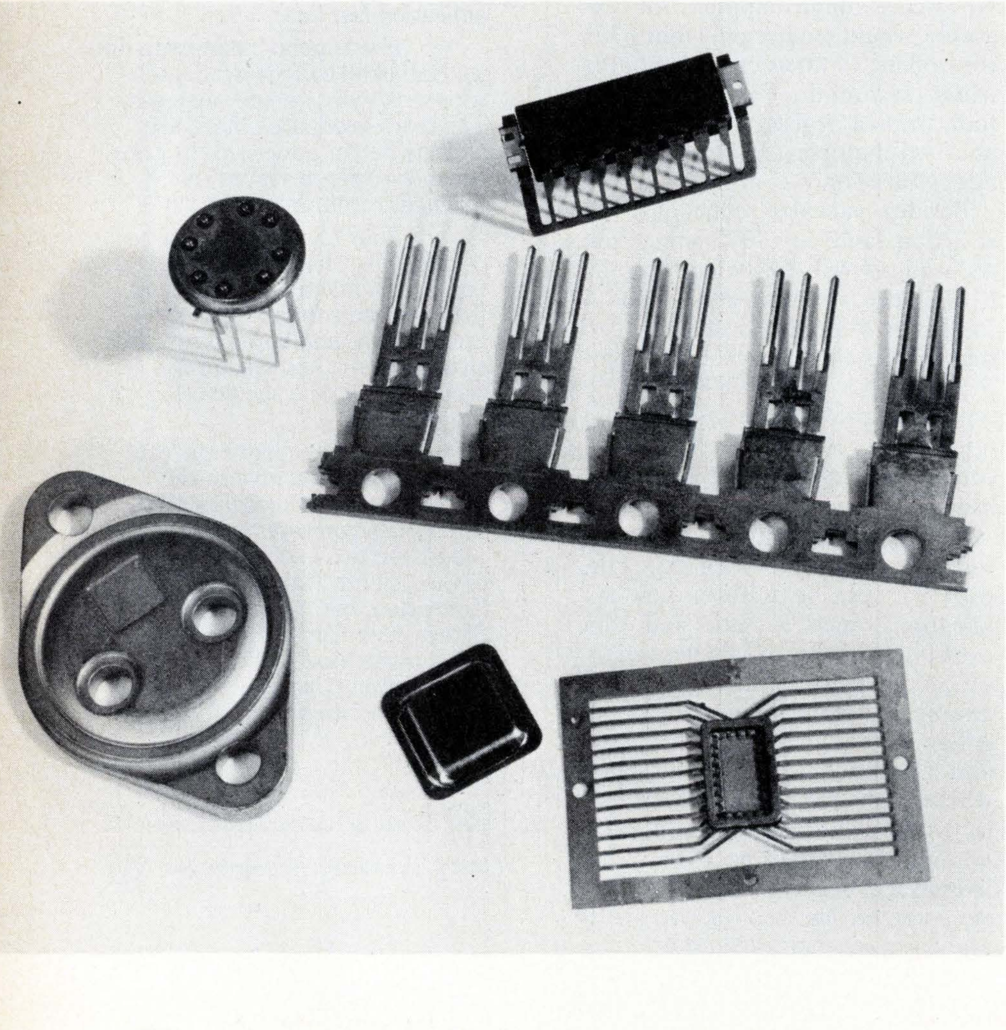
Plating for connectors, printed-circuit boards is one tenth the price; it's corrosion-resistant, solders well with rosin fluxes and wire bonds

by Stephen E. Grossman, Packaging & Production Editor

Gold plating on connectors and printed-circuit boards costs more than $100 million a year, but researchers at Du Pont have developed a nickel-boron substitute that they say rivals gold in performance for a tenth the price. The new material, called Sylek 201, consists of a nickel plating solution that weighs only 1% as much as boron.

For packaging engineers, the nickel-boron plating means they may be able to replace the costly metals that now house semiconductors with a relatively inexpensive nickel-boron-plated steel. Nickel-boron may make this substitution possible because the plating, besides being relatively immune to corrosion, solders with rosin fluxes and wire-bonds quite well. The plating may also replace gold on the contact fingers of printed-circuit boards.

Promising plating. Sylek 201, a nickel-boron plating solution, developed by Du Pont as a substitute for gold, may greatly reduce the cost of semiconductor components such as the lead frames, headers, and other electronic packaging components shown below.

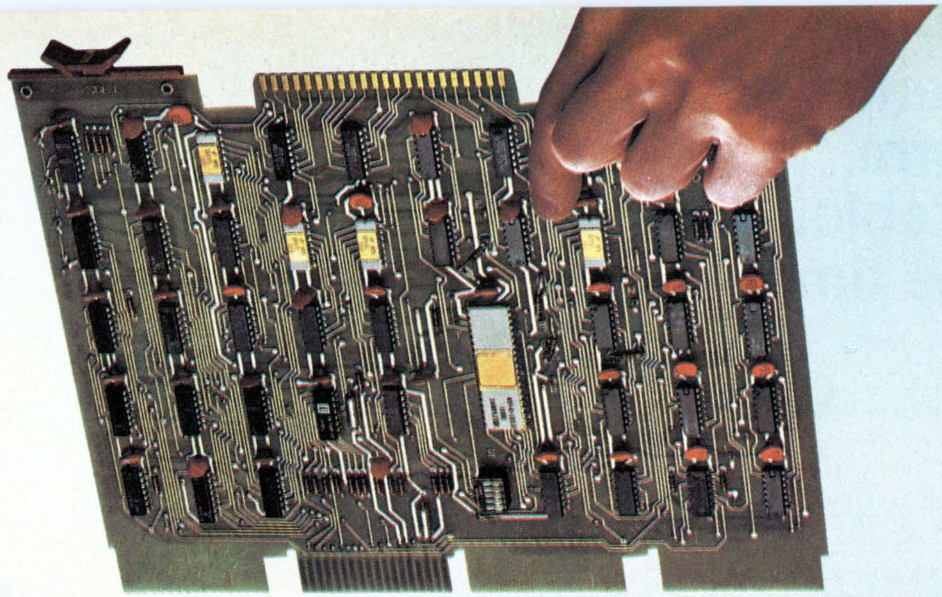


Despite the moves toward leadless designs and tin-alloy contacts [*Electronics*, Feb. 1, 1973, p. 86], gold plating is still used almost universally. This is because it forms virtually no surface films and, when two gold contacts mate, the resistance across the interface is low—on the order of 5 milliohms. Equally important, the resistance of a gold-plated contact remains low when subjected to all kinds of hostile environments.

While the contact resistance of Sylek 201 is somewhat higher than gold—about 15 milliohms—it is satisfactory for virtually all connector applications, according to Harold E. Bellis, laboratory manager of Sylek plating products. Bellis also states that the contact resistance of Sylek 201 remains low through a whole battery of environmental tests such as humidity, hydrogen sulfide, and high temperature (250°C). Even salt spray fails to raise the contact resistance above 25 milliohms, he says.

In addition, Sylek 201 plates out at about the same rate as gold—250 microinches per hour. And, since the solution is autocatalytic, it requires no electroplating setup, and thus can be used to plate nonconductive materials such as plastic and ceramic. Du Pont says Sylek 201 wears as well as chromium, yet it is ductile enough to survive flexing and deformation without cracking. The plated surface costs about $40 per square foot-mil.

Industrial Chemicals Dept., Du Pont Co., Wilmington, Del. 19898 [403]



Plug this in, and you've just designed a custom data acquisition interface.

Nothing to it.

Just plug in a few modules and tap in your instructions.

The new PDM70 programmable data mover will sample your sources, transmit your data in serial ASCII to a remote computer, and return control instructions to local devices. If you want, it can also communicate interactively, without computer intervention, between sources and local peripherals.

Off-the-shelf modules connect the PDM70 to any computer, to analog and digital input devices, and to such computer peripherals as Teletypes, X-Y recorders, storage oscilloscopes, printers, modems, and LED displays.

System prices start at $2000.

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We're Digital Equipment Corporation, Logic Products Group, Maynard, Mass. 01754. (617) 897-5111, extension 2785.

In Canada: P.O. Box 11500, Ottawa, Ontario, K2H 8K8. (613) 592-5111.

In Europe: 81 route de l'Aire, 1211 Geneva 26. Telephone: 42 79 50.

We think interfacing is so important, we've devoted an entire department to it. digital

Circle 163 on reader service card

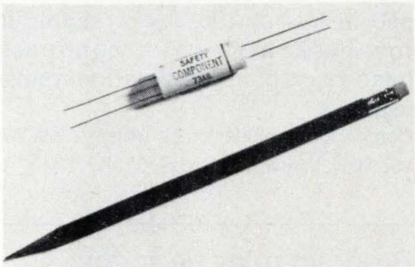
Components

Paper capacitors take high power

Extra leads shut off Mylar-paper devices if they overheat

Mylar-paper capacitors aren't known for their ability to withstand high voltages, but a variation of a proven component of that type specifically designed for high-voltage circuits will make its bow in Booth 1216 at the IEEE Intercon 74.

That's where Electro-Motive Corp., a subsidiary of International Electronics Corp., will show the



newly designed El-Menco type MPCE four-lead device, which offers safe high-voltage operation in such applications as the high-voltage horizontal oscillator circuit of color-TV sets. Two-lead versions might cause fire, explosion, or melting of circuits and components in such applications after prolonged overloading.

In the four-lead version, when the capacitor is wired into a circuit, overheating will cause one or more of its four terminal connections to increase in dc resistance so that the capacitor shuts down. Shutdown can also be triggered by excessive vibration.

As with its two-lead forerunner, the four-lead unit is non-inductively wound with Mylar and paper, and it is vacuum-impregnated with mineral oil. The sections are enclosed in an impervious ceramic tube and sealed with a specially developed epoxy and fill.

The conventional two-lead El-Menco type MPCE capacitors have demonstrated excellent ac and pulse characteristics. They are used in TV-flyback circuits (15 kilohertz), power converters (400 Hz to 50 kHz), fluorescent-light circuitry (100 kHz), and in noise-filter circuits with peak currents of several amperes.

El-Menco type MPCE capacitors range from .001 microfarad to 1 μF. Dc-rated voltages of 1,000, 1,600, and 2,000 V are designed for the temperature range -40°C to +85°C. They offer capacitance tolerances of ±10% and ±20%.

In the 1,600-V dc range (the range in which the four-lead critical safety component is presently being manufactured), .001 μF capacitors measure 1.187 inch by .41 in.; .056 μF capacitors are 1.875 in. by .8 in.

International Electronics Corp./El-Menco, 316 South Service Rd., Melville, N.Y. 11746 [341]

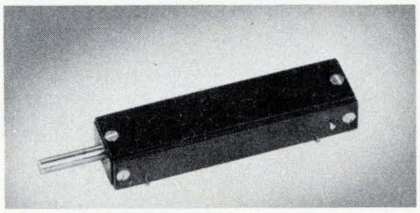
Stepper is aimed at floppy-disk applications

The Tormax model 020-029 stepper motor is designed for manufacturers of floppy-disk recorders. The output shaft of the motor is an integral lead screw, which is used to position read and record heads linearly. The device also offers a good torque vs displacement gradient, which makes not only for good settling time but also for the holding required for rapidly addressing information and maintaining track-to-track positional accuracy. Step angle is 15°, and maximum response rate is 220 pulses per second with a maximum input current of 1.65 amperes.

IMC Magnetics Corp., 570 Main St., Westbury, N.Y. 11591 [343]

Motion potentiometer is for automation uses

A miniature linear-motion potentiometer is designed for use as a position indicator for automatic machinery, such as industrial robots, servo valves, and actuators. The



model 120 provides a 1-inch stroke and has clearance holes for mounting. Various shaft endings, plain, threaded, or slotted, are available. The continuous conductive-film resistive elements are suitable for ac or dc operation without amplification. Linearity is to 0.1%, and resistance range is from 500 ohms to 100 kilohms.

Computer Instruments Corp., 92 Madison Ave., Hempstead, N.Y. 11550 [344]

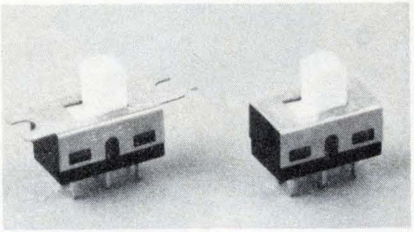
Lighted switches can be made into a keyboard

Users can make their own keyboard or data displays with a series of ½-inch push-button switches featuring independent lamp circuitry. Single-pole single-throw through double-pole double-throw functions are offered with ratings of 30 volts dc or 115 V ac, 2 amperes resistive, 1 A inductive. Minimum life is 100,000 operations. The series 61 is also available in momentary or alternate action with nominal operating pressure from 9 ounces.

Electro-mech Components Inc., 1826 North Floradale, S. El Monte, Calif. 91733 [345]

Subminiature slide switch inhibits flux contamination

Designated the Mini-Mike model 23-021-303, a subminiature slide switch is a double-pole double-throw unit with insert-molded ter-



minal pins specifically designed to inhibit solder and flux contamination. The use of thermoset plastic and gold-over-nickel-over-brass plating also provides low energy usage for pc-board applications, with minimal contact resistance. Quantity price is less than $1.

Chicago Switch Inc., 2035 Wabansia, Chicago, Ill. 60647 [347]

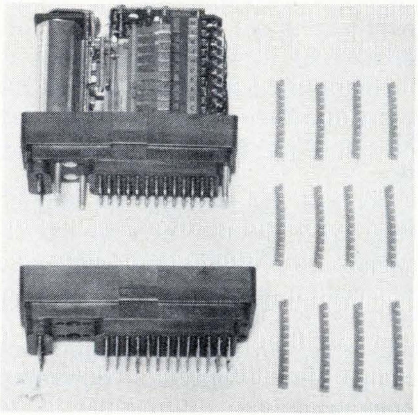
Liquid-crystal filters offer 51.2-MHz center frequency

A line of liquid-crystal filters, designated the 6918LA, offers a center frequency of 51.2 megahertz. Other specifications include a 3-decibel bandwidth of 28.4 MHz minimum, a shape factor of 1.5:1 at 30/3 dB. and an operating temperature of −10° to +65°C. The filters, priced at under $50 in lots of 100, are available in low-pass, high-pass, bandpass, band-reject or in combination configurations.

Damon Corp., Electronics Division, 80 Wilson Way, Westwood, Mass. 02090 [346]

Program relay performs multiple functions

The model P-69 program relay, using 12 in-line microswitches, performs multiple switching functions and is said by the company to fill the gap between complex relay gating and solid-state circuitry. The 12 microswitches are independently activated by interchangeable cam bars held in 12 slots around the periph-



THE NUMBERS GAME

(and how we can help you beat it)

Digital readouts. Ubiquitous in calculators and instrumentation. And the coming thing in all kinds of consumer gear. Appliances. Hi Fi. Cars. You name it.

You know it. We know it.

So what?

So, for starters, we can give you what nobody else can. All (that's right, all) of the standard character heights in the most commonly used digit combinations. With the best resolution in the business (because of our unique mask construction). And in easy to read, orange-red.

We call it DiaDigit.™ A differently designed, single envelope package, multi-digit gas discharge display. You don't need other package combinations to get what you want. It's IC compatible. Mechanically you handle it like other components in your system: leads like an IC, mounts directly to your PC board, no fancy sockets to buy. It also has low power requirements. Super reliable. Sounds good, right? But by now you may be wondering just what our qualifications are. Good question. We're well known as the leader in innovative packaging to the semiconductor industry. (You guessed it. Logically, our package is based on DIP construction techniques. The processes used are our own patents.)

Bonuses: We're fast on specials. We can give you many combinations of letters, symbols and digits. Because we're geared to handle the unusual, and the simplicity of our design lets us deliver what you need.

Now, if you're hooked on the possibilities, but worrying about the price. Don't. We're competitive.

After all, we think the name of the game is numbers. And we want everybody to play.

We can't spell out all the details here. And you probably have our competitor's specs. All we ask is you compare ours. (Along with price and delivery.)

Diacon, Inc., 4812 Kearny Mesa Road, San Diego, California 92111. Or phone 714/279-6992.

Diacon

Circle 167 on reader service card

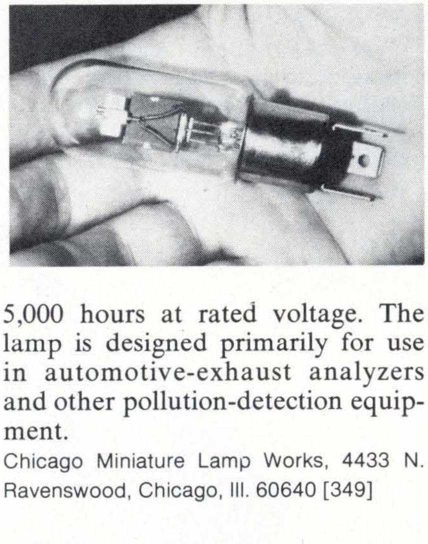
DiaDigit is a trademark of Diacon, Inc.

ery of a rotating cylinder. In each of the 12 operating positions, reached through an ac- or dc-powered stepping mechanism, any one of more than 1,000 combinations may be programed. When two or more relays are connected in series or parallel, the number of permutations multiplies accordingly.

Global Marketing & Management Inc., 947 Beau Drive, Des Plaines, Ill. 60016 [348]

Infrared lamp emits from 0.4 to 5 μm

An infrared lamp source, called the model CM8-3968, emits a spectrum wavelength from 0.4 to 5 micrometers. The device also operates on a total power input of 33 watts at 12 volts ac or dc and offers a life expectancy averaging in excess of



5,000 hours at rated voltage. The lamp is designed primarily for use in automotive-exhaust analyzers and other pollution-detection equipment.

Chicago Miniature Lamp Works, 4433 N. Ravenswood, Chicago, Ill. 60640 [349]

Heat sinks cool T0-116 devices

Dual in-line heat sinks are available in four styles to cool T0-116 and similar devices without taking up extra board-space. The models 141 and 142 measure 0.40 by 0.75 inch, the models 143 and 144 measure 0.25 by 0.75 in., and the model 145 is 0.21 by 0.75 in. The models 141 and 142 can also be used on ½-inch-wide microcircuit packages.

Aham, 968 W. Foothill Blvd., Box 909, Azusa, Calif. 91702 [350]

(Time to get serious about uninterruptible power sources.)

America's romance with energy is cooling off. We're running out of steam, out of waterfalls, out of electricity from any source. And as our power becomes less available, brownouts and blackouts become more likely. (Just ask your computer.) Fortunately, there's still time to install an Elgar Uninterruptible Power Source. It will protect your computer system against voltage dropouts and brownouts (regulation to ± 2%; up to 40 dB line transient reduction) and give 10 minutes of backup power in the event of a blackout. Write or call for details today... while you still have the energy.

Elgard Uninterruptible Power Sources are available in 500 VA to 15kVA models. They supply up to ten minutes of instantaneous reserve in case of power failure; and they have self-contained, maintenance-free batteries. Ideal for IBM Systems 3 and 7, DEC PDP Series, Burroughs Banking Systems, and Litton/Sweda P.O.S. Systems. Priced from $1,895.

