April 12, 1971

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Molybdenum gates speed up MOS ICs 68
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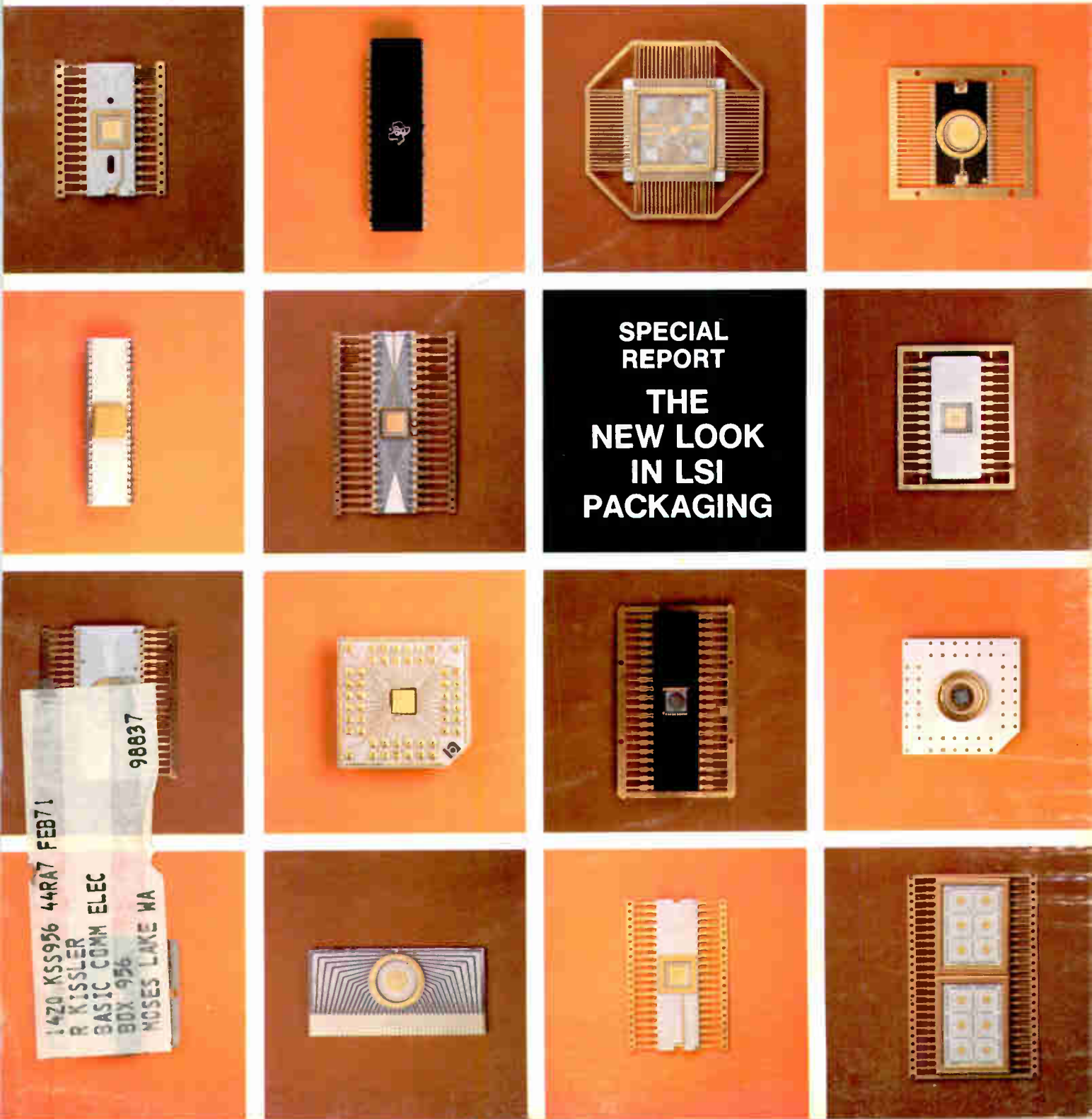
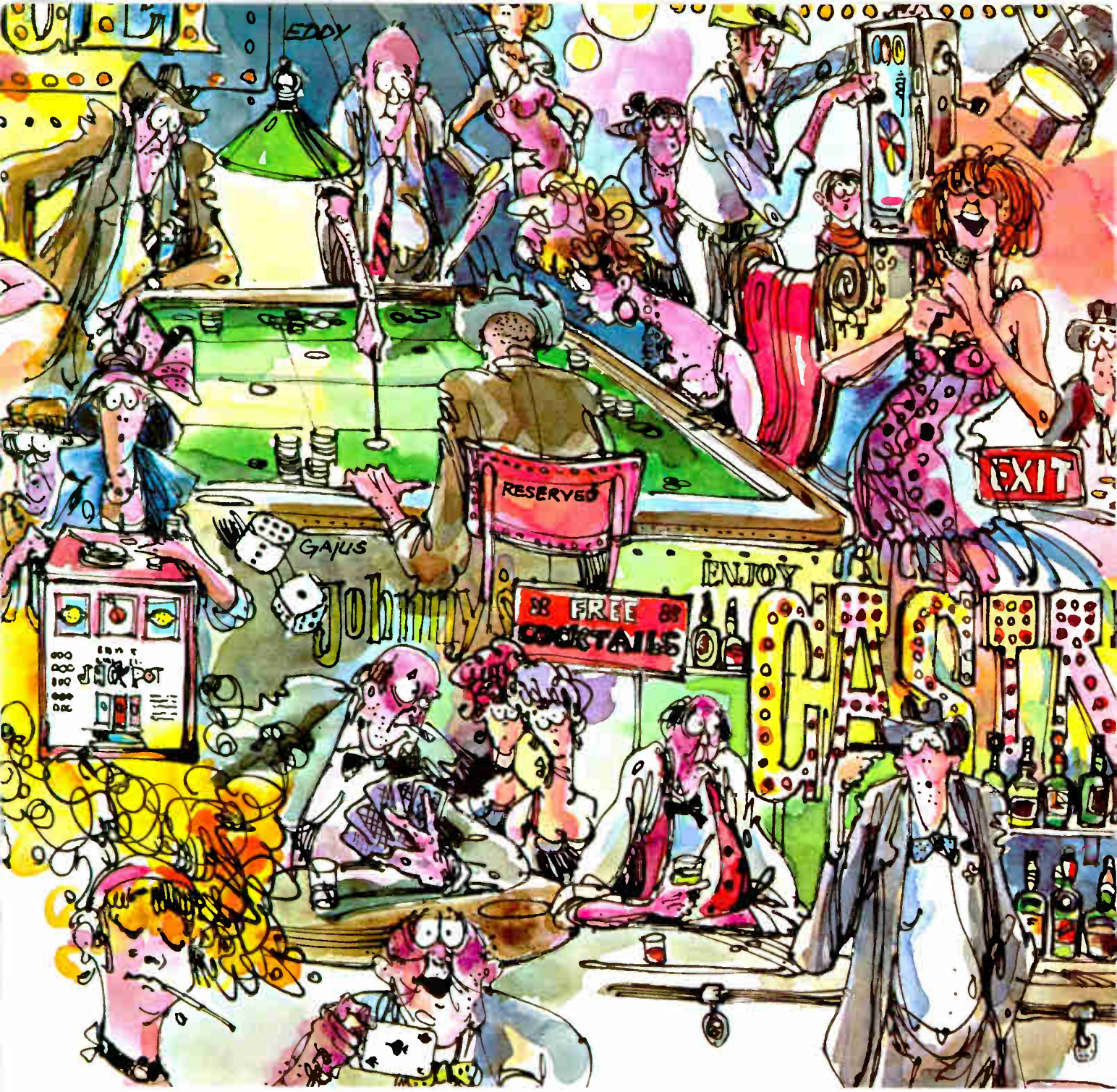
Electronics





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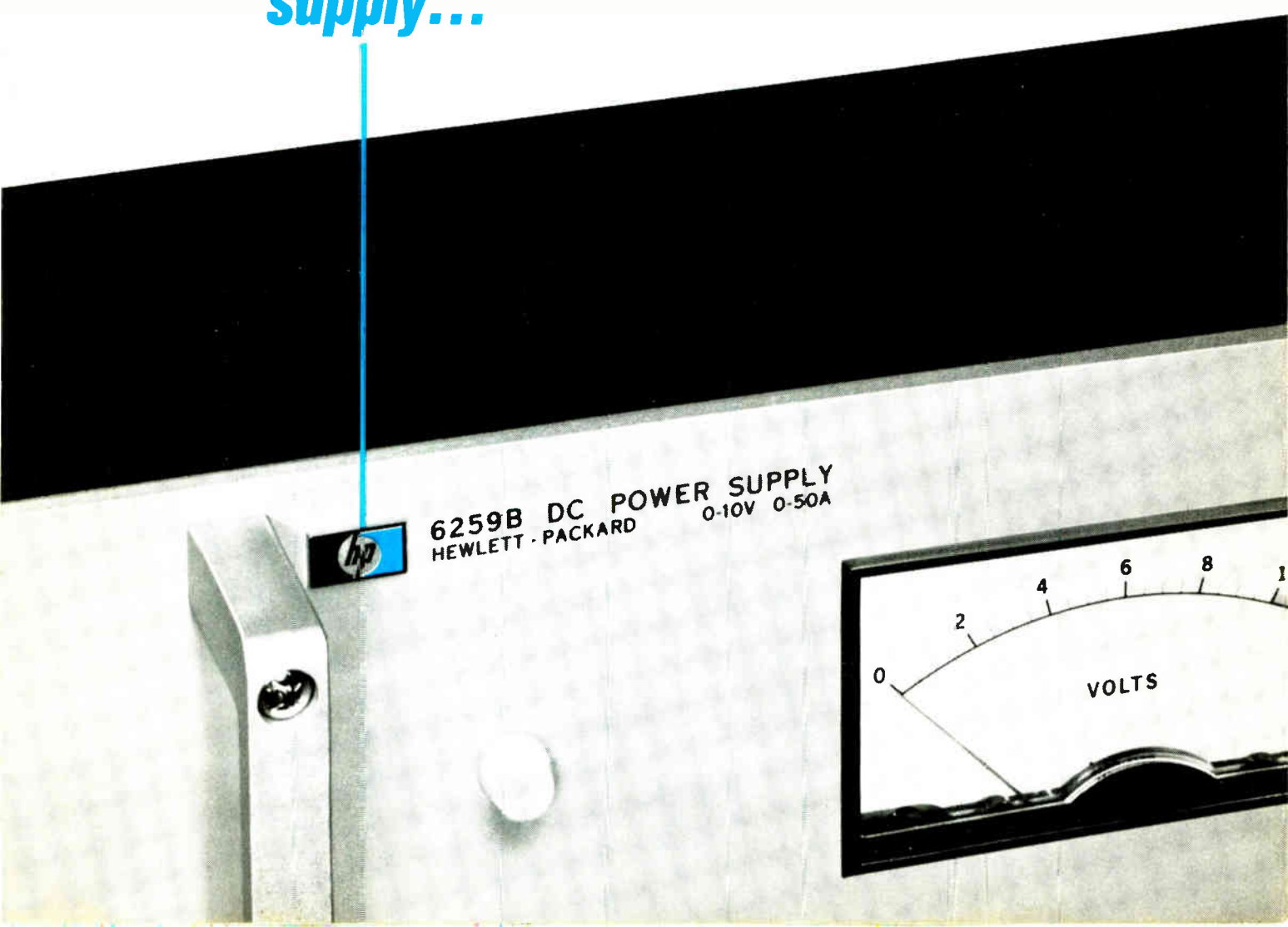

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SWEEP OSCILLATORS

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Electronics

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Publisher's letter

The checker pieces on the cover represent a cross-section of the wild variety of packages for large-scale integrated circuits that confronts the designer of electronics products today. Our Special Report on LSI Packaging, which starts on page 75 and will continue in the next issue, is the most comprehensive look at all the package types you'll find in any magazine. *Electronics*' staff, both in New York and around the country, interviewed more than three dozen companies to bring you the details of the LSI packaging revolution—and of its controversies: plastic vs ceramic, package maker vs user, package vs package.