ELGAR

8225 Mercury Court, San Diego, CA 92111 Phone (714) 565-1155

Instruments

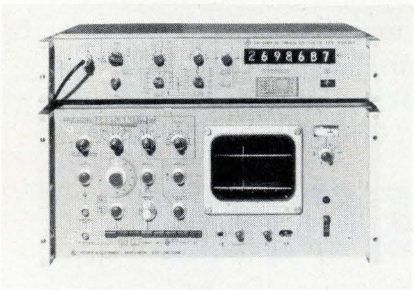
Analyzer boasts tuning accuracy

Spectrum-measuring unit operates in either frequency or time domain

Spectrum analyzers suffer from sensitivity problems and tuning uncertainties that make it difficult to use them on very weak signals, especially in the presence of stronger ones. To detect a very weak signal, a very narrow i-f bandwidth must be used—but a very narrow i-f passband must be positioned with great accuracy to ensure its being centered on the weak signal. This means that excellent tuning accuracy and low frequency-jitter are necessary for the acquisition of weak signals.

Rohde & Schwarz has therefore incorporated a very fast-responding varactor-tuned local oscillator, and a series of i-f filters with extremely steep skirts into its latest analyzer. Called the Analyskop EZF, the instrument is said to provide 1,000 to 10,000 times the tuning accuracy of more conventional instruments. The unit spans the frequency range from 6 kilohertz to 170 megahertz in four overlapping bands. With its add-on uhf tuner, model EZFU, the instrument's frequency range is extended to 2.7 gigahertz in two additional ranges.

Input sensitivity of the analyzer over a 1-kHz i-f bandwidth varies from about 0.5 microvolts to about 1 μV, depending upon frequency. The 1-μV figure applies at the top of the uhf tuner's range—2.7 GHz. The bandwidth can be made as small as 50 Hz with an accompanying improvement in sensitivity of three to five times.



In addition to functioning in the frequency domain as a normal spectrum analyzer, the Analyskop can also make time-domain measurements. In this mode, the frequency scan is stabilized at a selected point in the displayed band, and the frequencies passed by the i-f filter then in use are fed to either an a-m demodulator or an fm discriminator. The waveform that results is then displayed in the time domain by a time base that is synchronized with the input signal to provide a stationary display. When stabilized, the analyzer's local oscillator has approximately 1 Hz of residual fm noise on it.

With the uhf tuner, frequency is indicated from 0 to 2.7 GHz by means of a seven-digit counter. Tuning accuracy is within 1 kHz to 10 kHz, depending on range, while frequency resolution varies from 10 Hz to 1 kHz.

The basic Analyskop EZF is priced at $18,485, and the uhf tuner adds $8,070 to the price.

Rohde & Schwarz Sales Co., Inc., 111 Lexington Ave., Passaic, N. J. 07055 [351]

Three plug-ins added to 60-MHz scope family

Two amplifer plug-ins, models 5A38 and 5A45, and a time-base plug-in, model 5B40, have been added to the 5400-series of 60-megahertz oscilloscopes. The model 5A38 is a dual-trace amplifier with a 35-MHz bandwidth. It is intended for applications requiring more than the 2-MHz bandwidth of the company's 5100-series amplifiers but not requiring the full 60-MHz bandwidth of the 5A48 dual-trace amplifier. For applications requiring a wider bandwidth, but needing only a single channel, the 5A45 amplifier plug-in offers a 60-MHz bandwidth with a sensitivity rating from 5 millivolts per division to 10 mV/division. The 5B40 timebase unit provides sweep

generation and an external amplifier. Sweep rate ranges from 5 seconds per division to 10 nanoseconds per division. Price for the 5A38 is $350; the 5A45 is priced at $250, and the model 5B40 is $275.

Tektronix Inc., Box 500, Beaverton, Ore. 97005 [353]

Recorder delivers copy at 90 lines per minute

With a speed of 30 sweeps a second or 90 lines of data per minute, the model 600 Push-to-Print recorder employs a facsimile technique on electrosensitive paper. The instrument is meant to work with conversational terminals using bistable storage tubes. TV or CRT terminals can also be interfaced with the recorder directly through a scan converter. Paper advance is 100 lines per inch, and 400 frames can be provided on a 200-foot roll of paper. Price of the recorder is $2,500,

Think AVX NiGuard™

- **eliminates silver scavenging**
- **prevents base metal bleed-thru**
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- **allows either soldering or bonding**

AVX's development of a new, exclusive technique for applying silver, nickel and gold terminations on ceramic chip capacitors is another example of AVX technical leadership.

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Nobody makes more . . . or better multilayer capacitors than AVX. This combined with AVX technical leadership means you can depend on AVX to deliver consistent quality chip after chip after chip. Available in a wide range of sizes. Meets all standards including EIA, and high reliability MIL C-55681A specifications. Whether you need chips in ½ pf to 50 mfd ranges or higher, AVX can supply them. Need applications assistance, it's yours for the asking.

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P.O. Box 867, Myrtle Beach, S.C. 29577.
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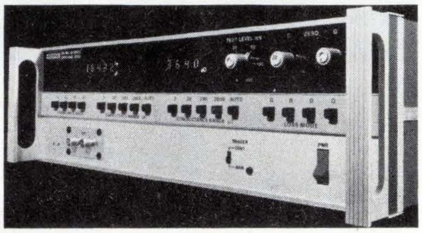
AVX

THE CERAMIC CAPACITOR MANUFACTURER

and delivery time is 60 days.
Alden Electronic & Impulse Recording Equipment Co., Alden Research Center, Westboro, Mass. 01581 [356]

Capacitance bridge operates at 1 MHz

A capacitance bridge operating at 1 megahertz provides automatic programable capacitance and conductance measurements. The versatile instrument displays changes of ca-



pacitance or percentage of change in relation to an internally stored reference, as well as series or parallel resistance, dissipation, and Q. Features include a 2-picofarad full-scale sensitivity, autoranging, and continuous and manual trigger modes. Price is about $4,900.
Boonton Electronics Corp., Rte. 287 at Smith Rd., Parsippany, N.J. 07054 [355]

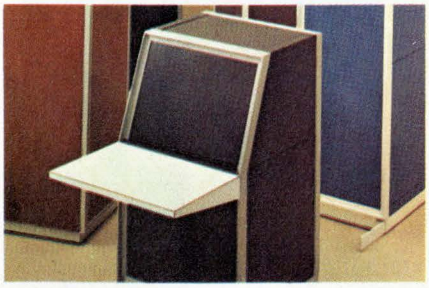
Fm/a-m modulation meters measure narrow deviations

The model 2300B fm/a-m modulation meter measures narrow deviations. The instrument uses a tuned local oscillator that reduces internal fm noise and almost eliminates microphonics. Fm deviation as high as 500 kilohertz can be measured at carrier frequencies to 1,200 megahertz, and a-m depth can be measured to 95% at carrier fre-

When the questions are about enclosures, Optima has beautiful answers.

Whether packaging small, digital multimeters or a huge, communications center, you need enclosures with structural integrity, access, and versatility. Doing their job and doing it well.

How do you get them? Consider the alternatives... job shop?... in-house construction? ... a manufacturer? To decide, it is important to ask the right questions and get the right answers.



Sales Appeal

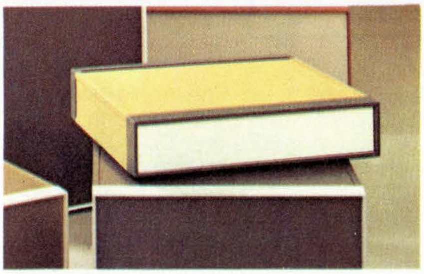
The first ten seconds of display for an electronics unit focus simply on its style, color and finish. They won't break a sale—the equipment inside does that. But they can sure help make one.

- Is an industrial designer with packaging skills involved?
- Can you get the superior vinyl finishes so much in demand today? Or woodgrains? Or special textures?
- Is a total range of designer colors on hand?

Versatility

An important sales tool is the ability to adapt to the changing needs of a client.

- Does a source offer hundreds of configurations to choose from? If, for instance, your client is thinking vertical rack, but wants the operator seated, can you offer a console-desk?
- Does a client need a ventilating grille? a blower? stabilizers? Wouldn't drawer slides help his operations? What about writing surfaces, storage areas, drawers, casters? Are they in production, on line and ready to go?



Customer Service

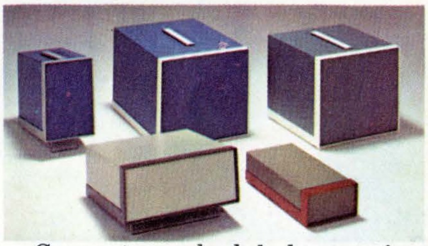
Are your own needs being served?

- Can you get personal service from engineers, designers, and production people?
- Can you get special applications assistance?
- Does your source have a knowledgeable customer-service representative?

The Optima Line

Our line of enclosures for electronics is the product of finding good answers to tough questions. Whether your question is component access, cooling, special applications or new product development and even safe shipping—we're ready!

Ready with Small Cases in 24 sizes from 133.6 to 1445.4 cubic inches; Instrument Cases and Racks in 124 sizes for 19- and 24-inch panels; Desk Consoles which are adaptable systems of instrument housing, counter and storage space; and the unique combination of chassis and case-Optima 17.



Computer scheduled manufacturing assures you of top quality control. We finish each unit inside and out with rugged vinyl and assemble them for final inspection—including most options and accessories—right at the plant.

Optima is the best answer. No question about that.

Write Optima Enclosures, 2166 Mountain Industrial Blvd., Tucker, Ga. 30084 or call (404) 939-6340.

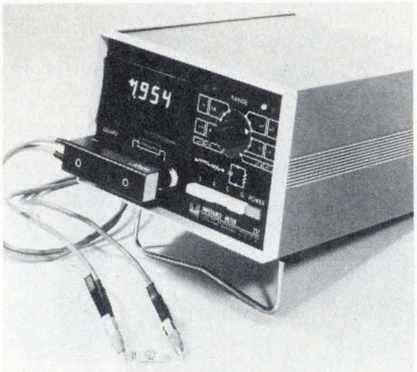
OPTIMA

Other Scientific-Atlanta Inc. Divisions are • Cable Communications • Instrumentation • Electro-Systems • Southern Tool and Machine • Security quencies to 400 MHz. Applications are in fixed and mobile communications, telemetry, and multichannel links. Price is $2,650.

Marconi Instruments, 111 Cedar Lane, Englewood, N.J. 07631 [354]

Digital impedance meter is accurate to 0.25% plus 1 digit

The model 275 digital impedance meter, which has an error of 0.25% plus one digit, makes four-terminal measurements of capacitance, inductance, resistance and conductance. In addition, lead resistance, leakage impedance, stray field effects, and temperature and humidity problems are said to be eliminated through the use of redundant circuitry. An

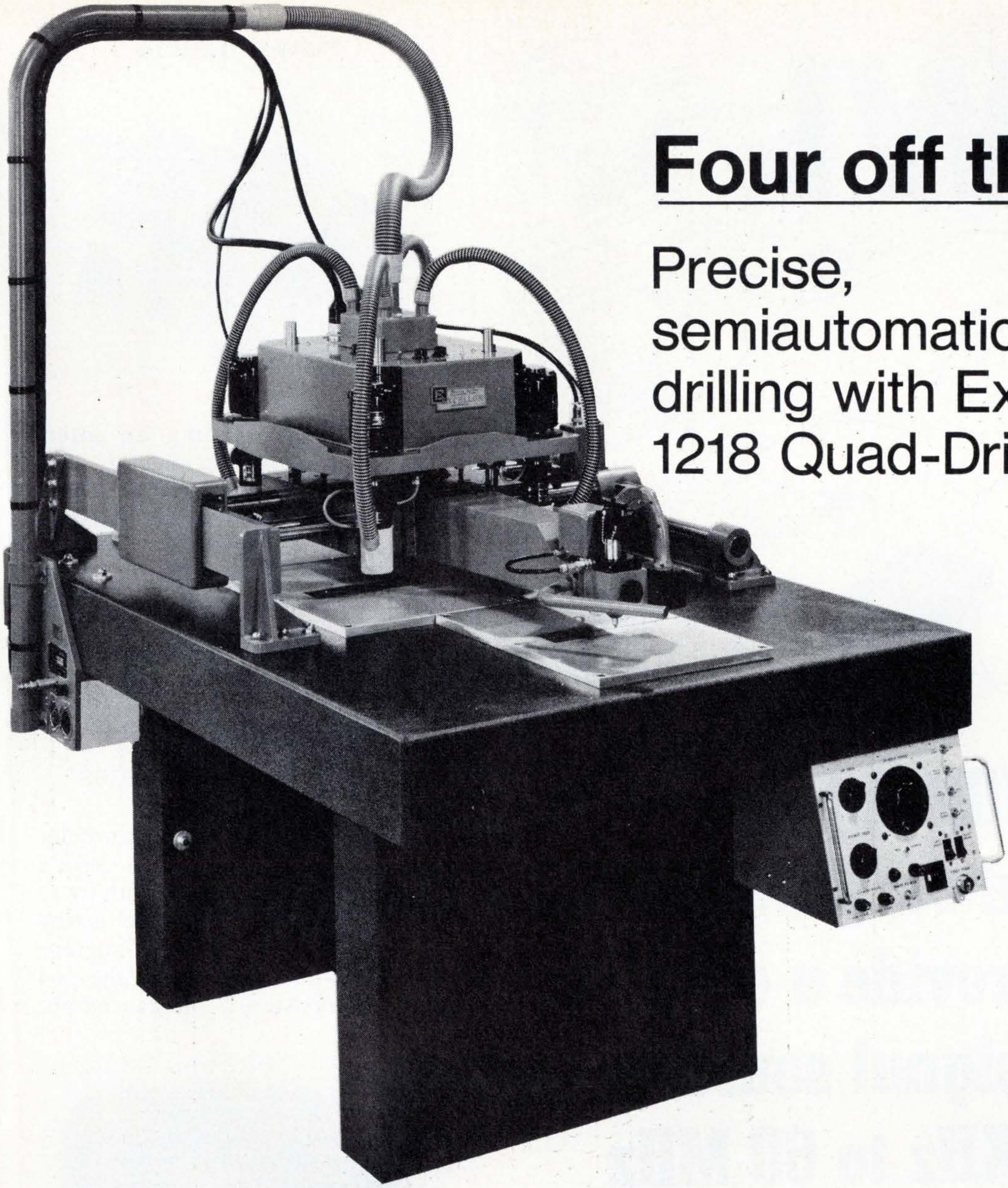


external guard signal is available on the front panel to keep stray shunt impedance from influencing the measurements; only function and range need be set. Indicator lamps tell the operator which functions are being used. Price is $990.

Electro Scientific Industries, 13900 N.W. Science Park Dr., Portland, Ore. 97229 [357]

Slotted lines measure from 2 to 26.5 GHz

The type 5240-series of slotted lines provide measurements over a range of 2 to 26.5 gigahertz of standing-wave ratio or impedance of instruments equipped with SMA connectors. To achieve the lowest residual SWR, the measuring connector is mounted directly to the slotted-line



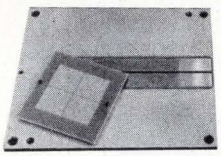
Four off the floor.

Precise, semiautomatic drilling with Excellon's 1218 Quad-Drill.

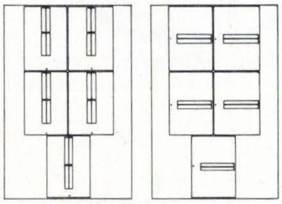
When you need short- to medium-run drilling at mass-production rates — and incidentally, almost eliminate template costs — consider Excellon's new 1218 Quad-Drill. This four-spindle machine offers both precision drilling of pc stacks and an adjustable, semiautomatic drilling cycle by a template-following stylus. An exceptionally flat, rigid, dimensionally stable working surface is created by a massive granite surface plate on a granite base.

Machine takes, in addition to template, four stacks of 12.5" x 18.5" boards. Despite the variable factors in hit rates, a conservatively estimated production rate of one million holes per day per machine can be achieved.

Very short loading/unloading cycles and extremely high registration accuracy are achieved through unique bushing-and-slot tooling plates.



Unique tooling plate provides spindle registration of circuit stacks, minimum downtime, with any tooling pin center distance.



The 1218 maintains ±0.001" accuracy indefinitely. Template-making or short production runs can be accomplished directly from circuit art. In fact, the cost of templates made this way is so low, it can be virtually ignored in relation to hole-production cost. That's no small savings in itself.

All in all, it's fast, it's neat, and it gets the job done economically. For more on the 1218 Quad-Drill, call Dick Hogan, Sales Manager, at (213) 325-8000. Or write.

Excellon Automation
A Division of Excellon Industries
23915 Garnier Street
Torrance, California 90505
Phone: (213) 325-8000
Telex: 67.45.62 Cable: Excellon Torrance

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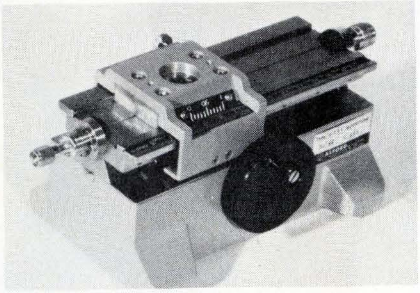
Circle 175 on reader service card

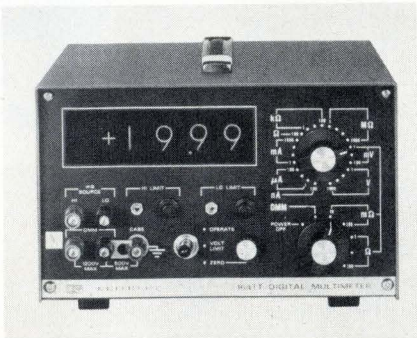


body without needing an intermediate precision connector. The residual SWR of these precision SMA slotted lines is tentatively rated at 1.05 to 18 GHz and 1.065 to 26.5 GHz. Price is $1,940.

Alford Manufacturing Co., 120 Cross St., Winchester, Mass. 01890 [358]

Milliohm digital multimeter measures over 13 decades

The 3½-digit model 164 multimeter measures resistance over 13 decade ranges with an over-all sensitivity of 10 microhms to 2,000 megohms by means of a dc constant-current method. The 28 ranges of the 164 include resistance measurement



from 10 microhms to 2,000 megohms, a voltage span of 1 microvolt to 1,000 volts dc, and over-all dc current sensitivity of 0.1 nanoampere to 1 ampere. Other features include analog output for recorder monitoring, 1,000-volt overload protection, 500-V floating capability, 80 dB normal-mode and 120 dB common-mode ac rejection, and 100% overranging on all except the 1,000-V range. Price is $995.

Keithley Instruments Inc., 28775 Aurora Rd., Cleveland, Ohio 44139 [359]

We put the Guardian Angel **TO THE TEST!**

"Hey, Angel," we said, "lots of engineers need a very small relay (like with all terminals on .1″ grid for PC boards) but they want it to carry a big load (like up to 50 amps)."

"Easy," said the Guardian Angel.

"Wait," we said, "this relay must be very dependable (like for computers and business machines) but must be very low cost (like for the competitive appliance business)."

"Not so easy," allowed the Angel.

"There's more," we told her. "Engineers want this relay in dozens and dozens of variations (like 5 to 50 amps, SPST to DPDT and everything in between). Oh, and AC or DC."

The Guardian Angel looked at us like we were nuts.

"And while you're at it," we went on, "give it a temperature range −45°C to +70°C... life span over 10,000,000 operations... and bring it in at about an ounce."

The poor kid just started to cry.

"Look," says we, "you're supposed to be *THE* Guardian Angel of engineers, so let's see you do your stuff. PASS US A MIRACLE, BABY!"

DID THE GUARDIAN ANGEL SUCCEED?
Or did she fall on her pretty patoot?

SEE NEXT PAGE FOR THE EXCITING ANSWER

Semiconductors

Calculator chip has 8 functions

IC for business, scientific machines also offers full memory control

Calculator manufacturers—those who make commercial and scientific machines—want to pack as many functions into one chip as possible. The newest calculator chip from MOS Technology Inc. does just that; it offers eight functions with full memory control.

Donald L. McLaughlin, engineering vice president, says that the chip operates a maximum of 30 keys. The user implements his calculator simply by electrically connecting his keyboard to the chip according to MOS Technology's instructions. While he doubts many users will want the full 30-key capability, "the flexibility is there if he needs it," McLaughlin says.

The eight basic functions provided by the MPS 2541-007 are add, subtract, multiply, divide, percentage, square root, reciprocal, and square. McLaughlin notes that the square-root function, the most complex, was included by reprograming one of the company's existing 512-word calculator chips with an algorithm written to add in both the square root and the full memory control.

Seven memory-control keys can be implemented with the chip, beginning with the simple "clear memory" function, moving to the "recall memory" step, which transfers the contents of the memory register to the entry register without modifying data stored in memory, and on to five others. The "memory total" function transfers the contents of the memory register to the entry register and clears the memory register. The "memory add" operation adds the number displayed to the memory register without changing the display, while the "memory subtract" step subtracts the displayed number from the memory contents without altering the display.

There are also "memory plus/equals" and "memory minus/equals" operations available. The former executes a prior stored command and adds the result to the contents of the memory register, transferring the new value to the display; the latter does the same thing in the subtract mode.

McLaughlin says that the eight functions plus seven memory-control operations represents just about any combination a commercial or scientific calculator maker could require short of slide-rule complexity. The chip also incorporates an internal clock generator, direct segment drive for a LED display, a low-battery detection circuit, and display-cutoff circuit, minimizing the need for external components.

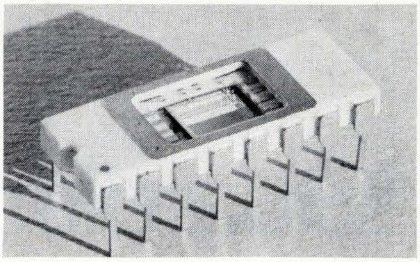
The price in 100,000 quantities is $12.75 each; prototypes will be available this month, with full production by late April.

MOS Technology, 950 Rittenhouse Rd., Norristown, Pa. 19401 [411]

Multiplexing technique packs 4-kilobit RAM in 16-pin DIP

Staking its new claim in the 4,096-bit RAM market on a substantial savings in memory-system real estate, Mostek Corp. has shrunk its random-access memory. Using a novel input-multiplexing scheme, Mostek fits the 4,096-bit part into a standard 16-pin dual-in-line package, an approach that should save considerable space in printed-circuit-board layouts. "We've also looked at pc-board-layout rules and automatic insertion equipment, and, taking conservative layout rules, we see that the 22-pin version takes 56% more space," says Bob Cook, applications manager.

The chip, which measures 157 by 185 mils, uses a single-transistor-cell design. A special self-aligned polysilicon interconnect enables elimination of all contacts from the memory matrix for increased manu-



facturing yields [*Electronics,* Dec. 18, 1972, p. 30]. To obtain the 16-pin configuration, Mostek breaks the 12 bits necessary to address the chip into two 6-bit bytes—the first 6 address one of 64 rows and the second, one of 64 columns.

Because the timing is more complex, the MK 4096, as it is called, requires two external clocks. But the chip's clock inputs are directly TTL-compatible, which eliminates the need for high-level drivers. In addition, clock-input capacitance is only 5 picofarads.

A multiplexer is keyed to the clocks to present to the chip either the row portion or the column portion of the address, in that order. The chip is selected as the column-address strobe goes negative. "But since a 2:1 multiplexer is necessary for memory-refresh of the 22-pin RAM, the complexity we're asking for in the controller design is that the multiplexer be 3:1," Cook points out.

Access time of the memory, which uses power supplies of +12, +5, and −10 volts, is 350 nanoseconds, and read and write cycles are 500 ns. Active power dissipation is less than 100 microwatts per bit; standby power is less than 2.5 μW per bit. The part, in quantities of 100, is priced at $45. Mostek expects a second source to be announced next month.

Mostek Corp., 1215 W. Crosby Rd., Carrollton, Texas 75006 [404]

1,024-bit RAMs provide 30-nanosecond access

A pair of bipolar 1,024-bit random-access memories developed by Signetics have typical access time of only 30 nanoseconds. The two ver-

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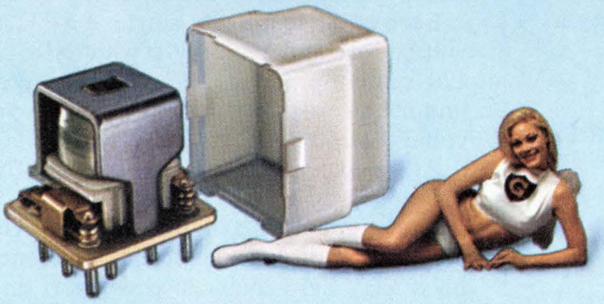

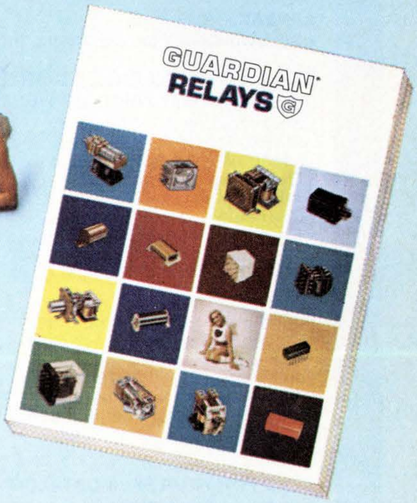

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Circle 177 on reader service card

sions being introduced are the 82S10, which has open-collector output, and the 82S11, which has tri-state output. The latter is apparently the first 1,024-bit memory to provide this feature. Both have the common 1,024-bit pin layouts and are compatible with Signetics' already announced 82S08 1,024-bit RAM with its power conserving "power-down" mode.

The RAMs are fully TTL-compatible. Signetics has used the same process to obtain the Schottky effect in earlier products, including 256-bit RAMs. The new RAMs, which are organized 1,024 by 1 bit, can be easily combined to make larger memories. The open-collector version is more commonly required, but the tri-state part is good for driving a capacitive line.

Both should find applications in buffer and scratch-pad memories, and Signetics predicts that they will be competitive in high-speed mainframe applications by 1975. The RAMs are also suitable for writable control storage. "They will get down to the 1-cent-per-bit level at the same time that the smaller 256-bit RAMs do," says Harry Neil, marketing manager for bipolar products. The present price in quantities of 100 is $63.20 each, which Neil says is cost-competitive with other bipolar memories of the same capacity.

Each RAM requires a single +5-volt supply and typically consumes 120 milliamperes at 5.25 V. Maximum power-supply current at that voltage is 160 mA.

All specifications are quoted for the range of 0°C to 75°C. Ac characteristics include maximum address access time of 45 nanoseconds and maximum chip-enable access time of 30 ns. Both parts are supplied in 16-pin dual in-line packages.

Signetics Corp., 811 East Arques Avenue, Sunnyvale, Calif. 94086 [412]

Voltage-level translator handles C-MOS devices

Solitron Devices Inc., San Diego, Calif., has introduced a voltage-level translator that handles C-MOS circuitry. Called the CM4104A, the quad unit translates logic levels from a low-voltage system to a higher-voltage system. The company says this function has not been available in integrated form for C-MOS until now, but could previously be accomplished only by using discrete transistors.

The CM4104A is useful in applications where C-MOS devices must be interfaced to the outputs of TTL when the C-MOS system is operating at a higher voltage, in bus-oriented systems, or in systems where high-frequency C-MOS oscillators are operated at low voltages to conserve power, but must drive higher-voltage logic or output devices used in the system.

Each unit consists of four translators, each with a true/complement output. Each translator shares a common enable input to provide a high-impedance output when the enable input is low. Output impedance is 700 ohms, output leakage is 5 nanoamperes, and input leakage is 100 picoamperes. Propagation delay from low to high is rated at 170 nanoseconds, and the figure from high to low is 350 ns. Power dissipation is 100 microwatts. Packaged in a 16-pin dual in-line package, the epoxy-encapsulated device is priced at $3.45 each in 100-lots.

Solitron Devices Inc., Box 23157, San Diego, Calif. 92123 [413]

256-bit SOS memory cycles in 180 ns

Using silicon-on-sapphire technology, a 256-by-1 random-access memory, designated the model INS4200S, offers a read-cycle time of 180 nanoseconds and a write-cycle time of 140 ns. Quiescent power dissipation is 40 microwatts, and operational power dissipation is 26 milliwatts. Input capacitance is rated at 6.5 picofarads at 25°C, and supply voltage ranges from 5 to 15 V. Other features of the device include a three-state-compatible output, full address decoding and bipolar-compatible pin-outs in a 16-pin dual in-line package. A minimum of

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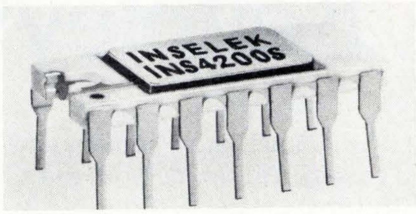


additional components is required, especially with large memory arrays, because of the three chip-select inputs. Price is as low as $26 each in 100-lots.

Inselek Inc., 743 Alexander Rd., Princeton, N.J. 08540 [414]

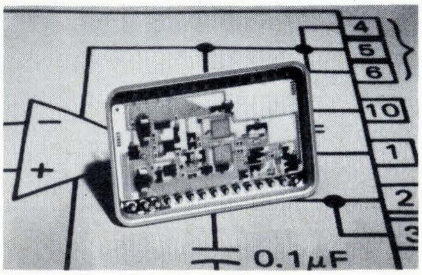
Divide-by-N counter has four decades on chip

A four-decade divide-by-N C-MOS counter, designated the model CD4059AD, uses LSI techniques, which allow all four decades to be placed on a single chip. The counter is programable and can divide a clock frequency by any number from three to 15,999. Three mode-select controls are used for programing. The device operates on 3 to 15 volts, and its output has the capability to drive TTL levels. Price in 1,000-lots is $13.60 each.

RCA, Solid State Division, Route 202, Somerville, N.J. 08876 [415]

FET-input op amp delivers 1,000 V/μs

The model 825 FET-input operational amplifier, which delivers 1,000 volts per microsecond, comes in a hermetic hybrid package that meets military standards. Full-power bandwidth is 10 megahertz, and the device can handle a 100-milliampere load current for video-



pulse amplifiers and coaxial line-drive applications. Other features include ±3 millivolts offset, 100-picoamperes maximum bias current, and 35-MHz unity-gain bandwidth. Further, the model 825 settles in 300 nanoseconds to 0.01% for d-a and a-d applications.

Beckman Instruments Inc., Helipot Division, Box 11866, Santa Ana, Calif. 92711 [416]

IC preamplifier is aimed at chopper replacement

Designed to replace chopper amplifiers, the model LM121 integrated-circuit preamplifier, when used with a conventional operational amplifier, is said to eliminate the problems, like a limited supply voltage, associated with choppers. The device is also said to improve the dc-input characteristics of the op amp, as well as increase loop gain, thus ensuring over-all accuracy, since the dc gain error is decreased. The LM121 is designed to give zero drift when the offset voltage is nulled to zero, and operating current is programable by the value of the null-network resistors.

National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, Calif. 95051

Fetron kits replace tubes in instruments

Fetron kits make it possible to substitute solid-state devices for the vacuum tubes in the Hewlett-Packard model 400 voltmeter and the Tektronix CA oscilloscope plug-in module. The Fetron duplicates vacuum-tube performance with a hybrid JFET circuit that plugs directly into the tube socket, but without the drift, screen grid or support power needed and found in tubes. The H-P kit, priced at $48 in small quantities, replaces all five meter-circuit tubes. The CA oscilloscope plug-in kit, which replaces 15 tubes, is priced at $110. Both are available from stock and distributors.

Teledyne Semiconductor, 1300 Terra Bella Ave., Mt. View, Calif. 94043 [418]

TYPE - 256 x 1 Static SOS/CMOS Ram
NUMBER - INS4200
READ CYCLE TIME - 180 nS
WRITE CYCLE TIME - 140 nS
QUIESCENT POWER DISSIPATION - 40 μW @ 10 V
INPUT CAPACITANCE - 6.5 pF
SUPPLY VOLTAGES - 5 to 15 volts
OUTPUT - Three-state TTL compatible, full address decoding and bipolar compatible pin-outs.
PACKAGE - 16 pin dual-in-line
PRICE - Mil Range (100-999) $38.00
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256X1 CMOS RAMS

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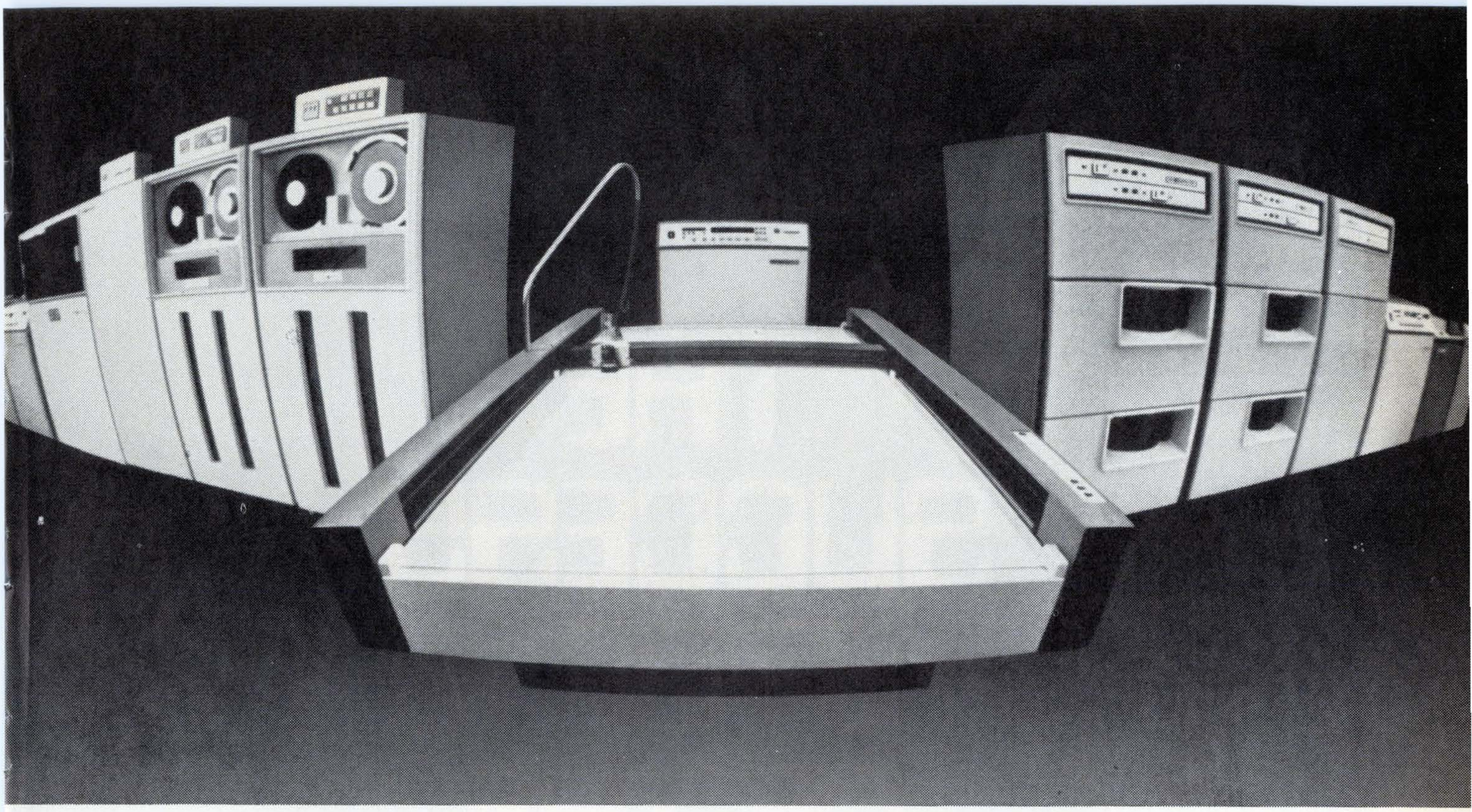

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Circle 187 on reader service card

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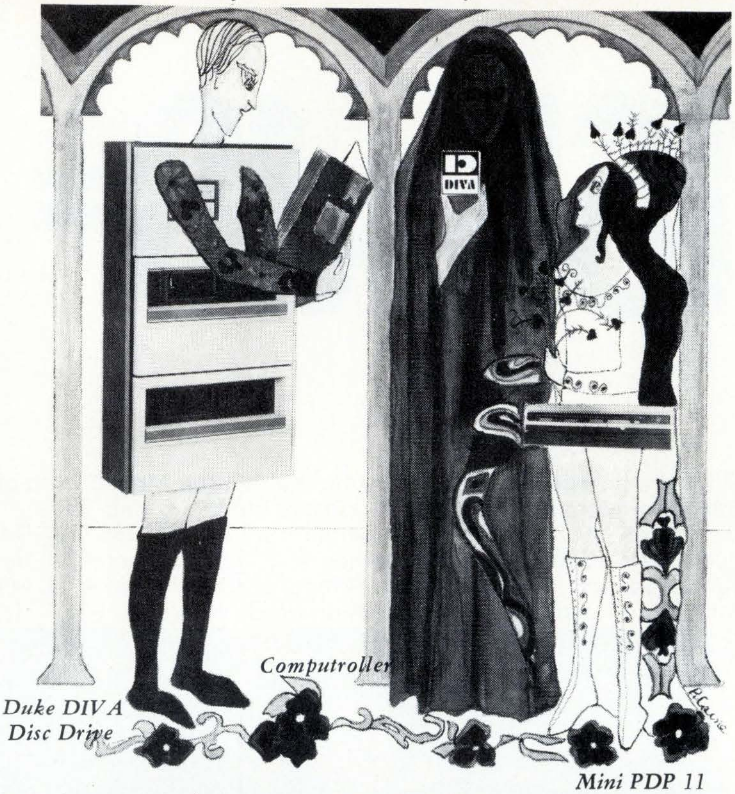

An Episode in the True Chronicle of the DIVAS, Proudest Peripheral Family in the Computerworld.