One thing that struck us as extremely significant in just about every interview was the persistent complaint about quality. In the report we mention charges by semiconductor companies concerning the poor quality of the packages that are being delivered. Among the most frequent complaints is that the lead frame is often too weakly attached to the substrate —and sometimes falls off. Steve Scrupski, senior editor in charge of the special report, can give some support to that. He says:

"After taking the cover photo, and trying to get small beads of wax off the back of one of the packages, one of the leads came off with the wax. And soft wax is among the most benign environments that the packages will ever have to work in. I don't want to say just which one fell apart, though. After all, we got the packages to use free of charge."

Actually, we want to thank all the companies who contributed samples of their products and who helped make this special report the valuable document it is.

Forty years ago, *Electronics* was a bouncing one-year-old, full of enthusiasm over technological advances. The hot news was the arrival of "The Midget," the tabletop radio that, at about $50, was challenging the expensive console models. The average radio price in 1928, three years before, was $115. But a survey made by the magazine disclosed that no radio manufacturer, barring those with other product lines, made a profit in 1930.

A month before, under the headline "Makes moving machines stand still," the magazine announced that an electronic stroboscope had been developed at the Massachusetts Institute of Technology by Harold E. Edgerton. There was a study of how radio made silkworms spin more silk. Clearly an industry in ferment.

We've decided to share those days with you by reprinting excerpts from back then, partly to give some perspective to today's problems (it turns out it has all happened before, only the names have changed), and partly for entertainment. The first installment of "40 years ago" is on page 16.

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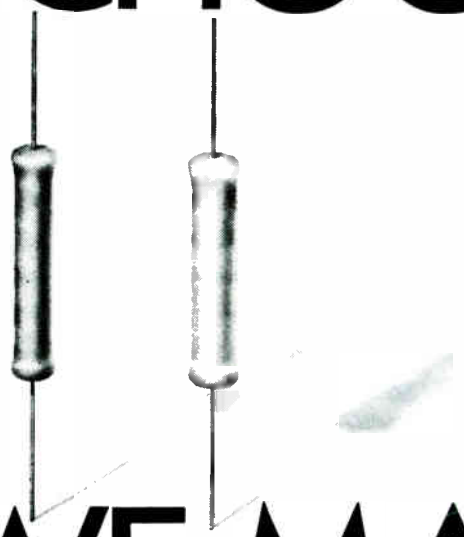

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Readers comment

The logic battle

To the Editor: The article on Schottky TTL vs ECL [March 1, p. 69] did not mention an important advantage of ECL: the availability of simultaneous complementary outputs. This feature is difficult to obtain with TTL. As you point out, the fact that complementary outputs help reduce package count is not very important. Hex inverters are available in TTL at nominal cost; the problem is that generating a complementary function with an inverter introduces timing problems between the function and its complement, and these can produce race problems. The skew in ECL is a small fraction of a typical propagation delay caused by the differential propagation delay of the logic cell. Since the logic cell is integrated on the same chip, differential propagation delay and skew between complementary functions is dependably small. With TTL, delays must be matched by going through a noninverting amplifier; the improvement is small and undependable.

Another handy use for ECL's simultaneous complements is differential drive capability. The complementary outputs can be used to drive a twisted-pair line directly or a differential input amplifier.

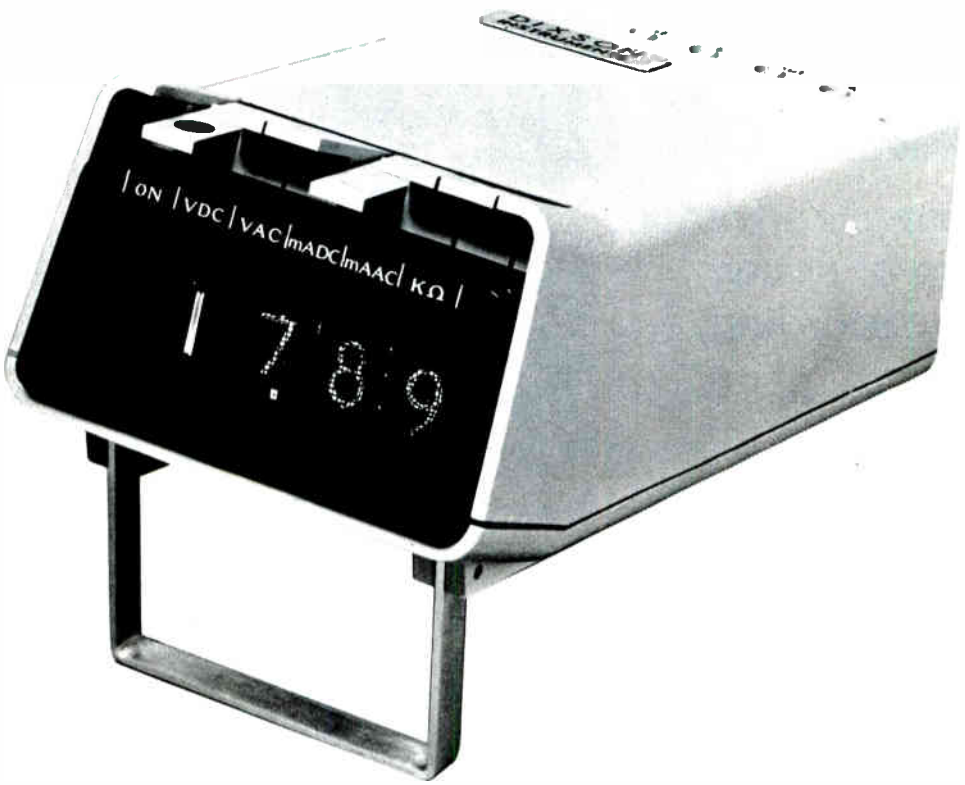
Edward S. Conn
Hewlett-Packard Co.
Colorado Springs, Colo.

Medical gear safety

To the Editor: The article on safety in medical electronics gear [Feb. 1, p. 54] is commendable. It is unfortunate that Government control and legislation are required to correct this situation.

It is true that hospitals are to be blamed in part for poor maintenance and calibration; however, the bigger share of blame and responsibility falls on the manufacturer of the equipment. Lack of reliability is only part of the problem; proper and suitable design is the rest. All too often, equipment is designed by engineers for use by engineers, rather than for nurses, doctors, and

Headrest.



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Readers comment

other medical personnel. Hospital environments for such equipment are rough from the point of view of application, handling, and treatment. Electronic gear does not get tender loving care in hospitals. Yet some manufacturers refuse to update their products and improve quality and performance.

Mort Arditti
Biomedical engineer
Department of Cardiology
Cedars-Sinai Medical Center
Los Angeles, Calif.

Charge-coupled devices

To the Editor: The article on charge-coupled devices and conventional MOS memories [March 15, p. 31] contained at least one gross error and many misrepresentations.

The gross error is the statement that dynamic MOS memories have cell sizes of 30 to 40 mil². Available dynamic RAMs have cell sizes of less than 6 mil² while developmental cells, to be available in 1971, have cell sizes of less than 4 mil². Under consideration are designs of 2 mil²; all of the figures include all access lines necessary to build a read-write RAM.

The entire tenor of the article is misleading: such claims as "a somewhat less than five-times improvement in bit density" and "conventional MOS can't hold a candle to CCDs on the density front" are completely fallacious.

Jack Schmidt
Computer Microtechnology Inc.
Sunnyvale, Calif.

■ *Dynamic memories are indeed available with cell sizes as low as 6 mil² but the major point was that at least a three- to fivefold advantage in bit packing density is possible with* CCD *technology, using present* MOS *fabricating rules—a point on which many memory developers agree. The Intermag Conference, to be held April 13-16 in Denver, devotes a session to* CCD *devices; the conference says that these devices, "by virtue of their structure and fabrication simplicity, offer the potential of very high density and low cost."*

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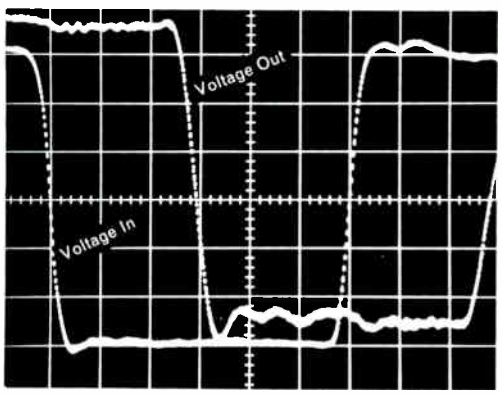

tpd minus: 29 nanoseconds
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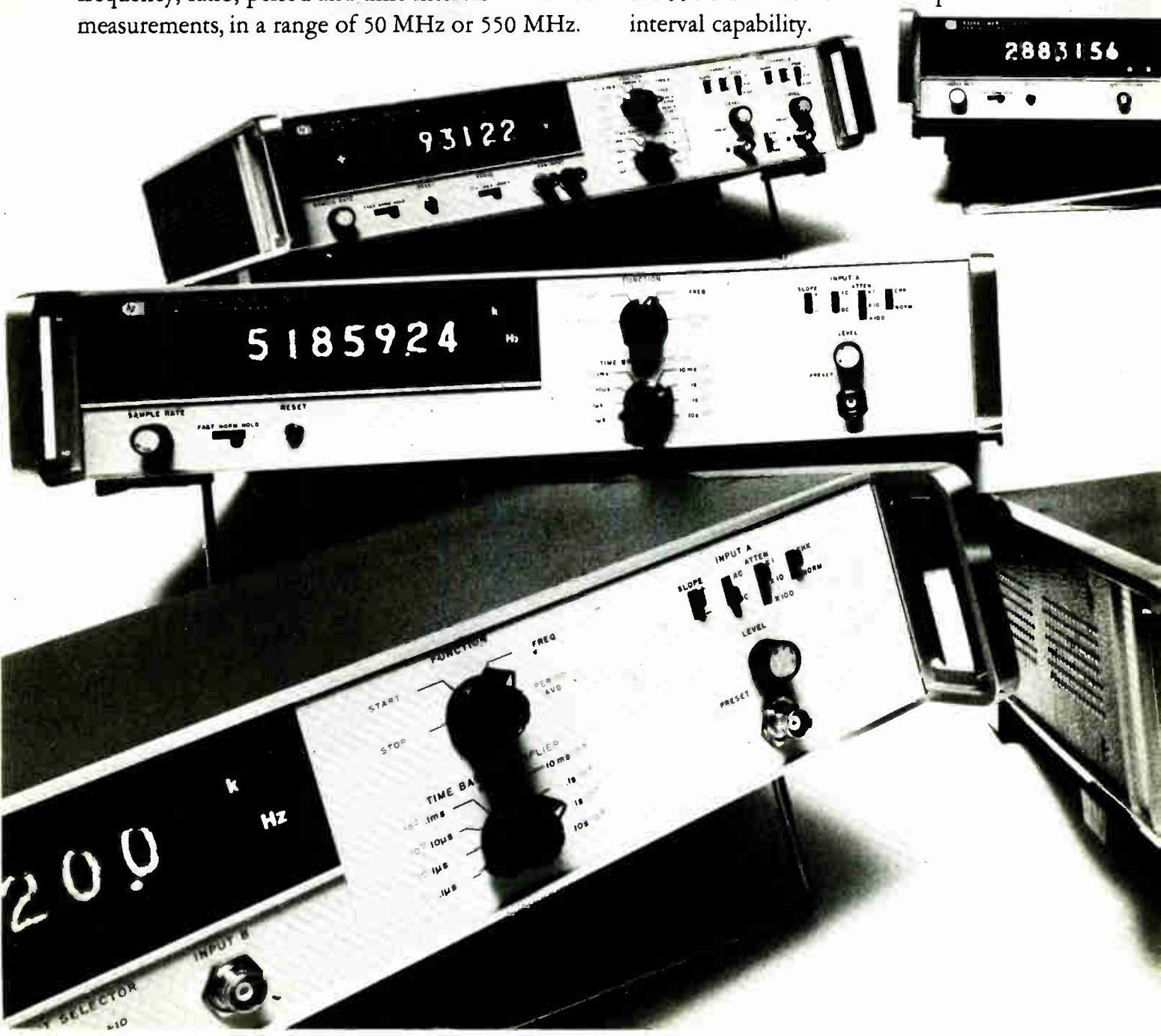

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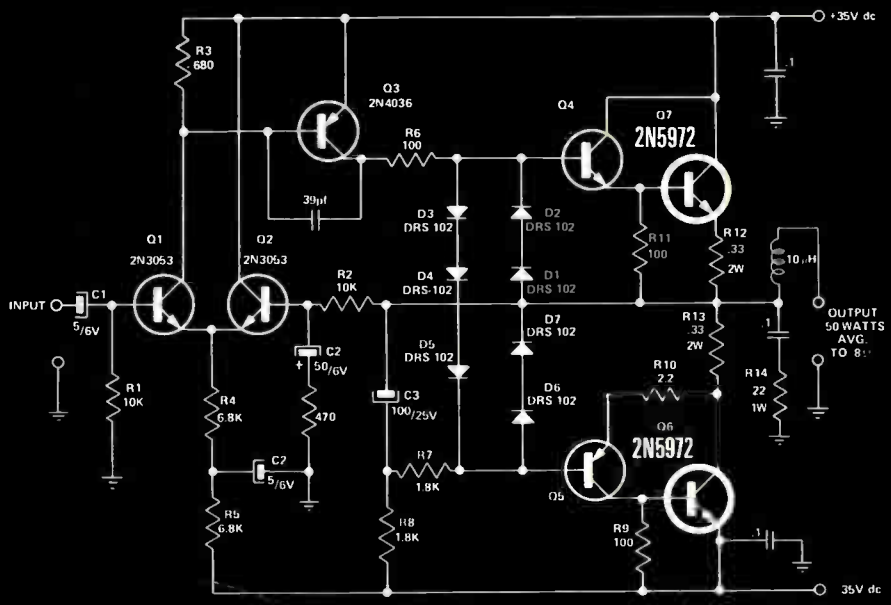

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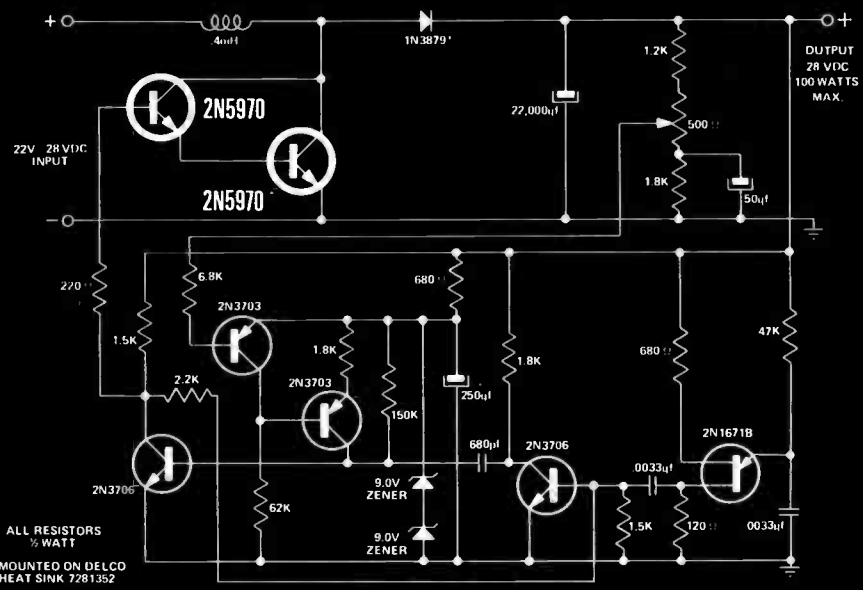

TYPE	I_C Cont. Amps.	I_C Pulsed Amps.	V_{CEO} Volts	V_{CEX} Volts	$V_{CEO(sus)}$ Volts	h_{FE}(min.) @ I_C=5A	h_{FE}(min.) @ I_C=15A	$V_{CE(sat.)}$ Volts @ I_C=10A, I_B=1A
2N5970	15	20	60	80	60	20	10	2.0
2N5971	15	20	60	80	60	50	20	1.5
2N5972	15	20	80	100	70	25	10	1.8
2N5973	15	20	100	120	80	25	10	1.8

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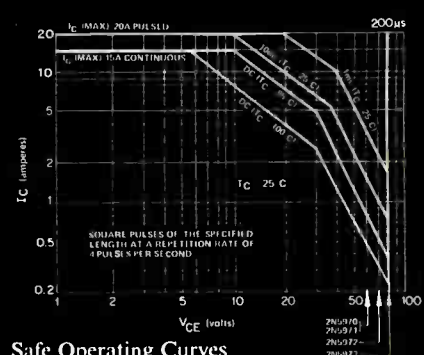

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Application Notes 42 and 43 provide the data on the circuits.

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N.Y., NEW YORK • Harvey/New York (212)-582-2590
N.Y., WOODBURY • Harvey/New York (516)-921-8700
OHIO, CINCINNATI • United Radio, Inc. (513)-761-4030
OHIO, CLEVELAND • Pattison Supply (216)-441-3000
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Power and Industrial Products Dept.,
767 Fifth Avenue, New York, N.Y.
10022. Phone: (212)-486-3723.

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People

Baughman

The only way to run a $2 billion program is—very carefully. And that's exactly how Capt. Fred H. Baughman is handling the Navy's S-3A, the carrier-based, antisubmarine warfare aircraft scheduled to enter the fleet by mid-decade. Mindful of the extra responsibility that goes with the extra authority conferred on major-program managers by Deputy Defense Secretary David Packard, the S-3A program boss tracks the performance of his prime contractor, Lockheed-California Co., with a green telephone. "It will put me right into their plant and let me talk with anyone on the program," he says.

Baughman—who pronounces his name Boffman—took over the S-3A program in the fall of 1968, before final selection of a contractor. The assignment came after more than a year at Naval Air Systems Command headquarters in Washington as "Aeronautical Engineering Duty Only Career Management Officer." Labored though the title was, it marked the soft-spoken, 45-year-old, four-striper as one of a new breed of military program managers, trained to run a major program from beginning to end.

To keep Lockheed and its 16 avionics subcontractors on their toes, Baughman's program is one of the first to employ the milestones concept developed in John Foster's Directorate of Defense Research and Engineering. With this approach, contractors must have to demonstrate specific performance achievements for portions of a system before proceeding to a more advanced phase of the program [*Electronics*, March 29, p. 83]. "The milestones were added to our program just before we went to contract," Baughman explains, "so we took from the things that were going to happen some good, gutsy items to make contractual milestones."

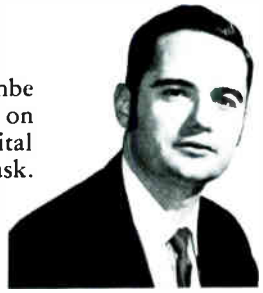
"There's a tendency to make medical electronic devices more accurate than they need be," says David Link. "Engineers are always trying to squeeze out another decimal point, and if you sacrifice reliability and cost for that additional decimal point, then it's a poor tradeoff."

Recently named special assistant for clinical medical devices at the Food and Drug Administration, Link is fast becoming the nation's leading expert in medical devices. Charged with the gargantuan task of classifying and inventorying all medical devices, he is now in the process of mailing more than 3,000 questionnaires to manufacturers and importers of medical and dental devices, and hopes to have the inventory completed in June.

Link is sensitive to industry needs. His philosophy, "The closer we work with industry, the more practical and pragmatic our results will be," was acquired, along with the needed expertise, at Hewlett-Packard Co.'s Medical Electronics division.

"Classification will undoubtedly follow the guidelines suggested by last year's Cooper report," says Link, although he cannot yet give an exact timetable. The Special Committee on Medical Devices, headed by Dr. Theodore Cooper, director of the National Heart and Lung Institute, recommended three categories for medical devices: those which show little or no evidence of being injurious, and do not require standards or scientific review; those for which adequate standards exist, or where there is enough data to establish new standards; and those, such as long-term implanted devices, whose safety and reliability are subject to question and would be subject to scientific review.

"Choosing the right digital voltmeter"



Product Manager, Charles Newcombe gives you some inside tips on choosing the appropriate digital voltmeter for your task.

"The single most important point to remember in choosing a digital voltmeter is *credibility*. That is, you must have confidence in the measurements made. When a Fluke voltmeter records a measured volt, you know you have received an accurate reading . . . you can believe, brother.

"Next, get yourself a DVM with the accuracy and stability needed for a given job. Fluke digital voltmeters are available in seven different models with certified guaranteed accuracies down to 0.004% and sampling rates up to 400 per second. Fluke voltmeters are so stable they seldom require recalibration more than once a year. And they are designed to work in a wide range of environmental conditions. As a matter of fact, Fluke off-the-shelf DVM's meet or exceed many military specifications.

"Get yourself a DVM that won't always be out of service for maintenance or repair. Fluke DVM's use our unique recirculating remainder analog-to-digital conversion circuitry. It uses far fewer components than other methods. So, as the parts count goes down, the reliability goes up. And as a bonus feature, power drain is low, so we can give you true battery portability.

Our DVM's are burnout proof, which is just another neat little trick to minimize downtime.

"Don't handicap yourself with digital voltmeters that can't be updated in the field as your needs change. Fluke meters let you drop-in circuit boards at anytime to expand measurement capabilities or tailor the instrument to systems application. Our wide range of options includes such things as millivolts (with 1 microvolt resolution), 4 wire ratio, AC-AC ratio and 4 terminal ohms. Isolated digital or printer output, and isolated remote control with memory were designed for direct computer interface—not just add on adaptability.

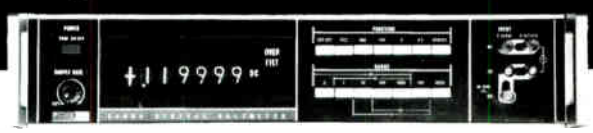
"Buy a new voltmeter with all the circuit refinements and convenience features that make it a genuine pleasure to use. Fluke meters give you autopolarity, autoranging, pushbutton function and range selection, and floated and guarded circuitry. All Fluke DVM's have an extra digit for 20 to 60 percent overranging.

"Don't fall for the price fallacy. When we introduced Fluke digital voltmeters a few years back, we offered them at a price that curled our competitor's hair. We did it by engineering the complexity out of the instrument. We did it by not taking the 'me too' path.

"We've got a full measure of new information on the complete line of Fluke DVM's. We'd like to send you a copy. Call us here at the factory, or better yet, contact your nearby Fluke man."

Here's one of our two new voltmeters. The Model 8200A is a fast systems DVM featuring 400 samples per second, 60% overranging, autoranging and remote programming. Accuracy is 0.01%. Prices begin at $995.

Here's the other, the new Model 8400A with the big accuracy spec, 0.004% for 90 days, 0.01% per year. Base price is $2450.