The computerworld stares in awe at the incredible wedding scene which has unfolded before them. The bride is minicomputer PDP 11, offspring of the illustrious maxi-computer clan, begat of Abacus. The bridegroom is DIVA COMPUTROLLER, scion of this proud, most respected peripheral family. Officiating at the ceremony is Duke DIVA Disc Drive, direct descendant of IBM compatible 3330 type disc drives.

Realizing the great impact this interfacing will have on the computerworld, our happy guests monitor the wedding with joyous solemnity.

"Mated," Interdata 70 whirrs, "PDP 11 will have access to 100 million bytes of data on a single spindle or 200 million bytes on a dual spindle disc drive unit within an average access time of 32 msecs."

"And with COMPUTROLLER providing a buffering sector, data will be transferable at the rate of 645,000 bytes/sec," marvels Nova II.

"And keep in mind," interrupts a breathless TI 980A, "that with COMPUTROLLER controlling eight drives, mini will have access to 1.6 billion 8-bit bytes of data!!"

But, hush! Listen to Duke DIVA repeating those always-inspiring words: "With the data stored in me, and with provided interconnecting cables and distribution panel, I now pronounce you linked in holy matrimony."

Resounding cheers befitting the occasion arise from the crowd. "A toast! A toast! A toast!" they roar. As is the custom, the proud parents, mini processor and DIVA controller, propose the toast to the dazzling couple: "To the most splendid and significant union in all our memories."

"*Vive,* DIVA! *Vive,* DIVA! *Vive,* DIVA!" Everyone unwinds.

But even as we listen to the clink of ceremonial glasses and the exuberant laughter, we sense an underlying sadness. Those unchosen minis — do they count for nothing now? Will they not be able to enter the world of high speed data storage/access and low cost/bit performance? And why — throughout this entire festivity — has COMPUTROLLER remained hidden under his purple robe? Is there more to COMPUTROLLER than meets the eye? Be sure to join us for the next episode in the True Chronicle of the DIVAS when we will hear the horrendous accusation: "Bigamy! BIGAMIST!"

In the meantime, learn COMPUTROLLER'S inside story. Find out about the free implementation and training courses, the software packages, and warranties that go with each disc system. All you PDP 11 users call George Roessler at 201-544-9000 for cost and delivery information.
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GSA CONTRACT NO. GSS-OOC-00159.

Data handling

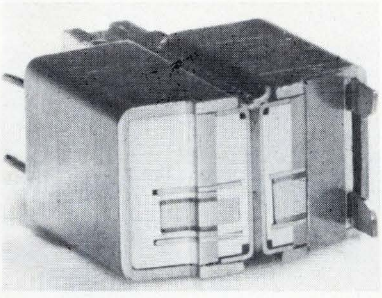
Cassette head has long life

10,000 hours claimed for read-after-write unit at tape speed of 8.7 in./s

Generally, West German companies don't flock to U.S. electronics exhibitions like Intercon with bags full of new devices because many of them consider the American market too competitive to begin with.

One of the exceptions at Intercon 74 will be Wolfgang Bogen GmbH, a West Berlin firm specializing in magnetic heads for consumer and commercial applications and reportedly Europe's biggest company in this field.

Among its exhibits will be a half-track magnetic head that at tape speeds of 8.7 inches per second has an operating life of about 10,000 hours—five times more than that of conventional units. It also achieves completely uniform resolution at a tape bit density of 556 bits per inch.



The result of two years of development, the DZ 1791 is a read-after-write head intended for commercial applications in Philips' compact digital cassettes. It is designed according to standards specified by the European Computer Manufacturing Association, the counterpart of the ANSI in the U.S.

The head's long life, says Bogen's marketing manager, Michael Limburg, derives from a core made of a special metal alloy. The alloy's abrasive characteristics are adapted to those of the carrier material, and that, Limburg says, "makes the head as longlasting as the equipment in which it's used."

Since crosstalk between a head's write and read portions can be a problem in read-after-write applications, a special precision shielding was designed that reduces crosstalk voltage considerably—typically to 3% of the read voltage.

A high resolution is achieved by a 2-micrometer gap width between the head's read and write portions. At that width, a resolution of 100% is obtained with tape storage densities of 556 bits per inch, of 85% with 800 b/in., and of 70% with a 1,600 b/in. Limburg adds that since the write and read gaps are of equal widths, the write portion can be hooked up so as to perform the read function—a feature which makes for fast data search operations.

The DZ 1791 operates on a write current of 6 milliamperes peak-to-peak and has a read sensitivity of 14 millivolts p-p, both values referenced to a bit density of 556 b/in., a tape speed of 8.7 in./s, a rise time of 10 microseconds, and a read bandwidth of 100 kilohertz.

The head is available as the clamp version shown in the photo, but is also sold as a unit that can be mounted on a precision base plate. Unit prices, Limburg says, range between $25 and $30.

The head's core material comes from Vacuumschmelze GmbH, a metals producer near Frankfurt. It's a permalloy material enriched with small amounts of titanium and niobium. After subjection to a special annealing process, it exhibits a crystal structure that is highly resistant to abrasion by the tape.

For its DZ 1791 and other nonconsumer magnetic heads, Bogen expects a big sales push to come from the market gap left by Philips Gloeilampenfabrieken, reported to be getting out of the commercial magnetic-head business. Commenting on the U.S. market, Limburg says that experts predict the share of read-after-write heads to reach 20% on the digital cassette market. According to Bogen's marketing manager, forecasters further expect that by 1975 such cassettes will account for about 60% of the market for small data-storage terminals, whereas cartridge units and floppy disks will have shares of approximately 22% and 18%, respectively.

Wolfgang Bogen GmbH, 1 West Berlin 38, Potsdamer Chaussée 80, Germany [361]

Printer operates at 600 lines a minute

Designed for computerized management reports and financial data, a high-speed line printer developed by Vogue Instrument Corp. can be coupled to telephone lines and provide printouts from remotely located computers.

Designated the Vogue model 400C, the machine prints at up to 600 lines per minute, completing a full page in 6 seconds. It can produce from one to six clean copies without penetration controls or adjustment. A novel ribbon-reversing system makes it possible to print more than 300,000 lines using a standard commercially available ribbon. The model 400C is compatible with all major minicomputers, as well as with the Bell System's 201 and 202 modems and their equivalents.

An eight-channel, vertical-format unit saves computer and print time by enabling the 400C to vertical-tab to any position on a form. Vernier controls permit horizontal and vertical placement of forms while the machine is running.

Paper feed is actuated by a simple stepper motor that drives fan-fold, sprocketed paper up to 6-ply. All operator functions are accomplished through the front door of the cabinet, and the compact integrated logic circuits are contained on removable cards.

Price of the 400C ranges from $9,800 to $13,800, depending on system configuration. Delivery time is 60 days.

Vogue Instrument Corp., 131st St. and Jamaica Ave., Richmond Hills, N.Y. [374]

Flexible-disk recorders handle 250,000 bytes

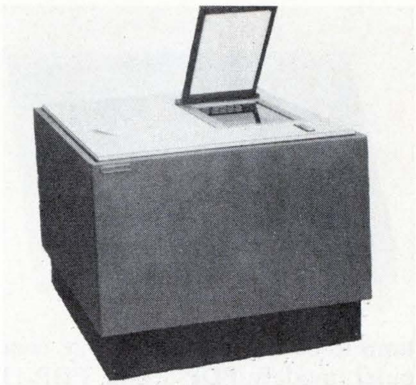
An IBM 3740 compatible flexible-disk recording unit called the model 145 is field-upgradable from a single-disk to a dual-disk unit. Aimed at the OEM market, the unit uses 8-inch Mylar diskettes that handle to 250,000 bytes on each side. A side sensor mounted in the recorder detects the operational side of the disk and forwards this information to the status line. The two heads are mounted on a common positioner driven by a stepper motor. Each step of the motor indexes the heads by one track. Average access time for a random seek is 176 milliseconds or 2.5 ms track-to-track according to the company. Sycor Inc., 100 Phoenix Dr., Ann Arbor, Mich. 48104 [365]

Electronic desktop calculator solves engineering problems

The model 1920 electronic desktop calculator for engineering applications provides full register arithmetic in all 10 storage registers. The display format is said to eliminate errors by permitting the engineer to work with units of his or her choice. A total of 18 engineering functions are hardwired, and parentheses up to three levels can be nested. In addition, there are 11 working registers, a floating minus sign, and leading and trailing zero suppression. Monroe, 550 Central Ave., Orange, N.J. 07051 [363]

Optical character reader has facsimile capability

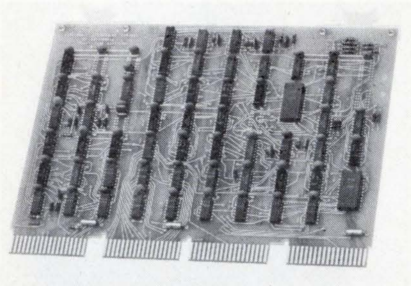
The model OCR/FAX combines the capabilities of optical character recognition and facsimile in a single unit, so that an operator can scan and transmit full page documents. In the OCR mode, input can be from a standard typewriter and typical typewriter pages are scanned, compacted to 8 bits per character and transmitted in 8 seconds over standard telephone lines. In the facsimile mode, input can be any kind of document, which is scanned, compressed and transmitted in 1½ minutes over telephone lines. Input ter-



minals are priced from $32,700, and output terminals from $5,500. Dest Data Corp., 1285 Forgewood Ave., Sunnyvale, Calif. 94086 [364]

Pc board permits link with PDP computers

A plug-in printed-circuit board enables a line of high-speed punched-tape readers, punches and combina-

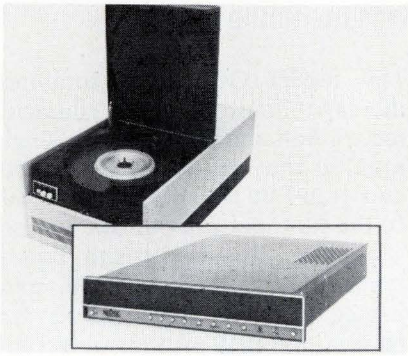


tions to be interfaced with DEC computer models PDP-8 and PDP-11, with no modification to the DEC equipment necessary. Part of an interface kit including cables and diagnostic software, the board employs MSI and TTL technologies as well as passive filtering and antiambiguity logic to reduce the ill effects of tape jitter, pin holes, and cable noise. A tape reader with interface is priced at $1,205, while a reader-punch combination with interface costs $2,595.

Electronic Engineering Co. of Calif., 1441 E. Chestnut Ave, Santa Ana, Calif. 92701 [366]

Disk system provides up to 80 megabytes storage

Two disk systems for use with most minicomputers provide either 40 or 80 megabytes capacity. Called the 7,000 series, the units come in five-



disk packets. Rotational speed is 2,400 or 3,600 rpm, access time is 30 milliseconds average, and data transfer rate is either 6.5 megabits per second or 9.67 megabits per second. The mode of transfer used is data channel. Price of the 40-megabyte unit is $14,500; the 80-megabyte system, $16,800.

Xebec Systems Inc., 566 San Xavier Ave., Sunnyvale, Calif. 94086 [368]

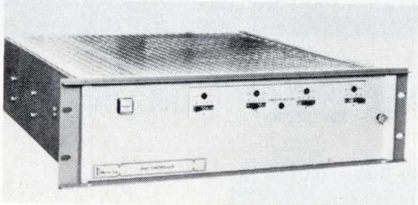
Key-to-disk system stores 2.5 million bytes

An eight-station key-to-disk system with 2.5 million bytes of disk storage is designated the System IV/70 model 7008. The unit is intended for keypunch users seeking an economical introduction to shared-processor data entry and for key-to-disk users desiring more power from their systems. The system can store up to 20,000 80-character records, reducing the need for frequent disk purging. Stations use 12-inch video terminals for entry of records of variable lengths up to 192 characters. Six program levels per job and six accumulators are provided. Monthly rentals vary from $120 to $960.

Four-Phase Systems Inc., 10420 N. Tantau Ave., Cupertino, Calif. 95014 [367]

Disk systems store up to 10 million 16-bit words

The series 4091 Univac 1616 disk system is composed of a disk formatter, computer adapter, up to four magnetic-disk units, and interconnecting hardware for installation in standard 19-inch cabinets. Storage capacities up to 10 million 16-bit words per controller are offered, with an access time averaging 40 milliseconds at 2,400 rpm. Each drive has one fixed and one removable disk. Bit density is 2,200 bits per inch, and transfer rate is 156 kilohertz words per second. Price for a system starts at under $11,000.

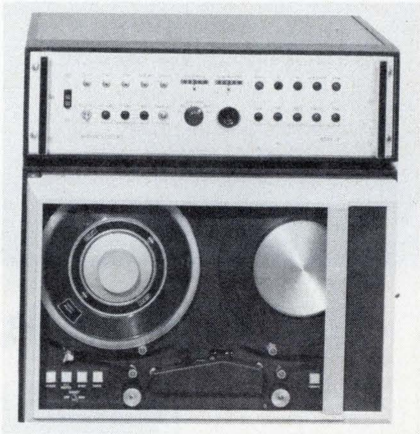


Datum Inc., 1363 S. State College Blvd., Anaheim, Calif. 92806 [369]

Magnetic-tape terminal links Selectric and computer

An optional port for the IBM Communicating Mag Tape Selectric Typewriter (MCST) has been added to the MDRS-9 terminal to provide an off line interface between the MCST and computers. The MDRS-9 will accept information sent by MCST stations over the dial-up network and record it on computer-compatible magnetic tape, while computer-prepared magnetic-tape data can be sent by the MDRS-9 to MCST stations. Line discipline is the same as when MCST stations are communicating with one another. Code conversion is available. The MDRS-9 terminal can also be used as a central pooler for a wide range of asynchronous terminals in the 110- to 1,200-baud range.

Mitron Systems Corp., 5026 Herzel Place, Beltsville, Md. 20705 [370]



Circle 195 on reader service card

ANNOUNCING THE NEW NEC REFRESH-DRIVE PLASMA DISPLAY PANEL

Now! Bright, stable, accurate alphanumeric and graphic display!

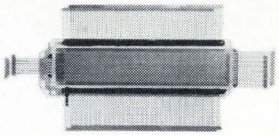
Name your number, letter or pattern, and NEC's new plasma display panel will display it—brightly, stably, accurately.

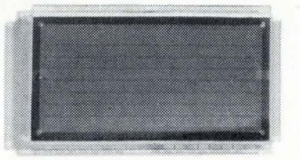
The new panel effectively utilizes the refresh-drive technique, but with a difference: instead of conventional gold or silver electrodes, transparent tin-oxide film deposited in a special structure is applied. The happy result is sharp, clear display with directly visible discharging dots.

Whatever your application, NEC's new plasma display panel offers you these features and others, such as high contrast, wider operational voltage range and long life.

(You are cordially invited to visit us at:
BOOTH Nos. 1505 & 1507
IEEE Intercon '74)

NEC
Nippon Electric Company, Limited Tokyo, Japan





Now available are the following types of panel.

Panel Type	External Dimensions (mm)			Dots per letter or number	Letters or numbers per line
	Width	Length	Thickness		
PX0606-32	37	210	6	5 x 7	32 x 1 line
PX0704-20	47	163	6	5 x 7	20 x 2 lines
PX0705-32	111	265	7	5 x 7	32 x 8 lines
PX0501A-32	118	213	7	7 x 9	32 x 8 lines

For more information, contact:

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Head Office:
277 Park Avenue, New York, N.Y. 10017, U.S.A.
Tel: 212-758-1666 Cable Address: NIPPELECO NEW YORK
Telex Address: NECA UR 234936
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Airport-Century Bldg., Suite 924, 9841 Airport Boulevard, Los Angeles, California 90045, U.S.A. Tel: 213-776-5923/5924 Cable Address: NIPPELECO LOS ANGELES CALIF
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We've put all this into one small box.

The PS²L.

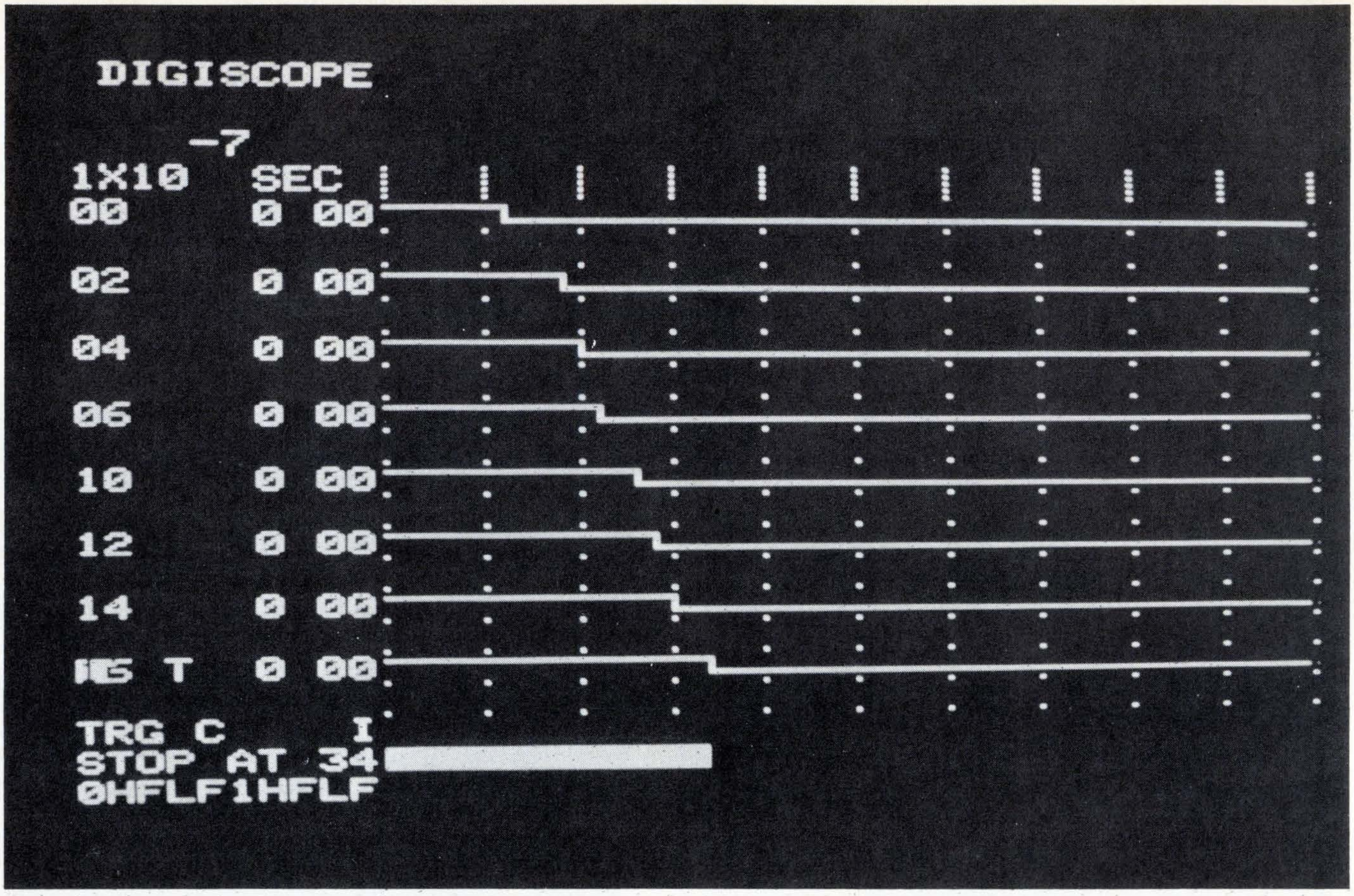
It's new from Acme Electric Corporation . . . a programmable solid state load device. The PS²L load tests DC power supplies and batteries faster, more efficiently and with greater accuracy than conventional test equipment. It's ideal for incoming test, quality control and lab work. The PS²L saves set-up time and eliminates recalibration and maintenance that's necessary with conventional test equipment.