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40 years ago

From the pages of Electronics, April 1931

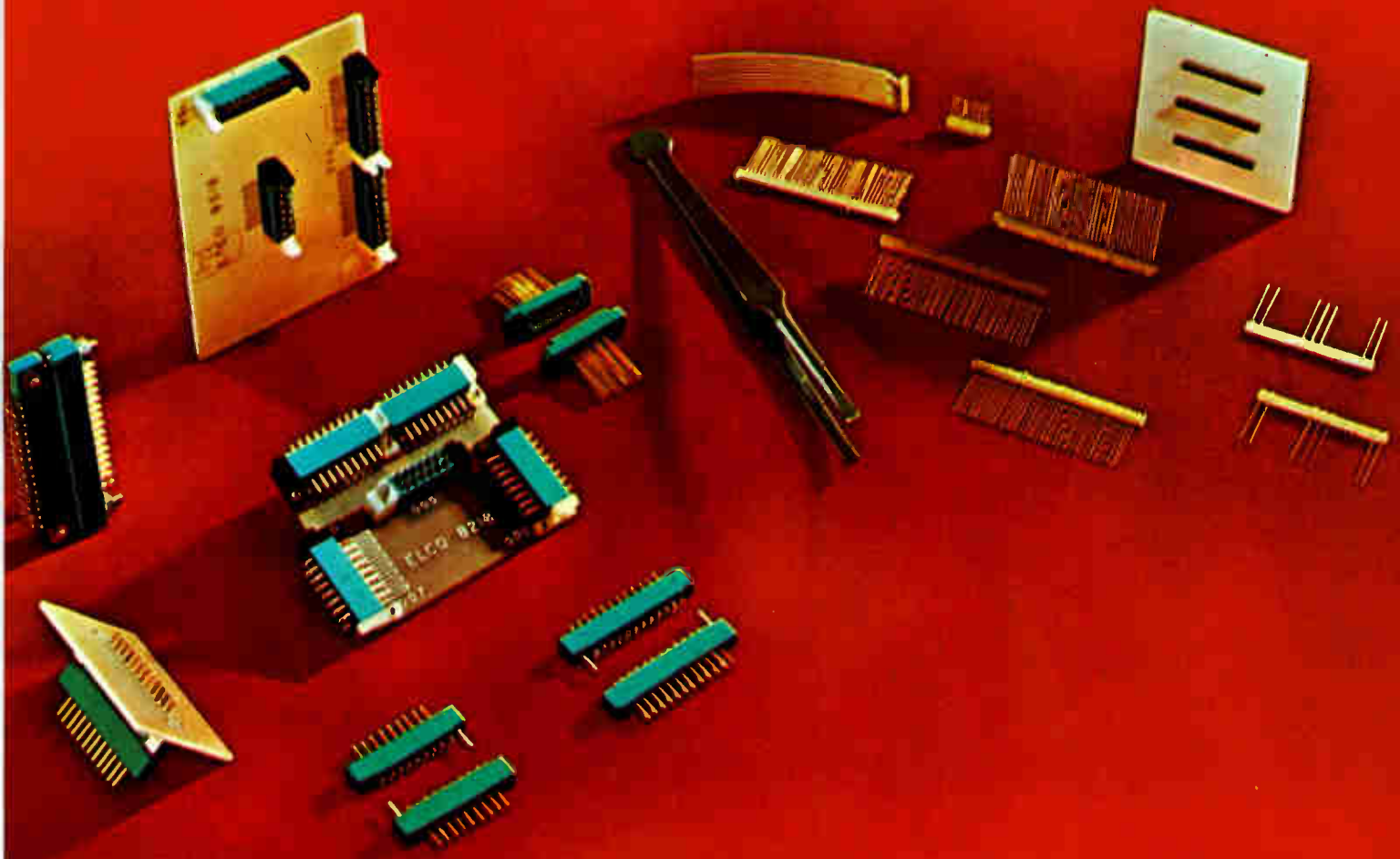
Spring is the season of germination and of "growing things," and certainly the Spring of 1931 has been a period of hectic germination of ideas, and of helter-skelter growth of new schemes in the field of radio tubes. Meanwhile, the rest of the radio industry stands by and wonders, "What next?"

Pentodes, variable-mu's, exponential tubes, special tubes, permanent tubes, built-in tubes, shock-proof tubes, horizontal tubes, automobile tubes—these are some of the new or resurrected ideas which are right now budding into physical form.

Let us put down the various causes which radio men and economic students have assigned for the predicament in which radio finds itself.

1. General economic depression.
2. Overproduction of radio sets.
3. The licensing situation.
4. The coming of the midget.
5. Failure of distribution machinery.
6. Apathy toward broadcasting.
7. The approach of saturation.

With the development of radio sets at the crossroads as to future design from a price viewpoint, the opportunity for popularizing automatic record-changing units in the better class of such equipment, has an excellent chance for success. The liquidation of development costs, and larger production, has made available record-changing equipment that might well be incorporated in radios for a much wider market. An important factor that might also be considered is the replacement of some 4,500,000 obsolete sets now in the hands of the public. It is true that first purchasers of present-day radios look with favor on the cheaper units, but a percentage of the replacement buyers will look with discrimination for some *important additional feature* before parting with their present sets. That additional feature must stand out, and might well be the automatic record-changing unit.



Miniature, subminiature connectors, yes.

Miniature, subminiature contacts, no.

Microelectronics can give you a pain in the tweezers. You have to be perfect. And you have to be perfect in places so small that a flea would have trouble scratching his back.

Actually, the electronics part isn't too hard, what with piezoelectric this's and thin-film that's to work with.

But, inevitably, there comes the day when all the this's and that's have to be put together. It's a problem. Mechanically. Electrically.

You don't want to put a big fat plug on a skinny little mini-circuit.

So you need miniature or subminiature connectors. Those we have. By the catalogfull.

But you sure don't need undernourished contacts. You need all the strength you can get, all the contact area you can get, all the hang-togetherness you can get.

Those we give you. Every miniature in our catalog is made with our patented Varicon™ contacts (you probably already know about them). Our newer subminiatures are made with Bi/Con™ contacts (which is sketched at the left).

See the four mating surfaces?

Four mating surfaces, coined so that they're exceptionally hard and smooth.

Four mating surfaces, held together snugly by the spring-like action of the design. And by the innate characteristics of the phosphor-bronze.

Four mating surfaces, strengthened by a reinforcing web.

Four mating surfaces, on a contact that floats in its insulator to make sure that the four mating surfaces mate.

No comparably sized contact can match the Bi/Con's dimensional, electrical, and mechanical characteristics.

And no subminiature contact can match the Bi/Con's incredibly low price, either.

For your copy of our Microelectronics catalog, write us at Elco, Willow Grove Division, Willow Grove, Pa. 19090 Elco, Huntingdon Division, Huntingdon, Pa. 16652. Elco, Pacific Division, 2200 Park Place, El Segundo, California 90245.

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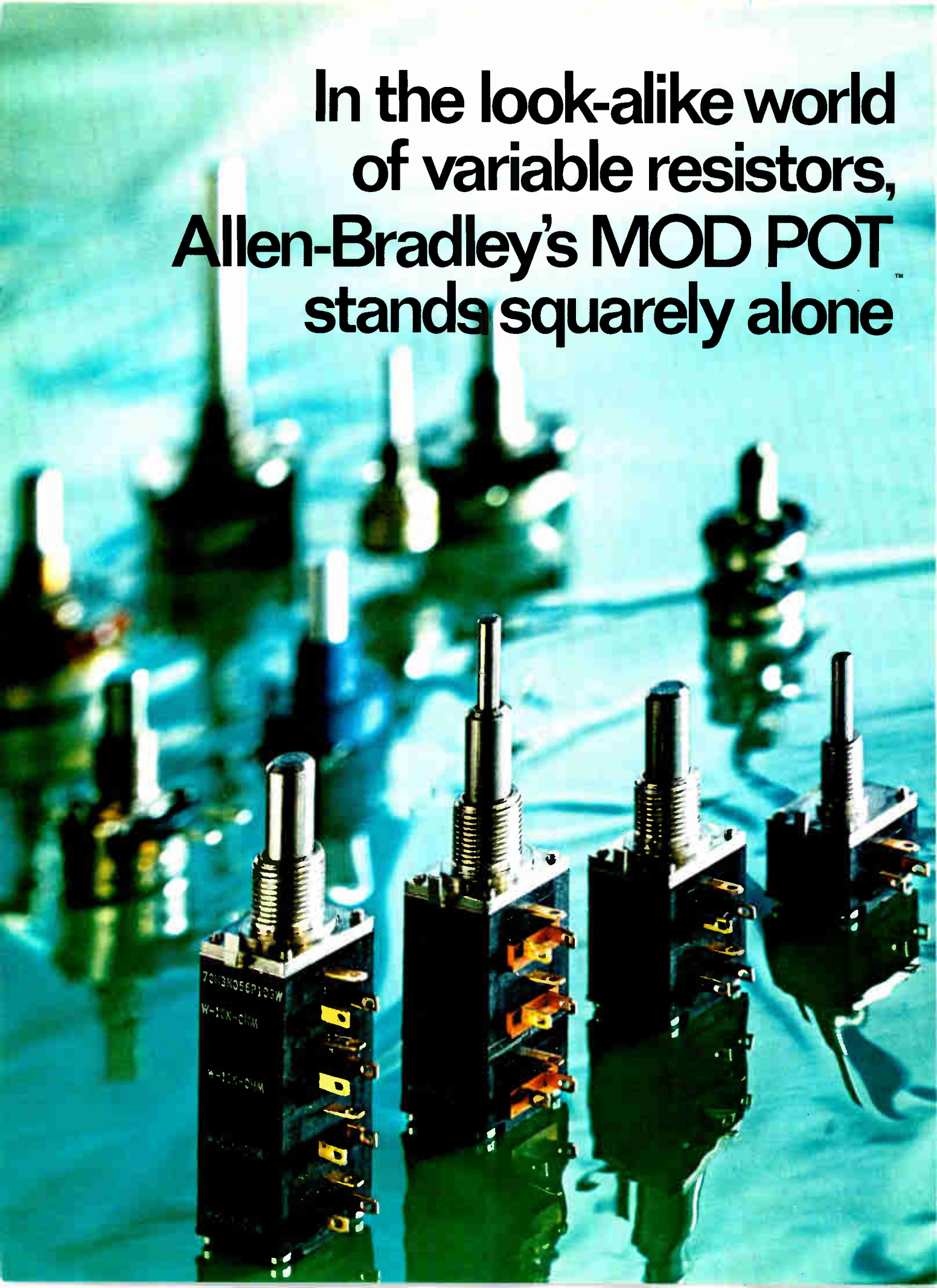
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stands squarely alone

MOD POT: the most versatile 5/8″ square potentiometer available today.

Series 70, designed for the 70's. There are a multitude of basic combinations. Potentiometer, switch and vernier drive modules combined to form single, dual, triple or quadruple section controls. With single or concentric shafts. But that's only the beginning.

Resistance modules come in cermet or hot-molded composition. Cermet, 100 ohms to 5 megs. Composition, 50 ohms to 10 megs, available in five standard tapers and also special tapers.

Switch modules in push-pull, momentary or rotary styles with actuation at the beginning or the end of rotation.

All standard options are available, including: two different shaft diameters, sixteen lengths with plain, slotted or flatted ends; bushings in two lengths and two diameters with your choice of plain or shaft lock styles. Marked with your part number, or ours.

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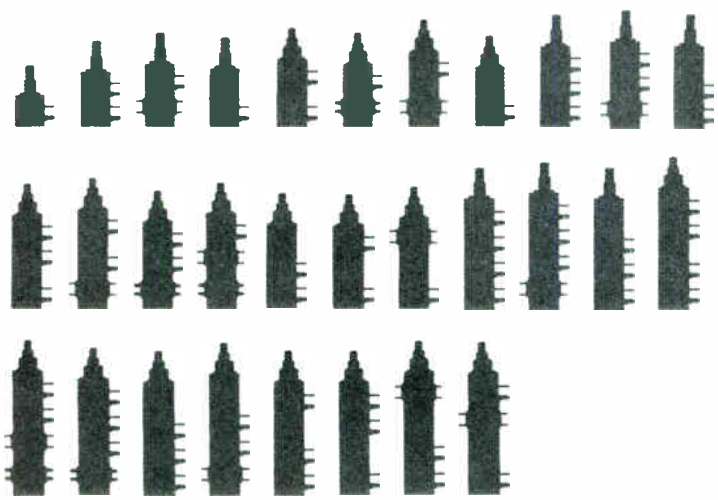
Call your A-B appointed electronics distributor, or write: Allen-Bradley, Electronics Division, Milwaukee, Wis. 53204. Export: Bloomfield, N. J. 07003. Canada: Galt, Ont.



NEW DIMENSION ELECTRONICS

ALLEN-BRADLEY

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Meetings

Calendar

Offshore Technology Conference, IEEE, Houston, **April 18-21.**

International Geoscience Electronics Symposium, IEEE; Marriott Twin Bridges Motor Hotel, Washington, **April 18-23.**

Conference on Electronic Crime Countermeasures, University of Kentucky; The Carnahan House, Lexington, Ky., **April 22-24.**

Frequency Control Symposium, U.S. Army Electronics Command; Shelburne Hotel, Atlantic City, N.J., **April 26-28.**

Relay Conference, College of Engineering, Oklahoma State University Extension, National Association of Relay Manufacturers; Stillwater, Okla., **April 27-28.**

Southwestern IEEE Conference and Exhibition, Houston, Texas, **April 25-May 2.**

Symposium on Theory of Computing, Association for Computing Machinery; Shaker Heights, Ohio, **May 3-5.**

Society for Information Display International Symposium, Sheraton Hotel, Philadelphia, **May 4-6.**

National Meeting, Operations Research Society of America; Sheraton-Dallas Hotel, Southland Center, Dallas, **May 5-7.**

Electronic Components Conference, IEEE; Statler-Hilton Hotel, Washington, **May 10-12.**

Electron, Ion, and Laser Beam Technology Conference, IEEE; University of Colorado, Boulder, **May 12-14.**

International Microwave Symposium, IEEE; Marriott Twin Bridges Motor Hotel, Washington, **May 16-20.**

Aerospace Electronics Conference (NAECON), IEEE; Sheraton Dayton Hotel, Dayton, Ohio, **May 17-19.**

Call for papers

Joint Conference on Sensing of Environmental Pollutants, IEEE, Instrument Society of America, National Aeronautics and Space Administration; Cabana Hyatt House, Palo Alto, Calif., Nov. 8-10. **May 14** is deadline for submission of abstracts to Dr. Robert L. Chapman, Beckman Instrument Co., 2500 Harbor Blvd., Fullerton, Calif.

When you place a big semiconductor order, you're naturally looking for technical competence, broad line availability, price, delivery . . . and continuity. That's why you should consider ITT's commitment. A mammoth investment in manufacturing facilities; a profitable position as fifth largest semiconductor company in the world; a well-trained and productive work force; a worldwide marketing base; a diverse and growing product line. These are the things that assure ITT's continued presence as a major factor in the semiconductor business.

If you're about to let a major semiconductor contract, and you want to be sure you finish up with the same supplier you started with, check ITT. We're committed.

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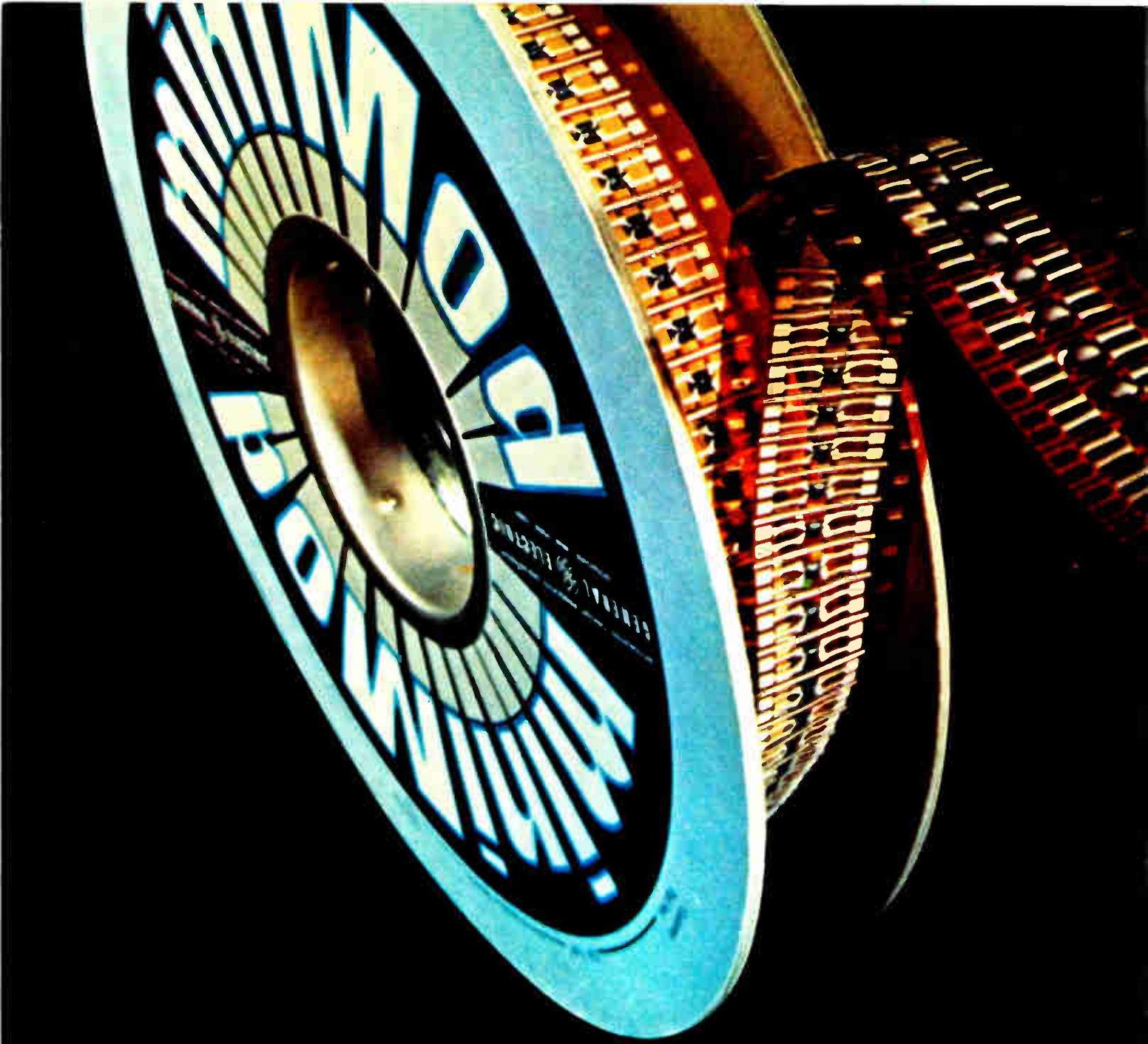


General Electric's new miniMod™

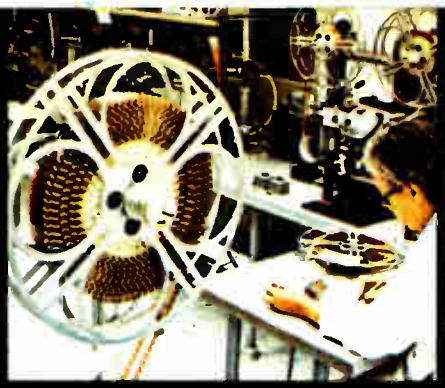
Tomorrow's IC package today

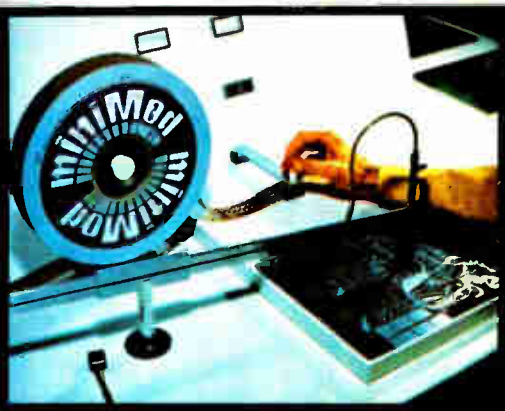
Dramatic new interconnection technique means smaller, more reliable IC's

Some time ago, General Electric research scientists came up with two great ideas for integrated circuit manufacturing. These ideas looked so good to us that we set about turning them into practical devices that you could use. And now, we've put these ideas into production.

The first idea is called multibond™. It's an exciting interconnection technique in which all bonds to the chip are made at once by reflow soldering. No individually-bonded wires; no lead frames; no thermo-compression. It results in a network of external lead connections that is both stronger and more reliable than that formed by individually-attached leads.

And it made possible our second idea. That's miniMod™—our new





packaging concept for integrated circuits. Inside the min Mod package, the IC chip and its metallized lead pattern are supported on a strip of 35 mm polyimide film. Chip, leads and film are then encapsulated to form a tiny, rugged integrated circuit that is available individually or on reels. That's right—reel-to-reel IC's for the high-volume user.

General Electric's miniMoc package offers a new dimension in the mechanization of IC installation and use. They can be tested quickly —right on the strip and can be molded or hermetically sealed into DIP, hybrid or other package configurations. For the low volume user, miniMod provides a very small IC package of high quality and reliability that permits simple, standard assembly techniques.

To turn our developments nto reality, we've now introduced two new integrated circuits in the miniMod package. The industry-familiar 741 op amp has become the GEL1741 featuring high gain amplification and short circuit protection. And our GEL1494 Accu-Switch™ is a regenerative threshold detector with controlled hysteresis. It's great as a Schmitt trigger while offering greater stability. These are just the first two products in our new miniMod package. There are many more on the way.

The photos above show operation of a miniMod IC mounting system developed for low-volume PC board or hybrid use, a typical miniMod hybrid application and typical high-volume handling equipment. In addition, we've worked with several manufacturers of production equipment, and they're now ready to discuss specific production needs with you.

For more information about GE's new miniMod IC's or how to use them, write General Electric Company, Integrated Circuit Products Department, Section 770-01, P.O. Box 131, Liverpool, New York 13088.

GENERAL ELECTRIC

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THE MOS DRIVER

$545

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Dear Sir:
I want you boys from E-H Research Laboratories to prove that I should think small. Here is my purchase order. I have a_____ phase problem, so please solve it by sending me_____ Model G720 MOS Drivers at the small price of only $545 each. I understand that your unique MOS Driver can be used as a clock driver or a data driver. And if my problem is 2 phase, 4 phase, or more, all I have to do is purchase several and stack them up. Apparently your Model G720 MOS Driver is from your new GENERATION 70™ line of low cost, high-performance instruments and it offers an Output of −30 to +12 Volts and has Remote Current Injectors with Rep Rates to 10 MHz and Delay and Width to 200 ms. I understand that color-coded signal probes, no adjustments, non-selected parts and a one-year guarantee are other features. How about a 5-day free trial in thinking small?

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If you don't want to cut up your magazine, just a purchase order to E-H or to an E-H Representative will do.

Electronics Newsletter

April 12, 1971

Sales of equipment for ion implantation show sharp gains

If sales of ion-implantation fabrication equipment are any indication, both MOS and bipolar versions should have a booming future. Accelerators Inc. of Austin, Texas, the major producer of such systems, reports sales bookings for the equipment grew from $75,000 in the first quarter of 1970 to almost $350,000 in the first quarter of 1971, and Alex Sheshunoff, chairman, expects April and May to be even better.

Accelerators Inc., which recently introduced its first production-line system (earlier ones were designed basically for research), has sold one to one of the Big Three firms. In addition, many of the smaller semiconductor houses have been buying, and the company has received five orders from Japanese semiconductor makers since November. The company is also starting an ion implantation service because of demand from experimenters and would-be users.

Fuel injection unit to hit the road

Look for the arrival by midyear of a new electronic fuel injection system, designed for high-compression U.S. cars, that is one-third the size of the Bosch system now built into Volkswagens. The control unit, developed by Conelec Inc., Elmira, N.Y., is being tested for certification under Federal emission standards for 1975. It has fewer than 50 components on a printed circuit board, compared to the 240-plus in the VW/Bosch system.

TI's new MOS process promises speed, economy

Texas Instruments has developed a new process for making MOS circuits that offers high speeds and low-cost processing while overcoming some of the objections related to silicon gate fabrication. The self-aligned thick-oxide process (SATO), which TI will not describe in detail, has been used to make a 1,024-bit dynamic shift register that operates at 9 megahertz at 90°C, and will be used for TI's version of the Intel 1103 RAM. The process also will be used for the TMS 4020, a dual 1,024-bit dynamic RAM.

TI also is producing an eight-bit parallel MOS processor on one 210-by-225-mil chip for Computer Terminals Corp. of San Antonio, Texas. Computer Terminals will use the chip, plus the TI 1,024-bit RAMs, in an "intelligent" terminal to be introduced in July. According to the company, the computer has the capabilities of a PDP-8.

Can aerial surveys detect pollution of waterways?

Remote-sensing techniques will be tested by Grumman Ecosystems Corp., Bethpage, N.Y., as a method of spotting discharge of pollutants into waterways. Under a study contract from the New York district of the Army Corps of Engineers, a Grumman aircraft, equipped with a thermal line scanner and both color and infrared cameras, will survey areas near industrial plants to check on the contents and number of discharge lines for conformity to Federal water cleanup regulations.

In a separate study sponsored by the Army, Sperry Systems Management division, Great Neck, N.Y., will define a system for onboard monitoring of waste disposal from dredges, scows, and barges into assigned offshore areas. Systems being considered for position-fixing include radar, radio direction finding, and hyperbolic radio aids.

Electronics Newsletter

EM&M to market core memories for 360

Watch for a new entry in the IBM 360 plug-interchangeable extended core-memory business. The Electronic Memories division of Electronic Memories and Magnetics Corp., Hawthorne, Calif., will introduce a system at the Spring Joint Computer Conference (May 18-20) that can be used with the 360 models 30, 40, or 50, and which will be "more than competitive" with IBM memory prices, a source says.