Most other load testing devices use a resistive load. They heat up. Need constant adjustment. Lose efficiency.

None of this happens with the PS²L. It can be programmed to *simulate* the load. This means no heating up and no load fluctuations. So down goes your test time, up goes your efficiency. The PS²L dissipates up to 1000 watts within a voltage range of 2 VDC to 50 VDC and a maximum current of 110 amps when de-rated per the power dissipation curve provided. It's equipped with two modes of operation: 1) constant current and 2) constant resistance. For dynamic loading, the PS²L is provided with a program input for external connection of a pulse or signal generator. Two models available: 500 and 1000 watts. For more information, write for our PS²L brochure: Acme Electric Corporation, Cuba, New York 14727.

Acme Electric

Circle 197 on reader service card



DIGISCOPE:
Eight channels of simultaneous digital logic at 50 MHz

"1973 will be remembered as the year of the Logic Scope . . . It is remarkable that since their introduction last spring, logic scopes have already evolved to their second generation. The first of these second generation instruments is the AMC 1320 Digiscope."

—Michael Riezenman, ELECTRONICS Magazine, 12/20/73

"In the world of analog test and measurement, there's no doubt that the oscilloscope reigns supreme. But if you're working with digital signals — as more and more people are — you're probably more interested in looking at the simultaneous time relationships of multiple signals. And that's where the AMC 1320 Digiscope comes in."

—Stan Runyon, ELECTRONIC DESIGN Magazine, 1/18/74

"The Digiscope is a test instrument designed expressly for the debugging and maintenance of digital electronic equipment . . . (it) permits the ready implementation of many features long desired in testing digital systems: Features like *Simultaneous display of many channels in true time relation *Negative trigger delay *Triggering on a logical combination of the inputs *Multi-channel recording of fast, one-shot events."

—Bill Furlow, EDN Magazine, 1/5/74

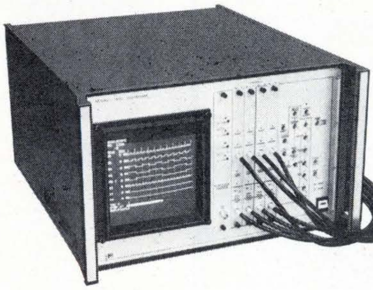
"A radically new logic state analyzer from E-H Research gives you the equivalent of an 8 or 16 gun, 50 MHz, real time scope display of logic timing. It lets you 'see' such analog parameters as glitches, ringing, rise and fall times, and voltage levels."

—Jerome Lyman, ELECTRONIC PRODUCTS Magazine, 1/19/74

The editors have had their opportunity to preview the Digiscope, and now it's time you discovered all the ways in which this new digital test instrument can help you save time and error in designing, producing, and trouble-shooting digital circuits and equipment. Our new brochure is ready for mailing to all engineers with an application for a compact instrument that offers, among other features:

50 MHz bit rate
Double-threshold comparison
Up to 100 bits of look-back before trigger
High impedance active probes (10 megohm, 8 pf)
Simple operation and clear, plain-English screen display of test parameters for photographic recording.

Write today for full particulars.



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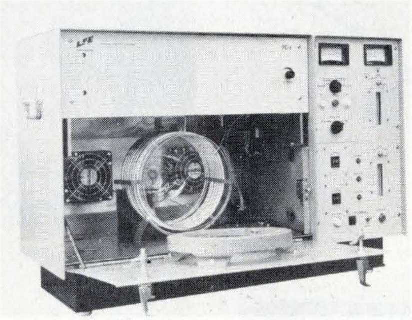
Packaging & production

Dry process cuts cost of masks

Plasma dry etcher/stripper for chrome masks increases yield and resolution

Emulsion masks have one big advantage—at about $1 per finished mask they are inexpensive. But they suffer from poor resolution and a relatively short life, since the contact method used to print them contaminates them and makes it necessary to clean them after every use. Hard masks such as chrome have double or more the life of emulsion masks, require thinner photoresist coatings during wafer processing, and offer higher resolution. But at $20 to $50 per finished mask using wet chemical processing, they appeal to only about 5% to 10% of the total mask market.

The LFE Corp., Waltham Mass., hopes to change all that with the introduction of its new PCrE/PDS-501 plasma dry etcher/stripper for chrome masks. It expects the etcher/stripper will bring the cost of processing the chrome masks down to that of emulsion masks. It also claims the unit increases yields, improves resolution, gives a finer edge acuity, and bypasses many of the problems of multi-step wet processing techniques.



The unit has three cycles: photoresist descumming, chrome etching, and photoresist stripping. The "flash strip" photoresist descumming cycle, which takes about 45 seconds, uses an oxygen-buffered gas to remove the layer of scum and residue left on the chrome after the photoresist is developed. (Hard masks have not been as easy to clean as emulsion masks, and, if descummed with only oxygen, have suffered from impaired resolution because the etch mask was removed as well as the underlying chrome.)

In the etch cycle, the unwanted chrome is volatilized by a composite halogenation process from which chlorine gas is absent. Unlike wet chemicals, which lose stability with use and thus must be replaced frequently, the plasma remains stable and reproducible. The etch rate for multiple masks is set at about 100 angstroms per minute, considerably less than the several hundred angstroms per minute of wet processing.

With wet chemicals, too, excessive undercutting may occur at high-resolution high-density geometries. But, since average distance between collisions of atoms in the gas plasma is controllable, LFE can etch vertical walls as the geometry of the mask commands. Moreover, no post-processing, with deionized water rinsing and drying after etching, is needed after plasma etching. Also, the action of the plasma stops instantly when rf energy is removed, whereas wet chemicals continue to react with the chrome even after the mask is removed from the acid bath.

The final strip step removes all photoresist at an average stripping rate of 500 to 1,000 angstroms per minute. LFE claims the special gas used here actually hardens the chrome, making it more durable than wet-processed chrome, without affecting the finish.

All gases used are nontoxic, noncorrosive, and nonflammable and require no special plumbing and handling. Gas is admitted automatically to the reaction chamber. The operator can select single functions or run through the three steps automatically. Temperature in the chamber reaches a maximum of 150° to 200°C.

LFE believes that the market for

chrome plasma-etching will grow rapidly and that it will replace other etching methods, as well as other hard-mask materials.

A PCrE/PDS-501 with a 12-inch-diameter chamber for 5-in. masks costs $25,000. Other sizes of chamber will be available. Price includes a supply of the three gases. Delivery time will be 30 days, starting in April.

LFE Corp., Process Control Division, 1601 Trapelo Rd., Waltham, Mass. 02154 [391]

Sputtering system has valve to limit pump contaminants

In a sputtering system, a source of thin-film impurities is the backstreaming of contaminants from the diffusion pump as it evacuates the sputtering chamber. But in a multiple-target sputtering system from Varian Associates, this problem is considerably reduced by a programed vacuum valve. Moreover, the pump works about six times as fast as conventional diffusion pumps, and the sputtering mechanism more than doubles target life, according to the company.

The vacuum valve counters backstreaming in two ways. First, it is programed to operate automatically at pressures up to 200 micrometers with a cycle that minimizes backstreaming. Second, the valve automatically adjusts itself in response to the gas load in the chamber and in this way reduces break-

New products

down at the top jets of the diffusion pump, thus eliminating primary backstreaming by that pump.

The pump itself has been designed to handle large flows of argon at the 10^{-3}-torr pressure at which sputtering is done. At this pressure, it can pump 300 liters per second, or about six times as much as conventional diffusion pumps.

The sputtering target module, called a suppressed ring source, extends target life to 172 days at four cycles a day rather than the more usual 64 days. The module also deposits the thin film with great uniformity.

Within the sputtering module are three targets—a fourth is optional. Four substrate carriers in the work chamber can be sequenced for rf sputter etching, rf bias sputtering, and deposition of three materials. Both 6- and 8-inch targets are standard.

The system features automatic sequencing for high throughput. A specially designed master control panel reduces the operator's task to lining up rows of lights. Emi/rfi gasketing on all removable panels prevents rf leakage, and each unit is checked out for FCC compliance. To fulfill OSHA requirements, electrical interlocks remove high-voltage potentials when terminals are exposed.

Delivery of the system takes 90 days. Price ranges from $40,000 to $60,000.

Varian Associates Vacuum Division, 611 Hansen Way, Palo Alto, Calif. 94303 [392]

System controls, records wafer diffusion processes

A diffusion-process-control system built for Western Electric Co. has evolved into a standard system for process-management and -control of diffusing semiconductor wafers that is now being offered by the Lindberg division of Sola Basic Industries. Built around a Digital Equipment Corp. PDP-11/40 with 16,384 bits of memory and a Teletype terminal, the system is able to monitor and control as many as 100 diffusion tubes, notes Richard Rock-

Everybody talks about the weather.

EMR is doing something about it...

For the National Oceanic & Atmospheric Administration

NOAA's new SMS/GOES Synchronous Meteorological Satellite will usher in a new era in satellite borne weather instrumentation. Once in orbit NOAA will commence processing and distributing weather data from the new Visible/Infrared Spin-Scan Radiometer (VISSR), which produces improved pictures of the earth's cloud cover. At the heart of VISSR are eight EMR Integrated Photoelectric Sensors. On earth the data from VISSR is processed by EMR Digital Interface Electronics using the latest PSK demodulation and bit synchronization techniques.

For NASA

NASA is responsible for launching SMS/GOES into orbit. EMR-Telemetry systems at the Kennedy Space Center and various tracking stations throughout the world will gather vitally needed data.

For Philco-Ford

Philco-Ford's WDL Division is building this advanced meteorological satellite. Critical data is being processed through EMR PCM Bit Synchronizers, PCM Decommutators and Displays during development and pre-launch checkout.

For the Bureau d'Etudes Meteorologiques Spatiales

France is typical of the many worldwide users of SMS/GOES who will use EMR Digital Interface Electronics to process vital weather data.

We're not only talking about the weather... we're doing something about it!

Now... what are we going to do for you?

EMR — EMR Schlumberger

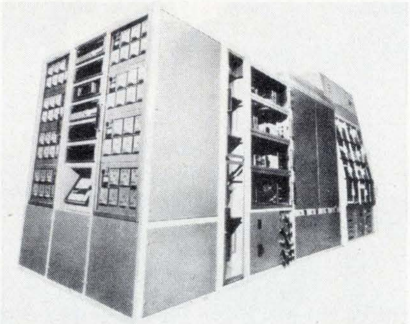
EMR Telemetry
Weston Instruments, Inc.
Box 3041, Sarasota, Florida 33578
813-958-0811

Circle 205 on reader service card

hill, system design supervisor.

Besides economically replacing individual gas-sequencing systems for each diffusion tube, the system contains a wafer-lot-tracking capability to insure proper processing sequence. Process-control panels linked to the computer and furnaces prevent operators from using the wrong tubes. Timing on the programable sequence system is accurate to within 1 second; the system can control eight timed events and can monitor eight additional binary inputs, such as contact closures.

The management end of the system will print out complete yield reports by lot, by device, or by operation, and it also exercises complete inventory control and reports system status, Rockhill says. Options include temperature and gas-flow monitoring and control, either supervisory or direct digital, as well as outputs from a CRT and keyboard printer.

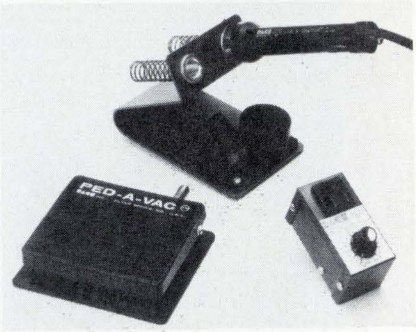


Typically, a 24-tube system sells for $52,000, while a 64-tube controller carries a tag of about $72,000. Part of the system, the programable sequence controller, is available separately at $30,000 for a 24-tube installation and $50,000 for a 64-tube installation. Delivery time is six months to a year.

Lindberg Division, Sola Basic Industries, 304 Hart St., Watertown, Wis. 53094. [401]

Desoldering system won't damage sensitive circuits

The model SX-211 Ped-A-Vac desoldering system is a vacuum system using shop air that can be attached to a soldering station for production

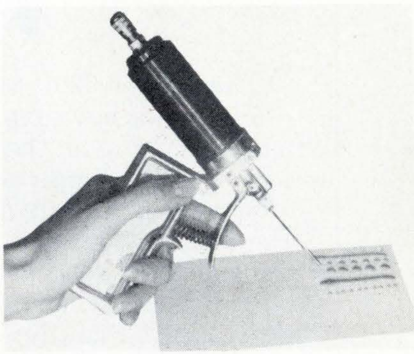


desoldering and repair and rework. There are no electrical spikes so the unit won't damage sensitive circuits. The system is particularly suited for use with multipin devices and other types of miniaturized circuit components regardless of lead configuration. The foot-controlled unit causes room-temperature air to be drawn up through a plated hole across pads and around leads as soon as the tool tip has melted the solder. In this way, the solder is removed and the area cooled to prevent resweating of the lead.

Pace Inc., 9329 Fraser St., Silver Spring, Md. 20910 [393]

Resin dispenser handles small potting applications

The model 102 Epoxer is a hand-operated resin dispenser designed for miniature and small potting applications. It dispenses epoxy, adhesives, potting compounds and other

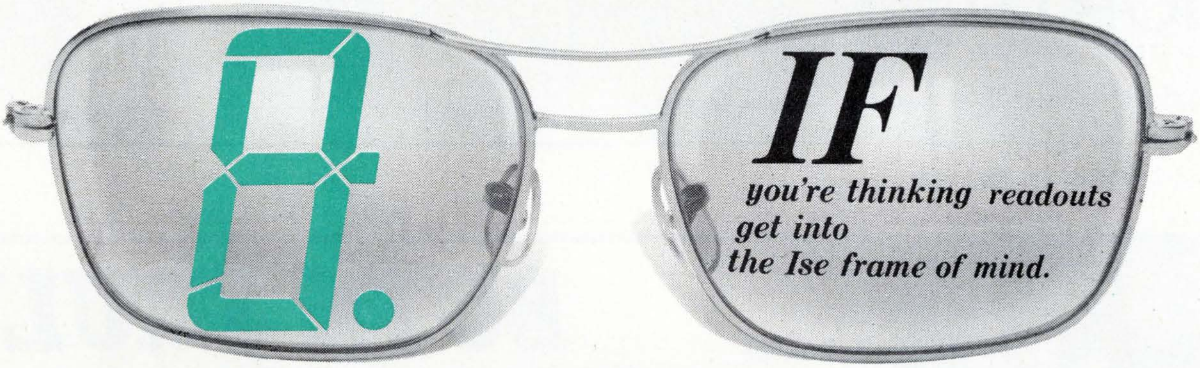


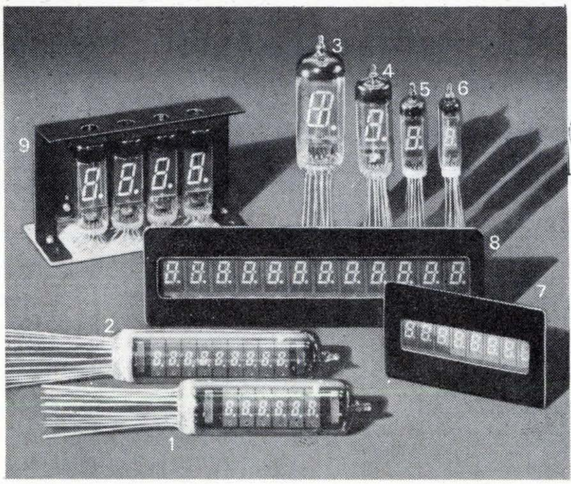
materials. The unit also provides a clean and measured means of handling liquids and pastes. Once filled and pressurized, it is self-contained until the material in the polyethylene cartridge is completely dis-

Frame them any old way

Or any new way.

Then sit back and watch your Ise display electronics get your ideas across. Beautifully.
In an eye-easy fluorescent green glow.
At the same time, they're low on voltage and current drain.
High on stability.
Pick the readouts that offer more of everything, including variety, for a whole host of digital display ideas.
They're a difference you can see.





1. DP60A
2. DP90A
3. DG19E
4. DG12H
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6. DG 8F
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8. DP127F
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Display module w/counter & latch
- Fluorescent green glow.
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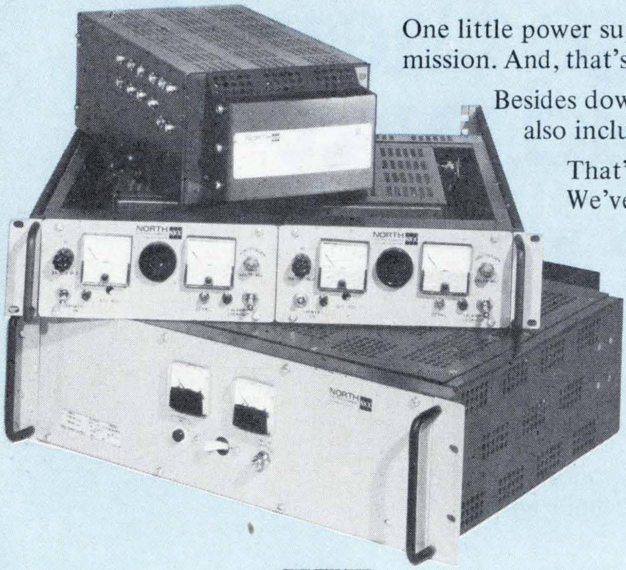
The standard power supply is a minor consideration... until it fails.



One little power supply can put a big piece of equipment out of commission. And, that's when "bargain-level power" can get very expensive.

Besides downtime and repairs, the cost of 'unreliability' may also include some loss of reputation.

That's why it will pay you to take a good look at North. We've been the leading producer of custom power units for over 40 years. And our standard modules get the same reliability treatment–including rugged life tests, EMI analysis plus shock, vibration and humidity tests.

If reliability is worth more to you, send for a bulletin, or call your North Standard Power Manager at 419/468-8874.

Listed here are the more popular models–many other voltages are available.