This puts Electronic Memories in competition with its cross-town rival, the Computer Products division of Ampex Corp., Culver City. The Ampex extended core memories are priced higher than the systems that IBM supplies but are faster. Electronic Memories maintains that speed isn't all gravy for the customer, however, because he would have to alter the central processor timing to accommodate the higher speeds.

Higher densities claimed with new magnetic particle

A manufacturer of computer tape has developed a new magnetic particle for tape recording that promises five times the density now possible with iron oxide particles. Cobalt is the major component of the material, which Graham Magnetics Inc. of Graham, Texas, calls Cobaloy. According to the company, the material permits recording of up to 20,000 bits per inch in computer applications, and longer playing times for audio and video tapes. Graham has not yet decided whether to market the material alone or to sell new tape and equipment.

Congressmen push for better air traffic control

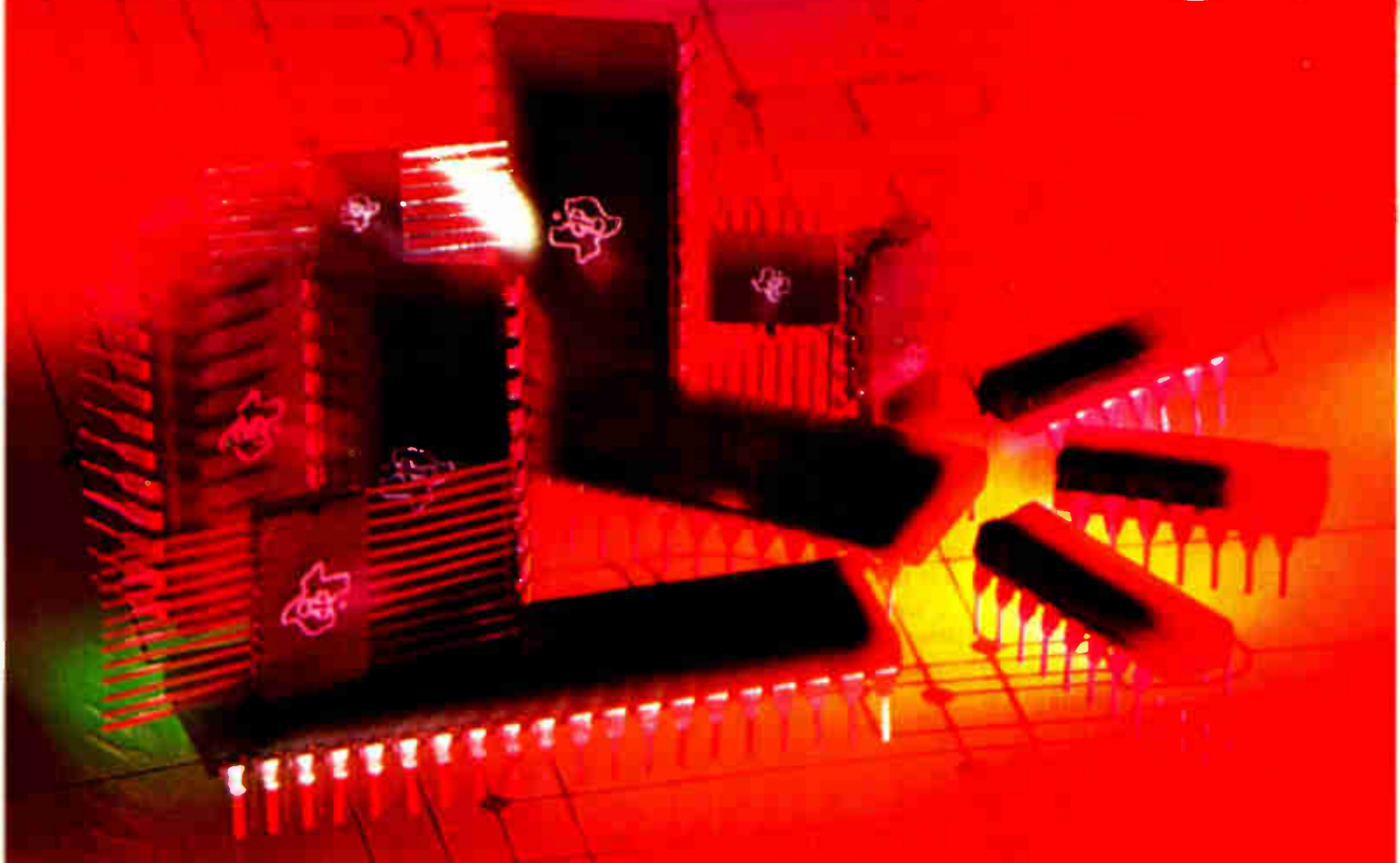
Congressional pressure is building to speed the installation of instrument landing systems, control towers and airport surveillance radars at all 585 U.S. airports served by scheduled airlines. Rep. Jack Brooks (D. Tex.), chairman of the House subcommittee on government operations, built the first fire under the Federal Aviation Administration by asking the General Accounting Office to begin an independent study of the nation's medium- and low-density airports. The GAO team assigned to the task will travel the same ground as the FAA's Office of Aviation Plans and Policy, which updates its 10-year plan for air traffic control facilities each year (see p. 40), but it's expected to reach different conclusions.

Other Congressmen, who also have small airports in their districts, are expected to support Brooks. Of the nation's 585 airports, 335 are equipped with towers, about 260 have instrument landing systems, and only 125 have radars.

Addenda

Varian Associates has developed an active III-V semiconductor material (indium arsenide phosphide–cesium oxide) for photocathodes in photomultiplier tubes. In the 0.9-micron infrared region, for example, devices with the new material are about 50 times more sensitive than present tubes. . . . Viatron Corp.'s application for Chapter 11 bankruptcy has been challenged by the Securities and Exchange Commission, which wants a Chapter 10 proceeding. A Chapter 10 provides for a court-appointed trustee who can call witnesses, take depositions, issue subpoenas—in other words, dig deeper into a company's background. . . . The space shuttle could fly a year earlier if Congress appropriates the NASA budget authorized by the House Science and Astronautics Committee. This provides $227.5 million for the shuttle, or $127.5 million more than the Administration requested.

The *Thrust* in Digital Design

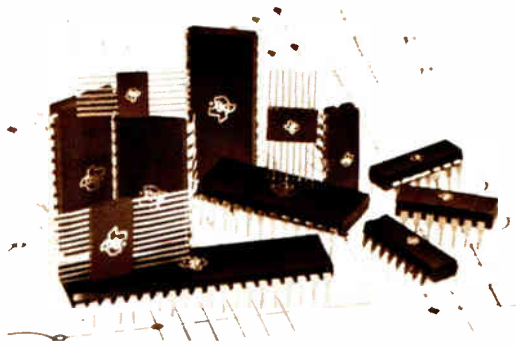


Plus news from Texas Instruments about

- The fast-growing Schottky TTL family
- Penny-a-bit bipolar ROM
- Economy-plus MOS shift registers
- MOS in plastic
- Largest MOS/LSI ROM available
- Linear ICs for MODEMs
- Programmable diode matrices
- Lowest-cost VLEDs
- Economy power transistors
- Higher-dissipation SILECT® transistors

Digital design: the thrust is ECL, TTL and MOS.

TI has the capability—across the board.



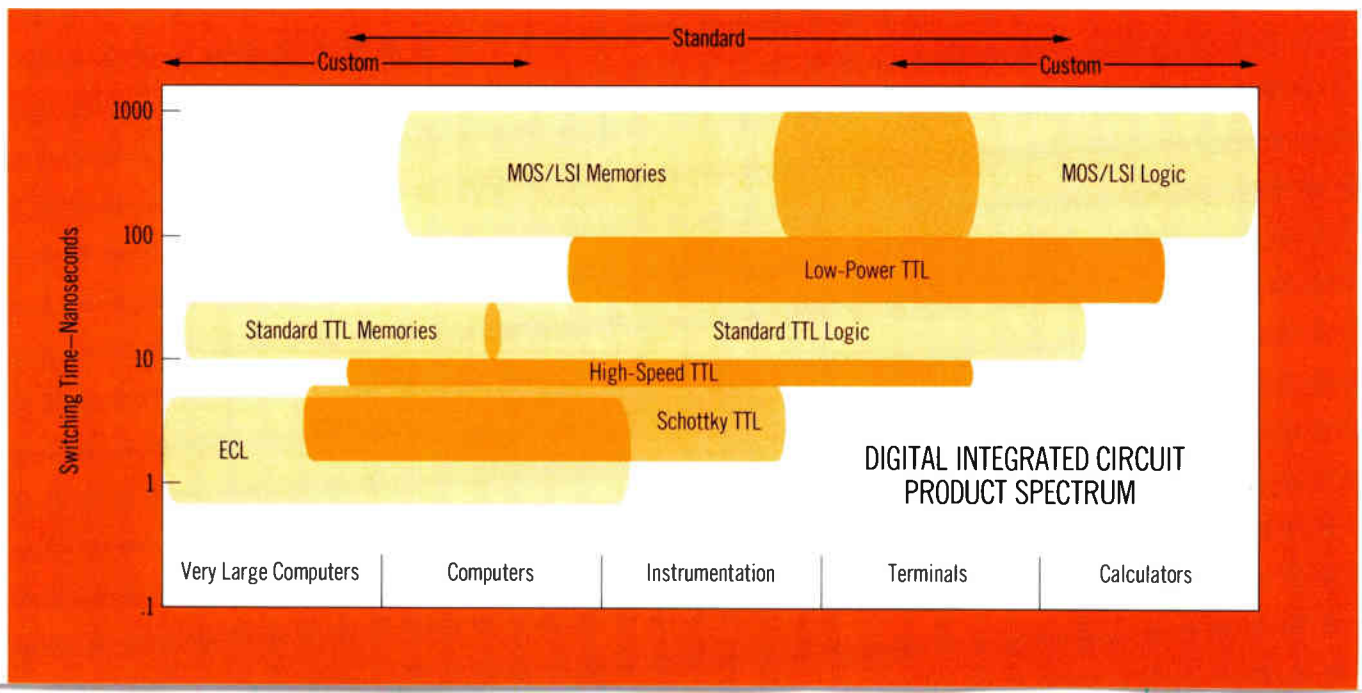
Digital design devours ideas very nearly as fast as men can express them. And its frontiers are extended daily. From switching speeds of well under one-millionth of a second to complexities of more than 300,000 transistors per square inch—that's today's designer's choice. But broad (and sometimes bewildering) as it is, your choice now focuses on three major technologies. The thrust clearly is ECL, TTL and MOS...and TI is at the forefront of all three.