MODEL	11000	12000	13000	14000	15000	16000	17000	18000
VDC	AMPERES							
5.0	3.9	5.3	11.3	13.0	20.0	32.5	49.0	82.0
12.0	2.8	4.2	8.0	10.5	15.0	23.0	36.0	58.0
15.0	2.4	3.7	7.5	9.5	14.0	20.5	27.0	47.0
18.0	2.1	3.3	6.0	8.0	13.0	18.0	26.0	40.0
24.0	1.5	2.8	4.2	7.0	11.0	15.0	21.0	33.0
28.0	1.4	2.4	4.0	6.3	9.0	14.0	20.0	29.0
36.0	1.2	2.2	3.1	5.6	8.0	11.0	14.0	23.0
48.0	95	1.8	2.6	4.2	6.0	8.0	10.0	18.0

MODEL	10000
VDC	AMPS
0–7.5	2.10
0–16	1.25
0–25	0.85
0–33	0.68

DUAL OUTPUT SUPPLIES	
MODEL	N03052
VDC	AMPS
±15-12	400MA
MODEL	N60052
VDC	AMPS
±15-12	1.0A

NORTH NEC
ELECTRIC COMPANY

North Electric Company / Galion, Ohio 44833 / A United Telecom Co.

SP-20

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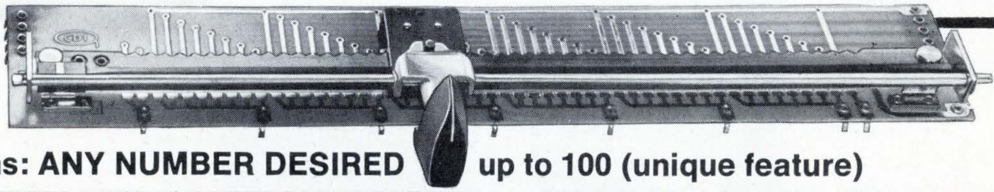
Beautiful New Babies

BOTH TRULY REMARKABLE

CDI's New Baby: Series SL, Linear Slide Switch (Pat. Pending)



Positions: ANY NUMBER DESIRED up to 100 (unique feature)

APPLICATIONS: CONTROL FUNCTIONS REQUIRING RAPID POSITION SELECTING

- CATV channel selecting
- High & Low limit switches
- Process equipment controls
- Computers & peripherals
- NC applications
- Many others

OTHER REMARKABLE FEATURES:

Mounts EITHER left/right OR up/down (versatile).
Single or multiple position selectors.
Solder lugs or dip solder termination for p.c. use.
1 or 2-Poles, or coded outputs available.

ELECTRICAL CHARACTERISTICS:

200 megohms min. insulation.
1000 volts min. dielectric strength.
2 amps @ 115 VAC current carrying capability.
125 ma @ 115 VAC current breaking capability.

CDI earns its reputation every day for Consistently High Quality, Consistently Good Delivery, Designing to Your Needs.

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PRECISION PRODUCTS DIVISION

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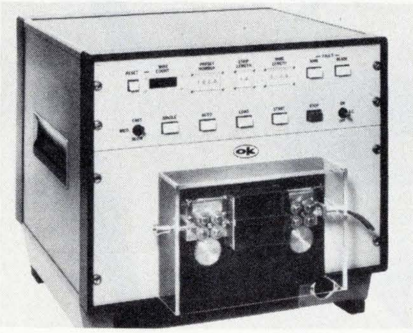
pensed. The Epoxer has positive, "no-drip" cutoff control.
Kenics, 1 Southside Rd., Danvers, Mass. 01923 [400]

Wire stripper requires no air for operation

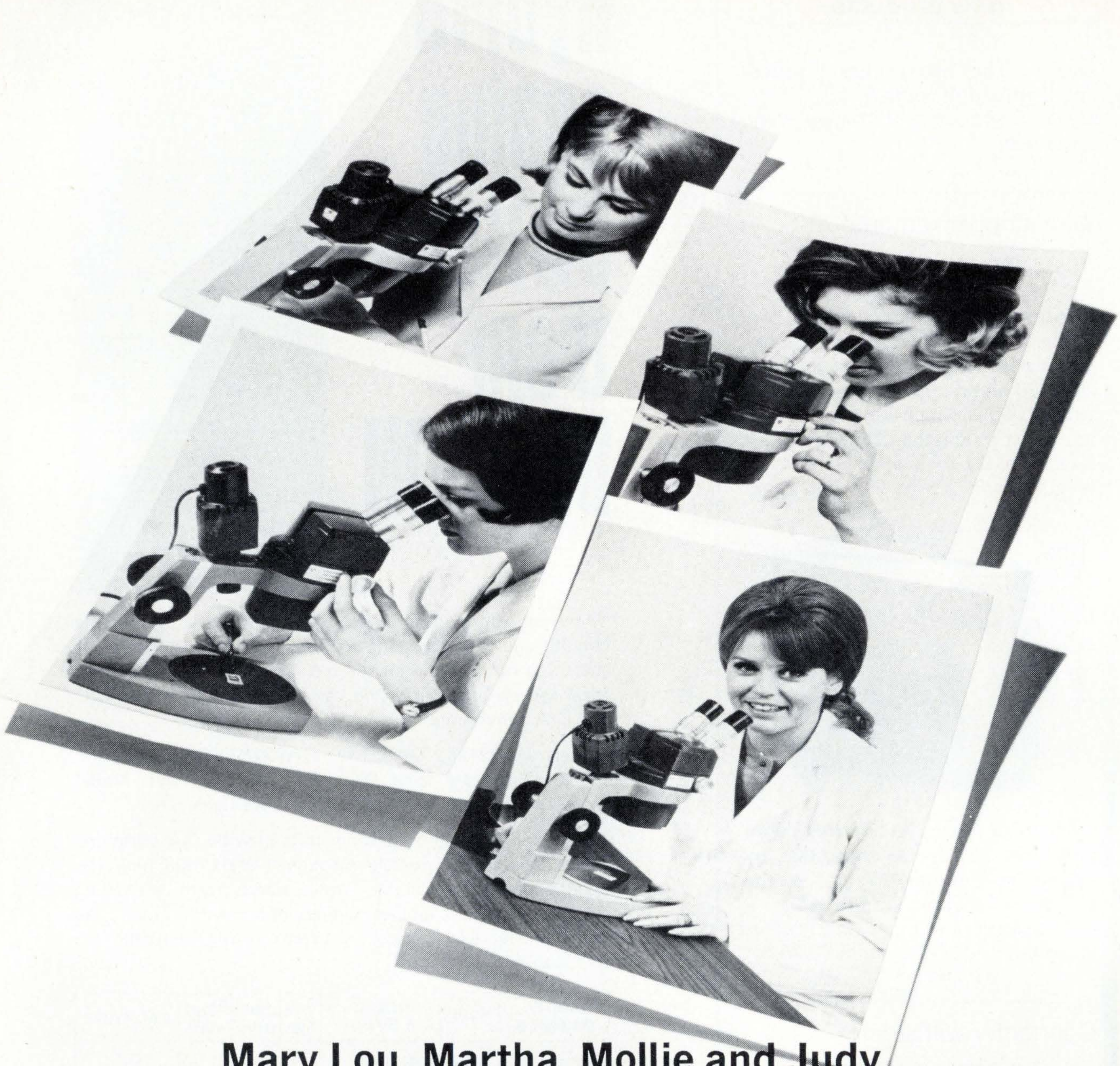
Featuring all-solid-state control, the model EW S-10K wire stripper operates without air. Measuring 18 by 20 by 20 inches, the unit will cut and strip 5,000 six-inch-long wires per hour. Strip lengths from 0 to 1.5 inches in 0.1-inch steps, and wire lengths from 2.5 to 99.9 inches in



0.1-inch steps can be handled. Wire and strip length are controlled by gating the number of steps of the two motors that feed in the wire.
O.K. Machine and Tool Corp., 3455 Conner St., Bronx, N.Y. 10475 [394]

Connector withstands over 20,000 mating cycles

A graphite coating technique enables the hermaphroditic contacts of the miniature model Dualatch connector to withstand over 20,000 cycles of mating and unmating without the plating wearing through. The coating is also said to reduce mating and unmating force, since the connector requires only three ounces of pressure per contact mating, and 0.1 ounce for unmating. These qualities, the company says, make the connector a suitable substitute for higher-cost, more complex zero-insertion-force connectors in many applications.
Amp Inc., Harrisburg, Pa. 17105 [395]



Mary Lou, Martha, Mollie and Judy are sold on the AO STEREOSTAR® Zoom Microscope.

Here's why.

The AO STEREOSTAR Zoom stereoscopic microscope was specifically designed for convenience, working ease and optical performance.

Zoom controls are located on both sides for convenience. It eliminates awkward reaching when changing magnification. The high resolution optical power pack may be rotated 360° to accommodate most any assembly or inspection situation. Full optical equipment offers a magnification range of 3.5x through 210x. Working distance of 4.0 inches is maintained at all magnifications in basic models, and if that's not enough, add a 0.5x auxiliary lens to make it 5.7 inches.

STEREOSTAR Zoom microscope assures a wide field of view, up to 2.25 inches with the 10x high eyepoint eyepieces. It also features an extremely efficient illuminator that stays cool even after long hours of continuous use.

See for yourself. Contact your AO dealer or sales representative for a convincing demonstration.

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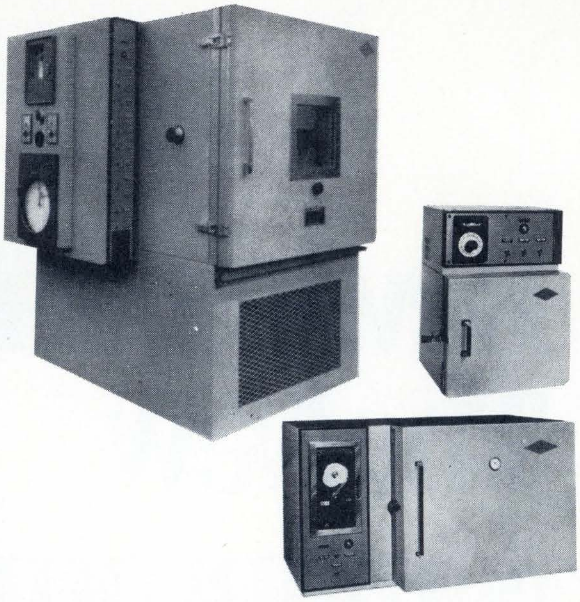
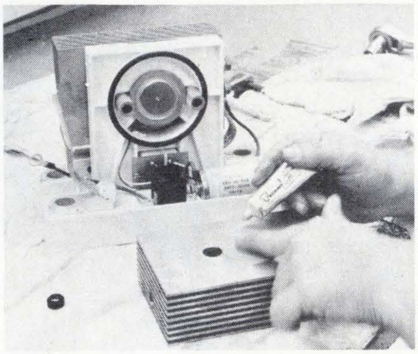
AILTECH
POWER OSCILLATOR



New products/materials



A thermally and electrically conductive grease compound is a silver-silicone base containing no graphite or carbon fillers. The one-part nonsetting material resists moisture and operates between -65 and +450°F. One of its uses is to conduct heat from high-voltage, high-current SCRs. One-pound jars and two-ounce tubes are available at below $4 per ounce in quantity.

Technical Wire Products Inc., 129 Dermody St., Cranford, N.J. 07016 [476]

A copper-epoxy-glass laminate for the construction of hybrid microcircuits and for high-line-density multilayer circuit boards consists of an epoxy-glass substrate clad on one or both sides with a 0.0001-inch-thick copper layer. Gold or nickel fine-line conductor patterns are plated on, the copper cladding serving as a plating electrode. The copper is then removed by immersion in a suitable etchant.

Mica Corp., 10900 Washington Blvd., Culver City, Calif. 90230 [477]

A solvent and cleaner for printed-circuit applications and for general bench work is a degreaser conforming to military specifications. The material has no flash or fire point, low residue, low toxicity, and good solvency. Called CD-240, the degreaser is available in a 16-ounce aerosol can for $2.10. It has no effect on other materials except polystyrene.

The Cole-Flex Corp., 91 Cabot St., W. Babylon, N.Y. 11704 [478]

A machinable ceramic with a fine grain structure, is designated material 902. It is made from aluminum silicate with a melting point of

3,200°F. Applications are in electrical insulators, rf heating fixtures, prototype ceramic components, soldering, and thin- and thick-film capacitors. Rods, plates, and special sizes are available.
Cotronics Corp., 37 W 39th St., New York, N.Y. 10018 [479]

A screen-printable thick-film paste is aimed at makers of electro-optic devices. All pastes in the system fire in nitrogen atmospheres, eliminating the possibility of explosion—a problem with firing in hydrogen atmospheres. The system also uses non-precious-metal conductors.
Bala Electronics Corp., Cermet Division, 14 Fayette St., Conshohocken, Pa. [480]

A thick-film conductor called Platinum+ is a reactive bonder containing no glass contaminates. Fired in air, the material wets quickly, is leach-resistant, and requires more than 6,000 psi to pull it off the chip, which fractures at this tension. Platinum+ is also peel-resistant, remaining intact after 100 hours at 150°.
Electro Oxide Corp., 3896 Burns Rd., Palm Beach Gardens, Fla., 33403 [371]

Ten sizes of 95% alumina substrates are available for applications in photocells, integrated circuits, and resistor and capacitor networks. The substrates are suitable for most types of thick-film and refractory metalization systems and are available in sizes ranging from 0.750 by 0.250 inch to 2.500 by 2.500 inches, offering good dielectric and mechanical strength. Price ranges from 5 cents each for the smallest size to 33 cents for the largest in 5,000-lots.
Centralab division, Globe-Union Inc., 5757 N. Green Bay Ave., Milwaukee, Wis. [372]

High-purity powders in the sub-micrometer range include 99.8% aluminum and aluminum carbide, 99.9% barium titanate, and 99.99% silicon. Advantages include chemically greater reaction rates and high density and hardness in flame or plasma-spray coating and casting formulations.
Aremco Products Inc., P.O. Box 429, Ossining, N.Y. 10562 [373]

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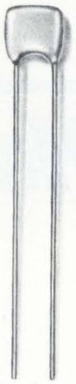

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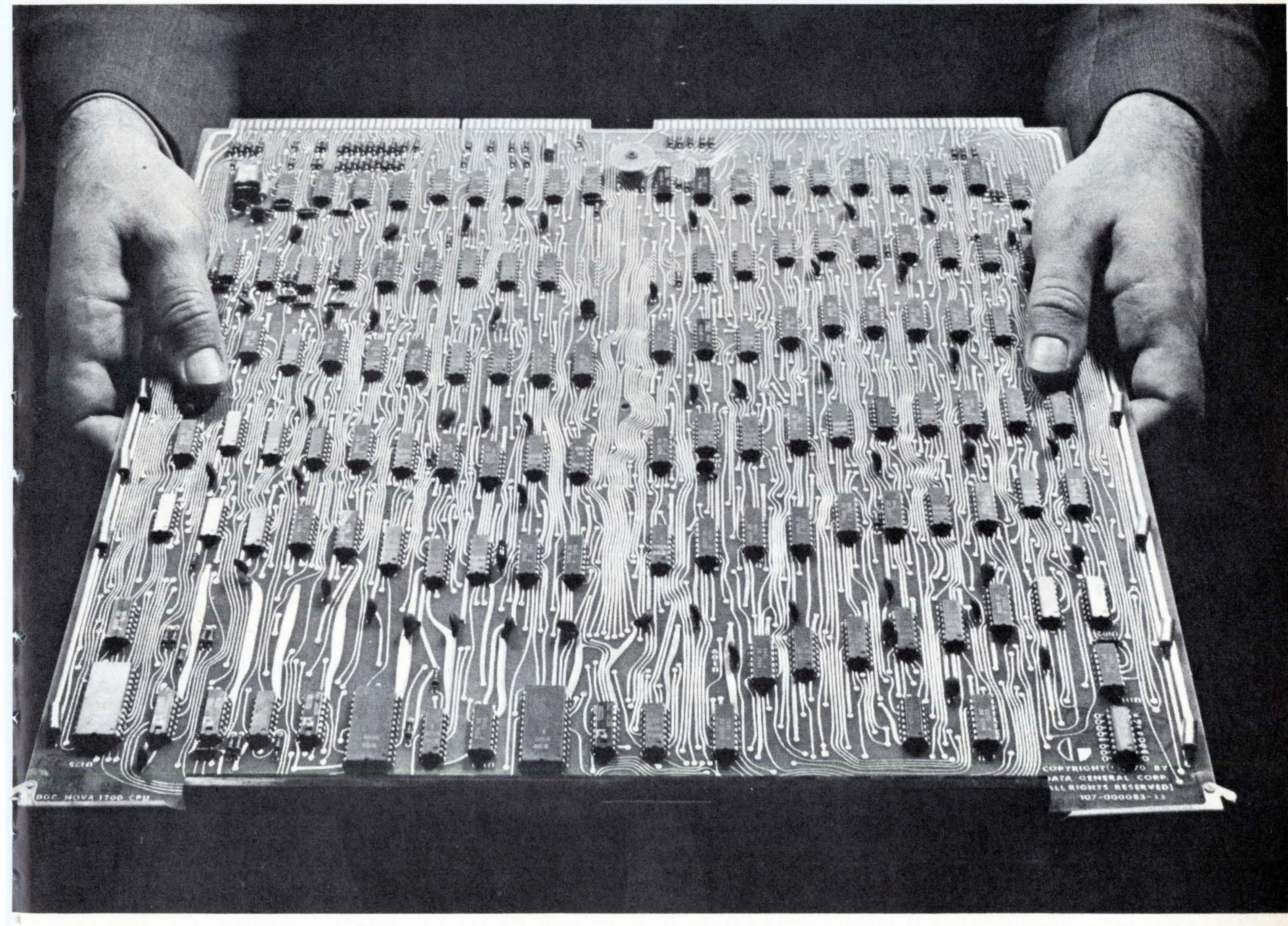


New literature

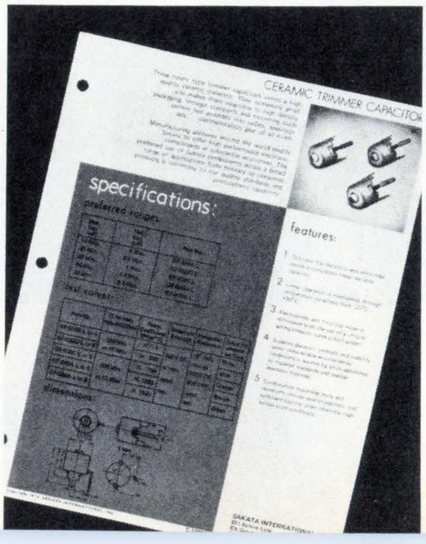
Rf transmission. Decibel Products Inc., 3184 Quebec, Dallas, Texas 75427. A booklet titled "About Rf Transmission Lines" is aimed at people involved in two-way radio communications. The booklet discusses the application of transmission lines and how they affect systems. Circle 421 on reader service card.