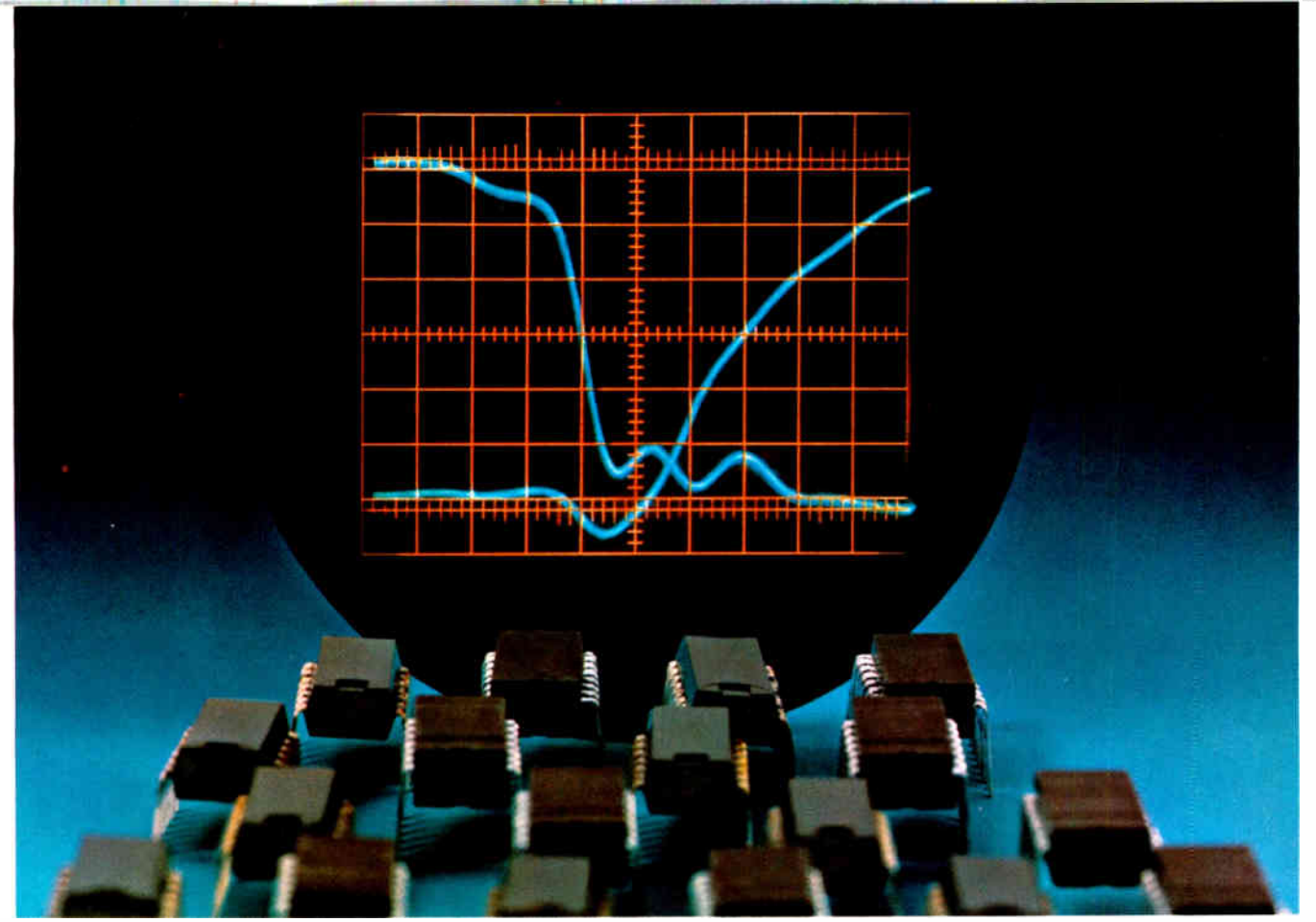
You may not know that TI sells more ECL than anyone else. We do. TI's been producing ECL since 1964. Most circuits have been custom designed, but a big standard line of 28 functions is also available. We have experience in all speed ranges, with delays as low as 0.7 ns currently being achieved. And industry's most advanced standard line is coming soon—with single power supply operation, temperature compensation, and low sensitivity to power supply variations. These features will simplify all very-high-speed system applications, from the smallest to the largest.

TI's development of TTL has paced the industry. Currently, there are more than 200 different functions from which to choose—83 of them MSI. A constant high rate of development assures continued flexibility for this most versatile of all digital logics. Standard MSI functions were *doubled* during 1970 and already have increased *40% this year*. TTL's widespread boundaries are being pushed still farther with new low-power functions and with the TI-patented Schottky-clamped TTL line. It's now possible to build a system with devices as fast as 1.5 ns/gate and those with dissipations as low as 1 mW/gate—using the same, perfectly compatible logic form.

MOS/LSI may be a bit younger than ECL and TTL, but TI has brought it to maturity fast. More than 40 standard functions are available. Six different MOS/LSI processes are now in production and a complete custom capability includes one of the most extensive computer-aided-design facilities in the industry. Complexity continues to soar. A newly announced 4096-bit read-only memory puts more than 5,000 transistors on a single chip of silicon. And new plastic packaging has reduced costs up to 25%.

This competent leadership in the thrust technologies—combined with such strengths as a complete facility for computer-designed controlled-impedance multilayer P'C boards—provides a unique ability to help you solve your problems. But it's more than broadest digital product scope and technology...it's also the largest and most cost-efficient volume production in the industry. TI has always been committed to leadership, and the large dollars-and-men commitments necessary to maintain this leadership will continue to be made.





3 ns at 20 mW Schottky TTL
Fastest and fastest-growing TTL family.

Applying the unbeatable speed/power combination of TI's Schottky-clamped TTL family to your designs is getting easier and simpler. And at a cost below equivalent ECL families.

In little less than a year, this revolutionary thrust in TTL technology has grown to a choice of 18 functions and gained unprecedented acceptance.

Big SSI choice

Your 1971 choice includes: two quad 2-input NAND gates, a hex inverter, two triple 3-input AND gates, a triple 3-input NAND gate, two dual 4-input NAND gates, two 4-wide 4-2-3-2-input AND-OR-INVERT gates, a dual 4-input NAND buffer, a dual 4-input 50-ohm line driver/NAND buffer, a dual D-type flip-flop and three dual J-K flip-flops.

Even faster MSI functions

Two Schottky/MSI data selectors/multiplexers are the first MSI additions to this fast TTL family. Both are quadruple 2-line-to-1-line devices. The SN54S/74S157 features a true output and a data-to-output speed of 5.5 ns through three logic levels. The SN54S/74S158 has inverted output and a corresponding speed of 4 ns through two logic levels.

More MSI coming soon

Schottky growth continues with the 1971 expansion of the MSI portion of the line. Among 12 functions on the way is an MSI arithmetic logic unit, SN74S181. Consisting of 75 gates, it will perform 16-bit addition in 20 ns, making it about twice as fast as the industry's standard, TI's SN74181.

Speed... and full DTL/TTL compatibility

TI's Schottky-clamped circuits are faster than any other TTL family. Internal storage time is eliminated by the Schottky-diode clamping of all saturating transistors, while shallower diffusions and smaller device geometries reduce internal capacitance.

These circuits have all the traditional advantages of TTL, and more. For example, they are directly compatible with nearly all saturated digital devices including TTL MSI/LSI as well as most DTL circuits. Switching times are virtually insensitive to power supply and temperature variations. And very low output impedances suppress line ringing.

TI Schottky TTL circuits are available in plastic and ceramic DIP and ceramic flat pack. **For data sheets** on the 18 benefit-packed Schottky TTL circuits, circle 271.

New economy semiconductors expand your broad choice at TI.

Optoelectronics

Lowest-cost VLED: TI's new 35¢ TIL209.

A new, highly-automated production line has made possible TI's breakthrough prices on visible light emitting diodes. The new VLED, TIL209, costs only 35¢ in quantities of 25,000 and 49¢ in small quantities of 100 to 4,999.

The TIL209 comes in a molded red filled plastic package, with an integral dome-shaped lens, 125 mils in diameter and 200 mils high. An epoxy filler in the VLED lens diffuses the emitted light creating a uniform light source throughout the dome structure.

The TIL209 features a radiated power output of 15 microwatts when forward biased at 20 milliamperes.

Because of its low cost, the TIL209 is ideal for use in home appliances, stereos and cameras; and as indicator lights in computer systems, data-processing equipment and communications systems. For your copy of TI's new optoelectronics brochure, including the full TI OPTO line of sensors, sources and coupled devices, circle 278 on the Reader Service Card.

Power transistors

TI reduces price, improves performance, doubles choice.

TI has turned on the power in plastic power transistors. Here's how:

Assembly time has been cut from 8 days to 4 hours to end delays and shortages. TI power transistors are there when you need them.

With industry-leading availability came industry-leading prices – down by an average of 20%. Plus, your ratings choice was doubled to 41 voltage/current combinations. Up to 100V and 25A, NPN and PNP complementary pairs, TO-3 and TO-66. Now industry's broadest line.

There's also a new high-performance plastic package. By far the most reliable you can buy, the new package design features an exclusive glass-passivated chip for lower leakage and better stability.

Also, all-soldered contacts boost resistance to thermal shock and vibration; solder-clad, copper leads facilitate solderability; nickel-plated copper heat sink improves thermal conductivity; pinned and soldered collector lead eliminates intermittent collector lead problems; plastic cap and epoxy fill solidly lock all elements inside the package.

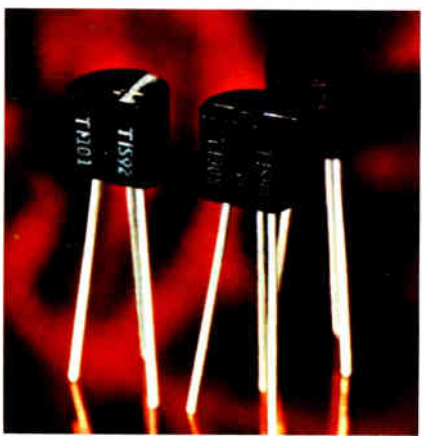
High volume production, low prices, improved reliability, and broad choice: a whole new package of value built into TI's new plastic power transistor line.

Circle 279 on Reader Service Card for Brochure CB-124.

Small-signal transistors

Metal-can dissipation at low-cost plastic prices.

The highest power dissipation available in a plastic package – up to 800 mW – is yours with TI's SILECT® transistor line. You don't pay any more for this; in fact, you actually pay less. The reason is TI's lower-cost, lead-wire construction method as opposed to the conventional stamped lead frame.



And these transistors have been approved in practically all known sockets requiring power dissipation greater than 400 mW.

Your choice includes an NPN general purpose audio amplifier delivering three watts Class B power, TIS92, as well as a PNP version, TIS93. TIS92M and TIS 93M are a complementary pair capable of three watts audio power. For video output stages, AFC amplifiers and Burst Amplifiers, there are the TIS100 and TIS101. Completing the line are the A5T5058 and A5T5059 high-voltage devices designed for operational amplifiers, high-voltage inverters and voltage regulators. For more details, circle 280.

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Let us compare our StereoStar/ZOOM to any stereoscopic microscope in your lab.

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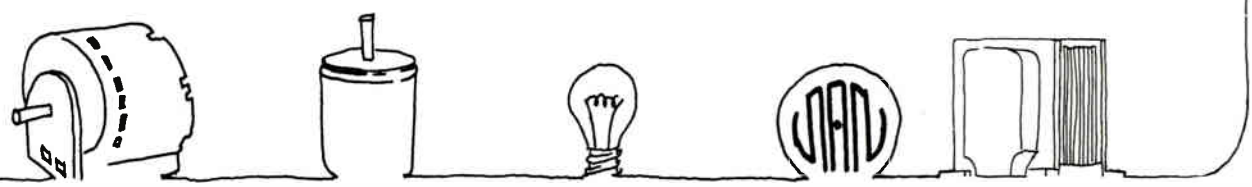

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Series 601 & Series 6, Solid State AC Relays. Loads from 1 Amp to 21 Amps—and up to 280 VAC, may be controlled from logic level inputs, DC inputs (7-85 VDC) or simply the AC line itself. All units have full solid state input circuitry—no reed relays. All Models available with or without zero-voltage turn-on and priced *sensibly* for industrial usage.

Reduce expensive and troublesome maintenance shutdowns. Build a reputation for reliability and quality into your product by using the latest solid state technology... from Teledyne Relays.

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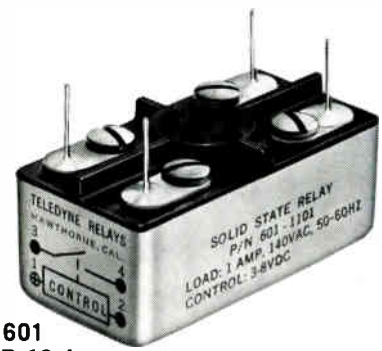

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Circle 34 on reader service card

Modulation scheme permits use of low-cost recorder

Differential pulse-width technique prevents distortion of data in instrumentation; 1% nonlinearity is claimed

A good multichannel fm instrumentation recorder costs $5,000 to $20,000. But results as good or better can be achieved with a simple audio tape deck, or even with a $39.95 cassette recorder—if one uses a recording technique called differential pulse-width modulation, or DPWM, says Y. T. Li, chairman of Setra Systems Inc., Natick, Mass.

With DPWM the wow and flutter of inexpensive recorders don't degrade the data recorded. In fact, claimed record-playback nonlinearity is less than 1% for the Setra system, much better than the 5% to 10% for competing devices.

These devices are costly because any machine trying to record pulsed or analog signals accurately must keep tight control of tape speed. If it doesn't, fm signals will vary in frequency, pulses will vary in duration, and replay will bear small resemblance to input. To overcome speed-control problems, deck makers have resorted to servo control, heavy flywheels to damp out flutter, pneumatic wow and flutter damping, and a variety of other electromechanical schemes, all of them expensive. And even then the best recorders often reserve a track for a sync or speed reference signal.