SCR selection. The method of selecting SCRs for single-phase dc motor drives is the topic of an applications note from International Rectifier Corp., Semiconductor division, 233 Kansas St., El Segundo, Calif. 90245. [422]

Pc connectors. Continental Connector Corp., 34-63 56th St., Woodside, N.Y. 11377, has issued a 16-page technical catalog describing a group of receptacle-type printed-circuit connectors with 0.025- and 0.045-inch-square terminations for wire-wrapping. [423]

Miniature connectors. From B&W Associates Inc., 21 B Street, Burlington, Mass. 01803, comes a six-page catalog, which covers miniature precision coaxial and strip transmission-line connectors and includes specifications on semirigid, flexible and stripline versions of the connectors. [424]

Trimmer capacitors. A bulletin on ceramic trimmer capacitors from Sakata International Inc., 651 Bonnie Lane, Elk Grove Village, Ill. 6007, describes the rotary design of the units, which use an optically flat



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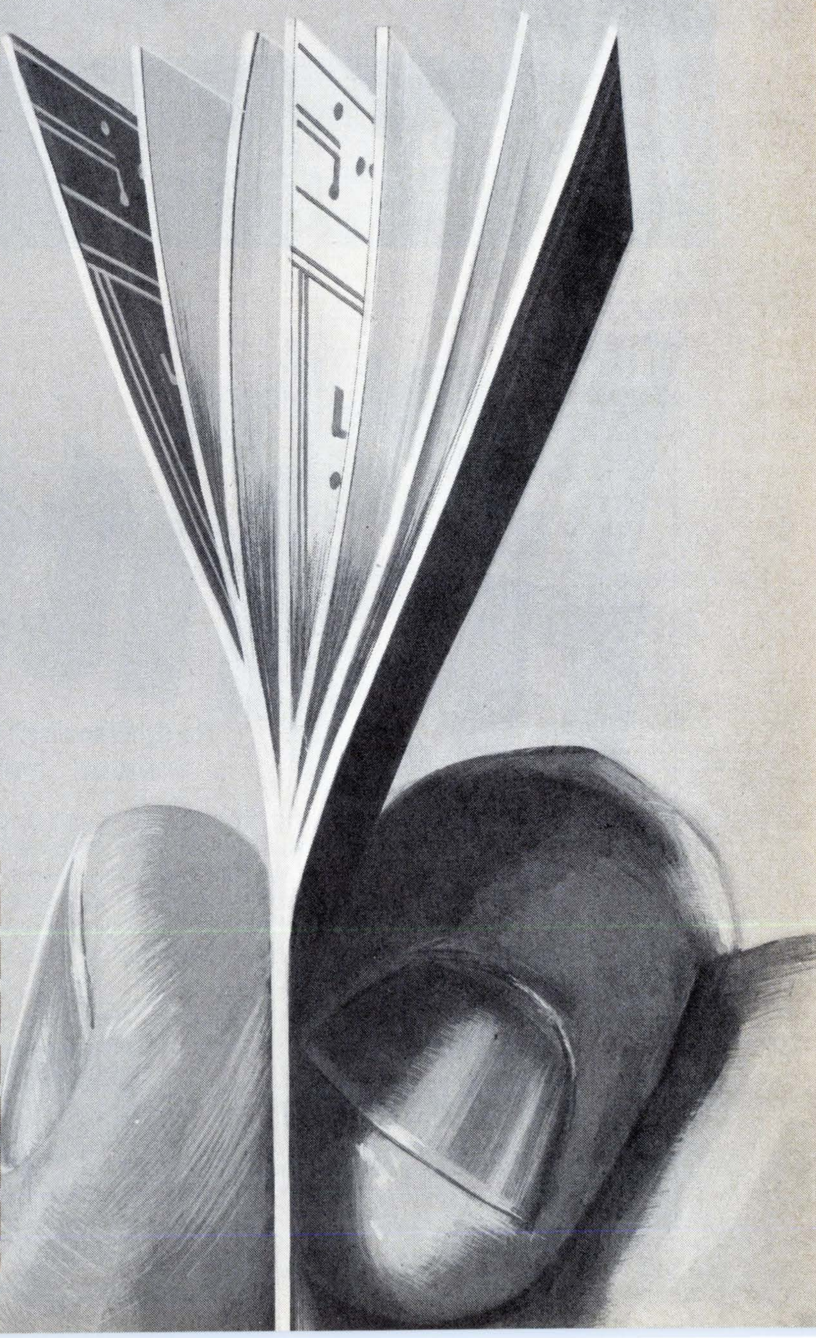

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New literature

ceramic dielectric and electrode to provide linear variations in capacitance. Dimensional information, ordering procedures, and test values are given. [425]

Logic. Teledyne Semiconductor, 1300 Terra Bella Ave., Mountain View, Calif. 94043, has issued two catalogs on the company's HiNIL family of logic. A 12-page condensed catalog and a comprehensive 64-page catalog provide applications and specifications on nearly 40 devices. [426]

Resistors. Vishay Resistor Products, 63 Lincoln Highway, Malvern, Pa. 19355. Applications bulletin AB-102 describes the series S102 and S105 resistors used in critical portions of pressure transducers to ensure stability. [427]

Power rectifiers. Medium-current single-phase bridge silicon power rectifiers are described in a bulletin available from Edal Industries Inc., 4 Short Beach Rd., E. Haven, Conn. 06512. [428]

Pulse driver. A bulletin from Electron Physics Ltd., Survey Ho., Poole Rd., West Molesey, Surrey, England, describes the company's Pockels cell pulse-drive unit, which provides a means for gating nanosecond pulses from a long-duration laser pulse, or for selecting one or more picosecond pulses from a mode-locked pulse train. [429]

Cassette transport. A four-page specification sheet from The Amilon Corp., 49-12 30th Ave., Woodside, N.Y. 11377, describes the model A7 digital cassette transport. [430]

Data communications. Computer Transmission Corp., 2352 Utah Ave., El Segundo, Calif. 90245. A 12-page brochure discusses the applications and benefits of the company's Multitran 4000 remote processing system for data-communications networks. [431]

Oscillator. Bowmar Instrument division, 531 Main St., Acton, Mass. 01720, has published a data sheet

INTRODUCING THE LATEST ROCKWELL MOS/LSI ADVANCE... AND NEW VERSATILITY IN MACHINE DESIGN:

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ROCKWELL PPS CHARACTERISTICS	
Instructions.............	50
Instructions Cycle Time—μS.............	5
Addition of Two 8-Digits—μS..........	240
Nesting of Subroutines—Levels...............	Unlimited
ROM Chip Size..........	1024 x 8 (16K Words Max.)
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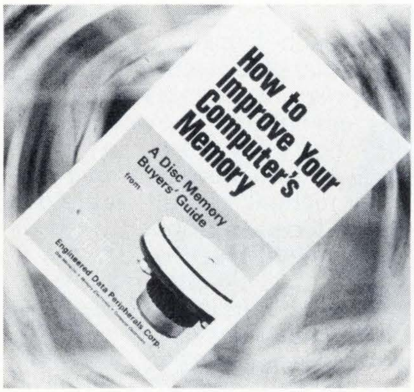
providing information on the model 415A digital-communications oscillator. [432]

Capacitors. A data sheet describing voltage-variable capacitor models IN5461 through IN5476 is available from Codi Semiconductor division, Codi Corp., Pollitt Drive South, Fair Lawn, N.J. 07410. [433]

Substrates. Electronic Slicing and Dicing Inc., 10 Railroad St., Lawrence, Mass. 01841, has made available a specifications and price sheet for a line of 96% alumina substrates. [434]

Disk memory. Engineered Data Peripherals Corp., 1701 Colorado Ave., Santa Monica, Calif. 90404, has issued a booklet designed to aid computer users and manufacturers in evaluating and selecting disk-memory devices. The "Disc Memory Buyers Guide" deals with choosing the right medium, such as core or tape, and includes a discussion of fixed-and moving-head and floppy-disk drives. [435]



Reed relays. A four-page bulletin describes the series 46 miniature reed relays available from North American Philips Control Corp., Cheshire, Conn. 06410. Mercury-wetted, dry-reed and magnetic-latching types are discussed, and specifications, dimensional drawings and performance curves are provided. [436]

Heat sinks. Aham, Box 909, 968 W. Foothill Blvd., Azusa, Calif. 91702, is offering an applications handbook

New literature

on heat sinks. A guide to thermal engineering, the 152-page book provides graphs, photos, and answers to problems that often arise in this field. [437]

Oscillator kit. A data sheet from Statek Corp., 1233 Alvarez Ave., Orange Calif. 92668, is also an ordering form that includes descriptions and applications for a low-frequency oscillator kit. [438]

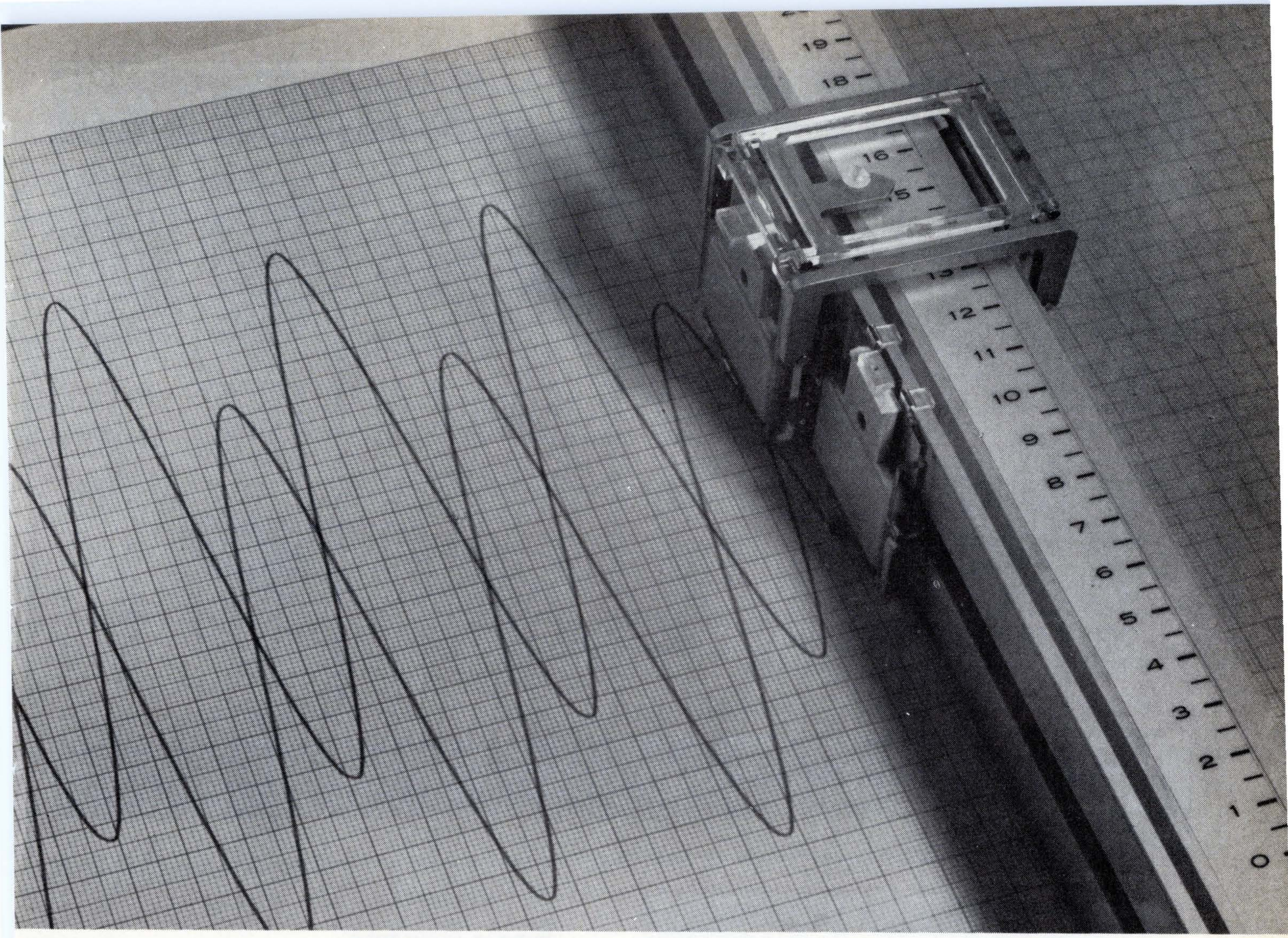
Transistors. A 32-page catalog describing a line of hermetic transistors made by Raytheon Semiconductor, 350 Ellis St., Mountain View, Calif. 94042, includes information on beam-lead chips, military devices, and wireless-bond semiconductors. [439]

Message withholder. A method of monitoring and controlling message traffic through data-communications storage devices is explained in a data sheet from Plantronics, 385 Reed St., Santa Clara, Calif. 95050. The publication discusses the operation of the model 1160 Message Withhold unit in communications networks. [373]

OEM recorder. Gulton Industries Inc., Measurement and Control Systems division, E. Greenwich, R.I. 02818. A bulletin describes the Mark III OEM recorder, which records while simultaneously printing alphanumeric data in the chart margin. [374]

Printed circuits. The Institute of Printed Circuits, 1717 Howard St., Evanston, Ill. 60202, has released two publications; "Specifications for Double-Sided Flexible Wiring with Interconnection" and "Specifications for Single-Sided Flexible Wiring." [375]

Displays. Liquid-crystal displays are discussed in a manual available from Hamlin Inc., Lake and Grove Sts., Lake Mills, Wis. 53551. The eight-page brochure explains the fundamentals of these displays, types available, and their advantages and disadvantages for various applications. [376]



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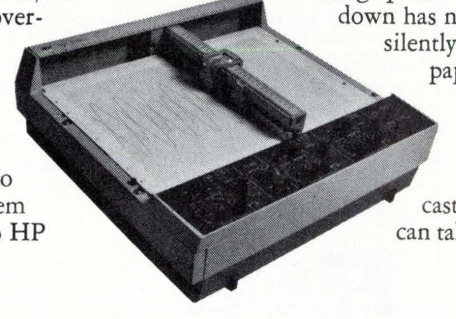

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The 7046 is a rugged machine. A heavy-duty aluminum casting means the recorder can take hard knocks without misaligning the axes. Inside, the continuous-duty servo motors have no complicated slip clutches.

The price is $2,650 (domestic USA price only) and a long list of options lets you customize the 7046A to your special applications. You can have internal time base, event marker, re-transmitting pots, TTL remote control and a rear connector, to name a few.

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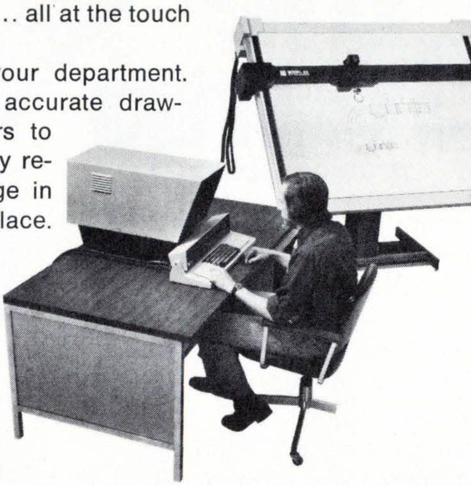

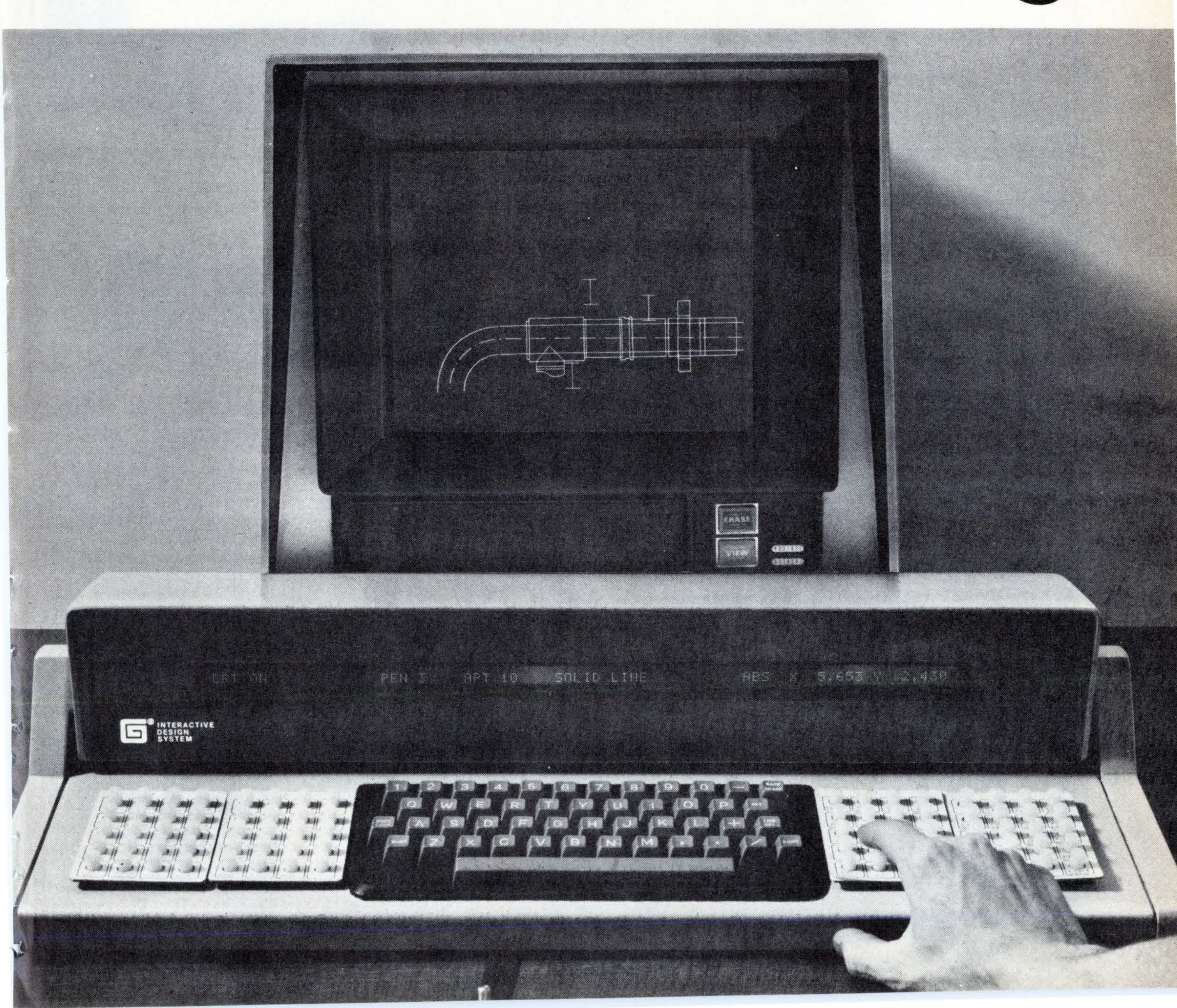

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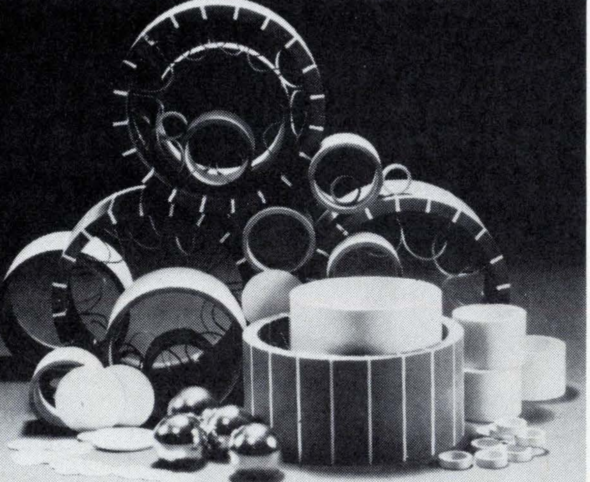

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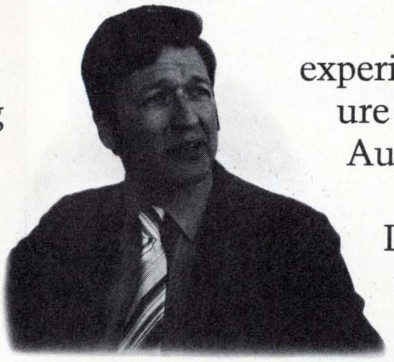

Robert A. Mesard

"When work began on the AN/TPX-42A, we started looking for an interconnection system that offered high reliability and design flexibility, without sacrificing lower initial costs or low field maintenance.

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New books

Handbook of Electronic Components and Circuits, John D. Lenk, Prentice-Hall Inc., Englewood Cliffs, N.J. 216 pp., $12.95.

Talk about not telling a book by its title! Although the title and cover will probably sell many volumes, the electronic components this volume deals with are discrete field-effect transistors and unijunction transistors, and that's about all. The text is strongly oriented towards applications, treats the device physics only perfunctorily, and doesn't even mention the use of a computer in circuit design.

Nevertheless, the book covers its limited subject matter quite well. It is a good exposition of practical design techniques for discrete unijunction- and field-effect-transistor circuits. The author's method is to present a basic circuit, then discuss individual component and bias selection, using few equations but giving lots of practical design tips. He finishes up with a design example.

A treatment of these devices as they are used in integrated circuits would have been helpful, however. For example, the author might have described the advantages and disadvantages of monolithic versus discrete gates for small-scale integration.

Individual design rules are discussed, along with component selection and biasing tips. Designers will find many hints about practical problems they may run into.

Clearly, the result is not a text for circuit designers, but an aid to engineers or anyone else who wants to build a unijunction or FET circuit for a test setup without becoming a circuit-design expert. But that fact is not at all apparent from the title, which does a disservice to the book's potential readers.

—Joel DuBow
Components Editor

The Fast Fourier Transform, E. Oran Brigham, Prentice-Hall Inc., 1974, 252 pp., $19.95.

Prof. Brigham, of the University of Texas, has taken a rather unusual approach in explaining the nature and applications of the fast-Fourier-transform (FET). He first introduces an intuitive description of the FET,

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3. **Clamps**	18	6	12
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6. **Trigger Pulse Pwr. Amplifiers**	6	0	6
7. **Isolated Gate Drive Windings**	18	6	12
Totals	117	33	84

International Rectifier

International Rectifier, 233 Kansas Street, El Segundo, CA 90245. ***. . . the innovative power people*** then supports it by a simplified but sound mathematical treatment, and finally presents examples to review and expand the concept.

It is a noble effort, and the book, by and large, is worth buying and studying; but it is definitely not the kind of book to be read in an easy chair, feet propped up on an ottoman, in front of a roaring fire. The reader must definitely be able to keep the esoteric relationships and symbols sorted out or he quickly gets lost. Even with the postponement of proof until later chapters, this reviewer wonders if a plainer—if perhaps longer—explanation would not have been possible in words instead of equations.

The intuitive description is presented largely in the form of mathematical equations backed up by drawings and plausibility arguments, rather than by rigorous proofs. Included here is a chapter discussing the relationship of the Fourier transform to convolution and correlation, as well as another chapter on the Fourier transform and sampled waveforms.

Sampled waveforms lead directly to the discrete Fourier transform, which is shown to be merely a special case of the general Fourier transform. A full chapter is devoted to applications of the discrete transform.

After nine chapters of prologue comes a specific discussion of the FET. It is first presented intuitively and then with mathematical rigor. In its simplest and most straightforward form, the number of waveform samples to which the FET is applied is a power of 2; in Chapter 12, Brigham shows how, even though the power-of-2 samples save much computation time, still more expeditious computation is possible under certain circumstances when some other number of points is used, provided the number is highly composite—that is, many factors.

Finally, Brigham describes in detail the use of the FET in convolution and correlation, as well as an approximation to the Fourier transform of other continuous functions.

Wallace B. Riley
Computers Editor

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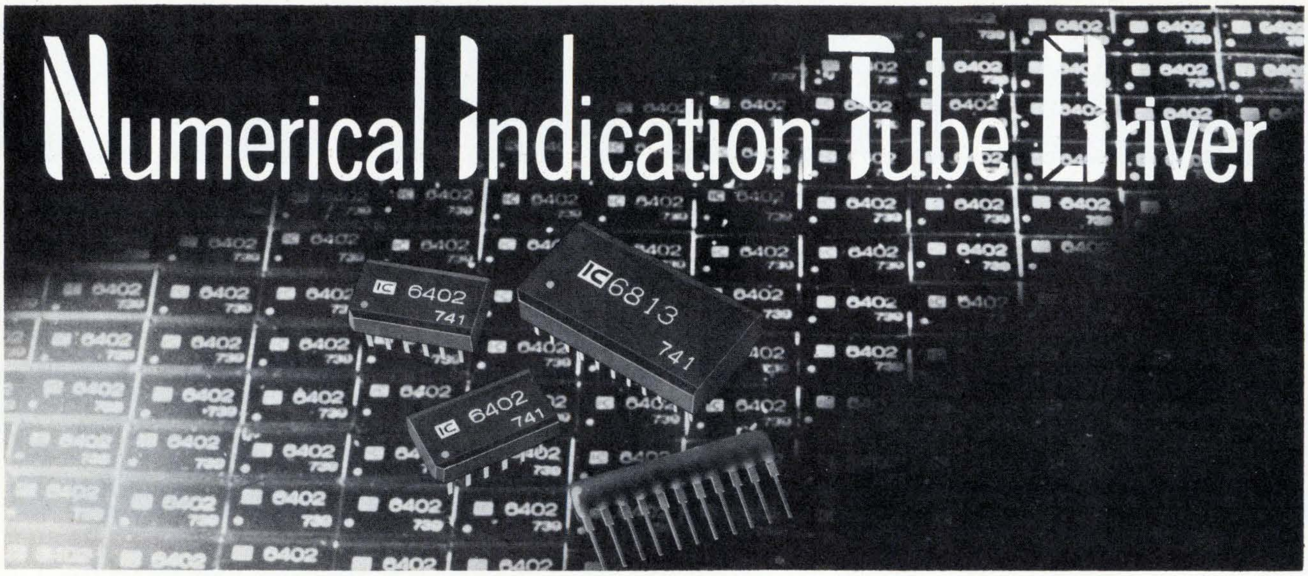

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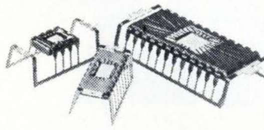

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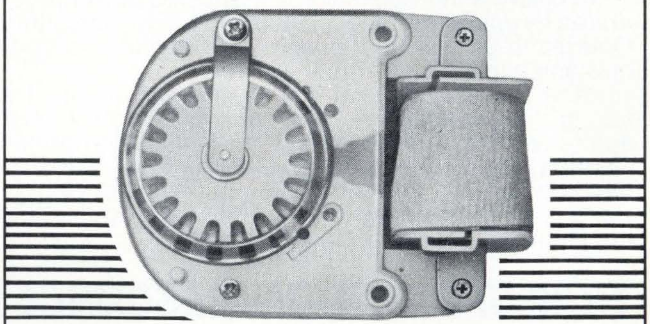

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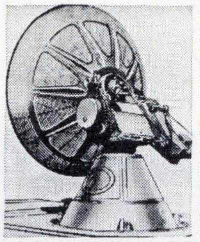

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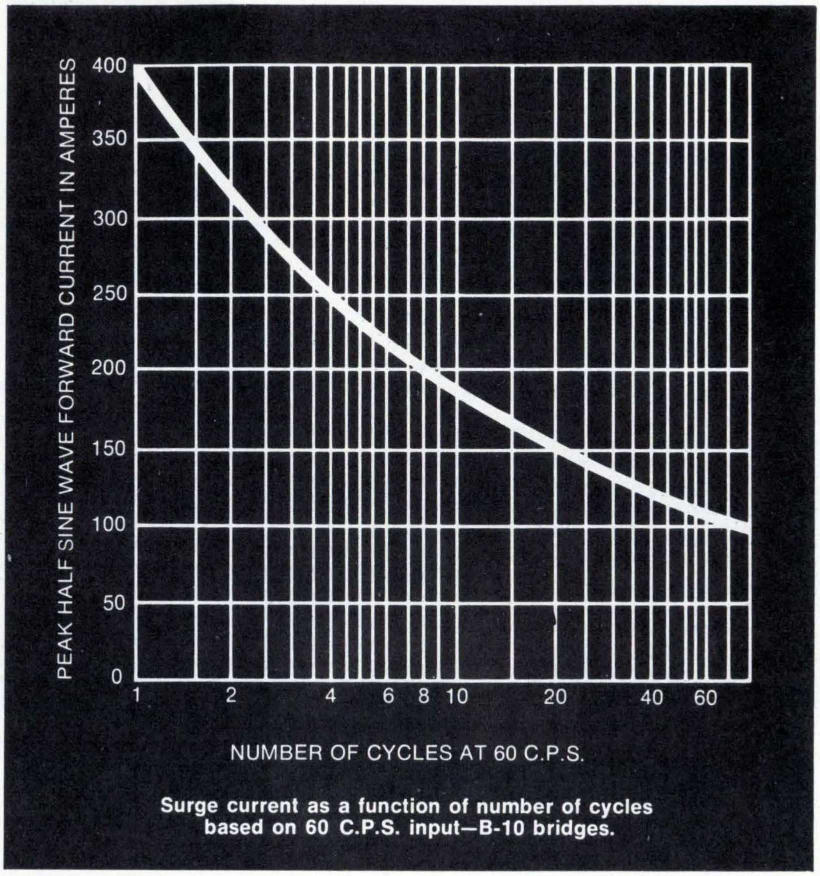

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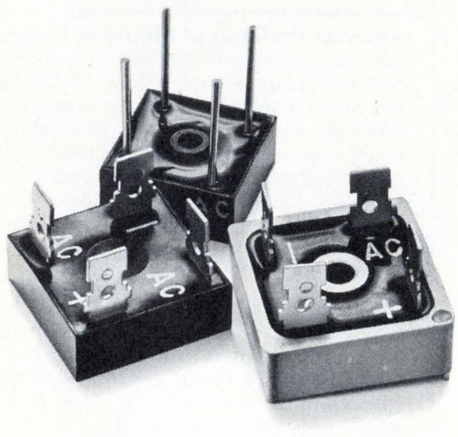

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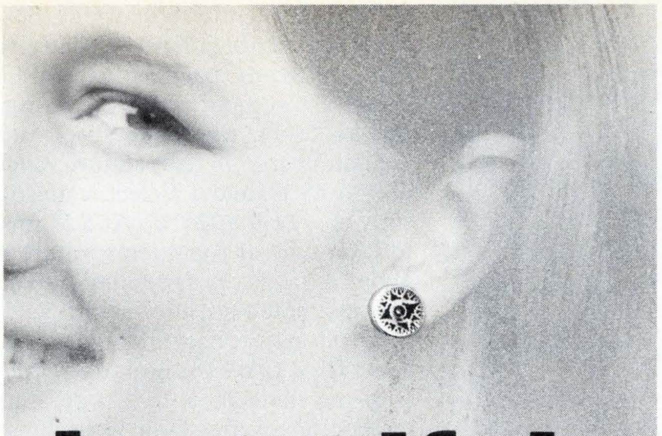

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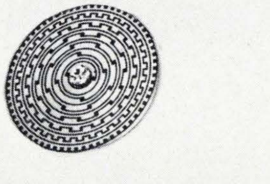

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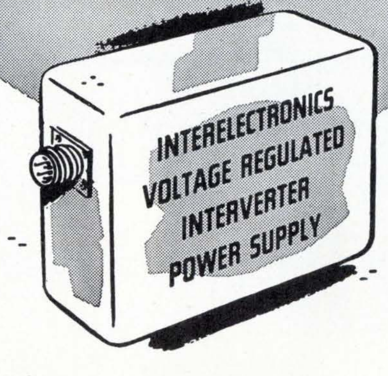

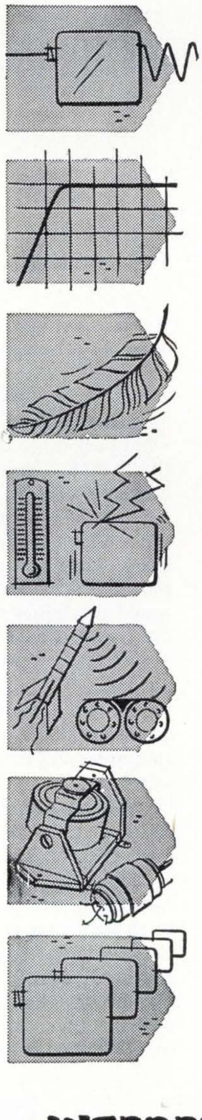

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Now in use in major missiles, powering telemeter transmitters, radar beacons, electronic equipment. Single and polyphase units now power airborne and marine missile gyros, synchros, servos, magnetic amplifiers.

Interelectronics—first and most experienced in the solid-state power supply field produces its own all-silicon solid-state gating elements, all high flux density magnetic components, high temperature ultra-reliable film capacitors and components, has complete facilities and know how—has designed and delivered more working KVA than any other firm!

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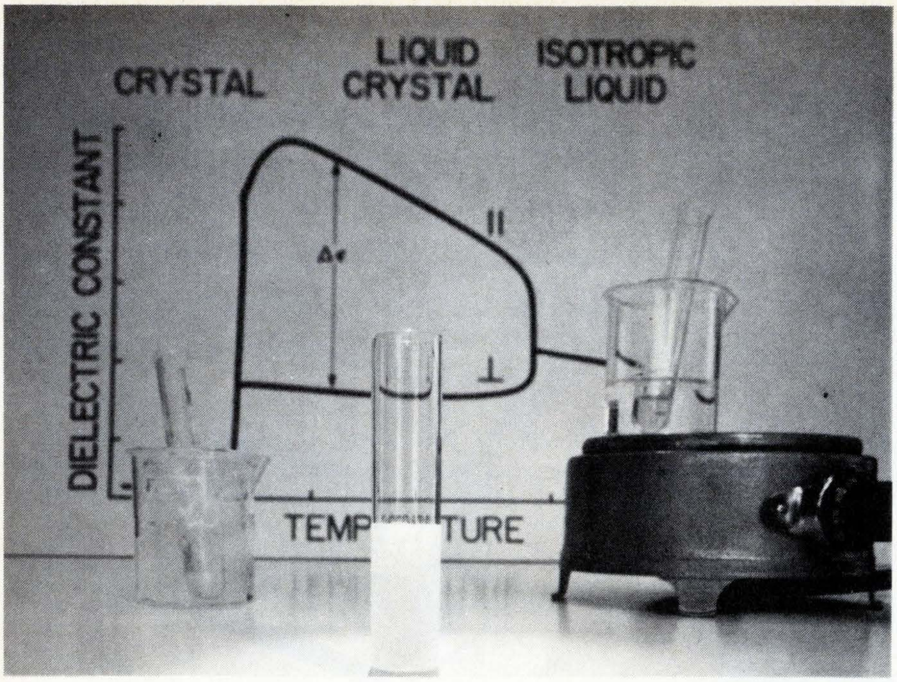

News: For field-effect devices, EASTMAN 14080 is now ready to ship. At 18 μm spacing, a typical lot shows a threshold of only 1.5 volts rms for 60-Hz sine wave (or 2 volts dc), an *operating* temperature range of 0 to 75°C, and a dielectric anisotropy of +11.9 at 25°C. At 5 V rms, turn-on time at room temperature is about 100 ms; turn-off time, about 350 ms; contrast ratio, about 50:1.

For dynamic scattering devices, EASTMAN 14099 is equally ready, with the same 0 to 75°C operating temperature range. It aligns itself homeotropically on clean electrodes without additional magic–an important advantage. Typical threshold is 4 volts rms, 5 volts dc.

More details from George Grau at Organic Chemical Sales, Kodak, Rochester, N.Y. 14650 (716-325-2000, ext. 57288).

Glamourous, mysterious liquid crystals.

We make them.

Behind the mystery and glamour: Those who could reasonably be expected to phone Mr. Grau are probably interested in making display devices ranging from mass-marketed consumer goods to some of the more ambitious reaches of the engineering imagination.

Liquid-crystal technology has blazed up after smoldering quietly for most of the time since 1888. Organic chemists get to collaborate with electronic engineers through the medium of the marketplace, if not personally. For now, Kodak has set up its booth on the chemical side of the street.

The present generation of electronic engineers catch on fast to subjects they didn't necessarily concentrate on in school. In liquid-crystal work, one deals with the different forms and degrees of orderedness among molecules, ranging between the randomness of an ordinary isotropic liquid and the periodic architecture when it freezes to a crystal. Only certain compounds assume this mesomorphic state. Molecules of such compounds have a generally elongated shape.

The most highly ordered kind of liquid crystal, called smectic, where the molecules tier up in layers and the layers can only slide against each other, can be seen when water sits in contact with a bar of soap. In a nematic liquid crystal there are no tiers, but the molecules stay parallel. Possibilities exist for controlling their alignment. And this alignment controls what they do to light passing through. And that's what the action is mostly about in industry circles.

Field effect, one approach used to create a visible pattern in a thin layer of nematic material between patterned, transparent electrodes, amounts to electrically tuned birefringence. (We hope you didn't cut the lecture on birefringence in Physics 1.) Contrast between "on" and "off" is attained through various arrangements of light polarizers and quarter-wave retardation plates. Where and when the field is off, the molecules must line up parallel to each other and to the cell walls. This is called "homogeneous" alignment. Surface treatment to make it happen is protected by patents or trade secrecy.

Dynamic scattering is the other approach. Here, in the "off" state, the alignment can be either homogeneous or perpendicular to cell walls. The latter is "homeotropic" in the lingo of the art. Either way, light passes straight through, and the layer looks clear. Where field is applied, then regardless of previous orientation, all the molecules strive for parallelism to the wall. But ions that have been incorporated in the mixture migrate, colliding with them to knock them every which way. The resulting optical inhomogeneity scatters light. These turbid areas can be made to look either darker or lighter than the clear areas, depending on directions of illumination and viewing. Appearance of the pattern is more sensitive to angle of view than with field effect. Power drain is more, because of the turbulence to be maintained. But you don't have to find (or license from somebody) a way to align the molecules. You just use EASTMAN 14099.

Say, if you've read this far you are probably interested enough to ask Dept. 412-L, Kodak, Rochester, N.Y. 14650 for Eastman Organic Chemical Bulletin, Vol. 45, No. 2 (1973), *where four scientists of the Kodak Research Laboratories, who write more like scientists than engineers, will take you farther into this than you'd want to go for just recreation. It has a 76-item bibliography. For our 3,281-item* Liquid Crystal Bibliography (Kodak *Publication JJ-193) on microfiche, make that Dept. 454 and send $25* (plus applicable state and local taxes).*

**Price subject to change without notice.*

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