But with the Setra system the ratio's the thing. The input signal—either ac or dc—square-wave-modulates a carrier. The modulator operates so that an input signal generates a train of output pulses with a specific relationship to one another—the difference between the duration of one pulse and the time it takes to reach the next square wave's leading edge is divided by the sum of the same two quantities. This electronic arithmetic makes the DPWM approach almost immune to the speed variations of tape decks. "We could use eccentric reels," Li claims.

As a result, many inexpensive decks became candidates for precision instrumentation recording. Teledyne Materials Research, Waltham, Mass., Setra's first systems customer, may have been forced to overspecify to get a four-channel capability—at the time, Sony's near-$500 TC-366-4 was the only four-track recorder generally available. With this recorder, plus a Setra model 300 modulator-demodulator, the Teledyne division hopes to replace an fm system it's now using aboard ships to collect data on stress, acceleration, and other movements. The information is going to a variety of customers from maritime standards groups to naval architects with the goal of generating specifications for hulls in the super-super-tanker class.

Cyrus H. Kano, senior engineer at Teledyne, figures the Setra system will be nearly immune to spurious signals induced by the ship's motion that made their way onto the tracks of his former fm recording system—and that it should cost about half as much per channel.

Meanwhile, Li and his engineers have also tried DPWM on a $39.95 single-channel cassette machine from Lafayette Electronics with success, even though its tape speed was a low 1⅞ inches per second, and no cassette deck is rock-stable where tape speed is concerned.

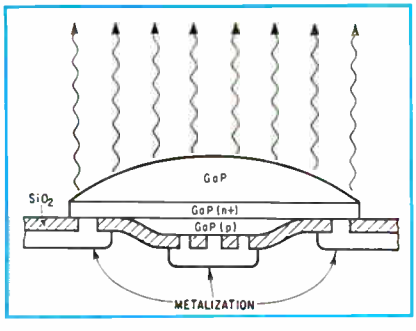
This brings up another potential advantage. Instrumentation recorders can eat tape faster than a starving pasta fiend attacks spaghetti, with many having 60- and 120- in./s speeds. Li figures that he gets equivalent performance at 1⅞ inches.

Manufacturing

Beam leads attached to GaP diode matrices

New technologies invariably must overcome a series of major obstacles before they reach commercial maturity. In the case of gallium phosphide light-emitting diodes, one of those obstacles is resistance of the material to high-volume production methods. Much of that resistance may have been beaten

Light touch. Bell Labs method makes GaP diodes easier to build in volume.



down by researchers at Bell Laboratories: they've developed a means of attaching beam leads to GaP diode matrices.

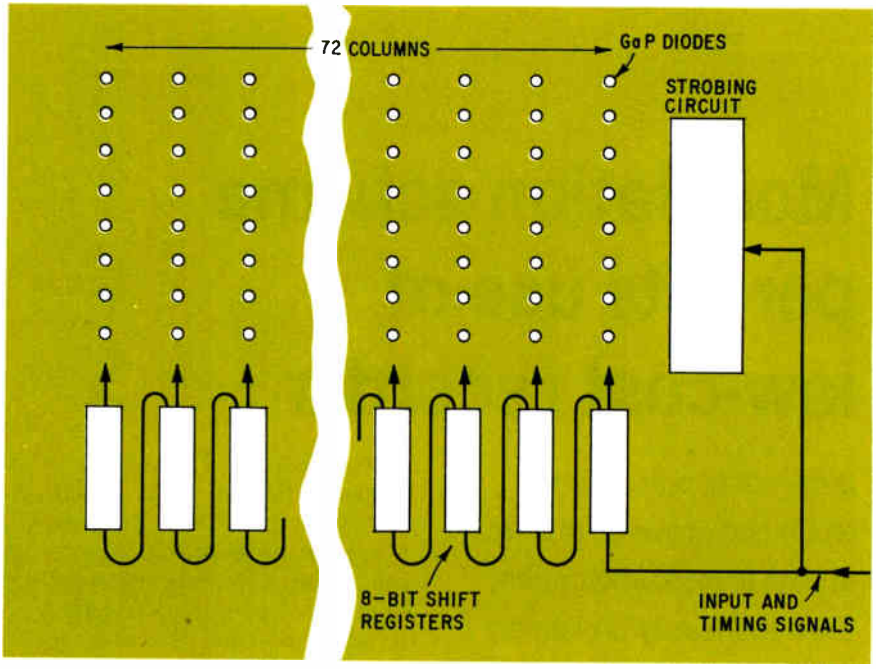
The root of the problem is that efficient GaP diodes can't be made by gas diffusion. Rather, dopants are added to wafers in a two-step liquid-phase epitaxial process. Then the wafer is diced and leads are bonded individually to each chip, a slow process requiring hand labor. The Bell people haven't eliminated the need to use liquid-phase growth, but they have automated the lead attachment process. To do this, they've developed some proprietary techniques for etching gallium phosphide.

An ingot of crystaline GaP is grown under high temperature and pressure; the ingot is sliced into wafers; and p and n layers are grown in the wafers by the liquid-phase epitaxial process. So far, the processes are the same—but then Bell scientists have been able to attach leads while the diodes are still in wafer form.

Part of the p region is etched away, leaving p-region mesas. An insulating layer of silicon dioxide is deposited over the wafer's surface, and holes are etched into the SiO_2. Finally, metalization layers are put down. Masks can be made to provide any interconnection pattern for the diodes.

As part of the beam-lead attachment process, the GaP substrate is etched into a hemispherical form to provide both electrical and optical isolation. Since GaP is transparent, light generated inside a diode leaves from all its surfaces. The hemispherical shape, combined with the reflective properties of the beam leads, focuses the light so that it comes out of the diode in a beam perpendicular to the diode's flat surface. There's no need to put an optical coating over each diode to shape its beam.

Bell's work with GaP is still in the development stages. But scientists already have put together dot-matrix displays with the diodes that could one day find their way onto telephones and data communication sets.



Showoff. Bell Labs' display, built by Walter Rosenzweig, gives some idea of applications Bell has in mind for gallium phosphide diodes. As readout with phone, for example, each digit dialed would appear on right side. As next one is dialed, previous one would shift to left. Unit's binary-to-eight-line converter strobes the vertical columns of diodes while an input in serial form goes into registers. Eight-bit shift registers can be interconnected to produce variety of displays, including letters and symbols of various heights.

Computers

Fairchild's Symbol due for workout

A research effort at Iowa State University with the Symbol 2-R computer could result in a new approach to data handling. Due to start by autumn, the project is expected to produce ideas for improving the machine's language and hardware, and learn just what it can do.

The computer, developed and built at Fairchild Camera and Instrument Co. and sold to Iowa State under a grant from the National Science Foundation [*Electronics*, Feb. 15, p. 25], incorporates a high-level programing language directly in the hardware, along with most of the requirements of a time-shared operating system. These functions are usually executed in software.

First there will be an evaluation of Symbol, its hardware, and its language to determine just what it does and how to manage it, and establish in what ways it's better or worse than a conventional computer. Second, the language itself and its use will be developed further. As implemented in the machine's hardware, the language is defined in simple terms only.

In conventional computers, data structures are defined in software modules, which are manipulated by address modifications. But in Symbol the means for defining the structure is in hardware, and manipulations are carried out directly on the data base. This idea has been tried out before, notably in the IBM 1400 series that began in the late 1950s; but data structure manipulations in that family still depended on addressing facilities. Symbol pursues this basic idea much further, into several levels of structure, but keeps all the manipulation in hardware.

As a result of these capabilities, a whole new approach to data han-

dling must be developed—just as 20 years ago people had to develop techniques that evolved into today's software systems. Iowa State hopes for more NSF support.

Meanwhile, back at Fairchild, interest in the project has not died. Although no new hardware is being built, Fairchild people will be working closely with Iowa State as its work continues. And Fairchild already has some ideas for a new machine if and when it gets a chance to build one. Rex Rice, manager of the digital systems research department who headed the effort at Fairchild, says, "We know now that in any new effort we'd want to retain those hardware features in the original machine that permit rapid and efficient compilation. Meanwhile, we might return some of the controls to software form—they're 100% hardware now —with an eye to programing in more than one language."

Rice thinks this might even improve the machine's speed, which is already an order of magnitude faster than conventional machines in compilation. He already has an improved memory access technique that could get into large files more efficiently than can the machine now installed at Iowa State.

Meetings

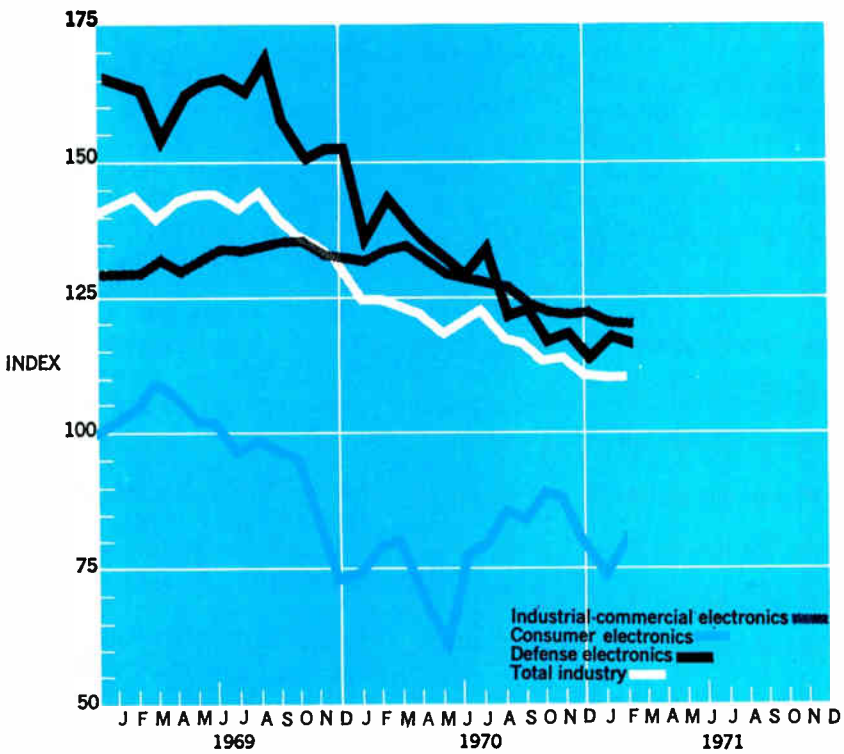
The 1971 IEEE: not bad, considering

The exhibits were moved in from the walls to make things look more crowded and the fourth floor of the Coliseum was empty enough for a basketball game. But this year's IEEE Convention and Exposition did pretty well, considering, says conference manager William J. Hilty. His consideration: most industry conferences have been hit pretty hard by the present economic conditions, with some off by as much as 50% in both attendance and number of exhibitors.

In this light, the IEEE show's attendance of 38,000 doesn't look too bad; it's a 12% drop from last year's. And the 426 exhibitors exceeded the target of 400 Hilty had said he was shooting for [*Electronics*, March 15, p. 88].

For every exhibitor who complained of few customers to talk to, there semed to be others who were quite pleased. One, Merrill Simon, vice president for marketing at power-supply-maker Lambda Electronics Co., Melville, N.Y., describes it as the "best IEEE show we've ever had from the standpoint of the number of real people interested in what we have to sell."

But a new factor at the convention was organized expression of opposition to the way both industry and the IEEE management were



Electronics Index of Activity

April 12, 1971

The February index of activity inched upward just 0.2% from January's upward revised 111.3. However, despite continuation of the climb that started in November, the total industry figure is off 14.2% from a year ago.

The only individual component to show an increase in February was consumer electronics, which rose 7.7% to 81.1—actually 1.8% above its year-ago total, the fourth month in a row it bettered its corresponding 1970 performance. Industrial-commercial fell 0.4% to 8.1% below February 1970. Defense dipped 1.1%, a whopping 20.6% below its year-ago figure.

Segment of Industry	Feb. '71	Jan. '71*	Feb. '70
Consumer electronics	81.1	75.3	79.7
Defense electronics	116.8	118.1	147.1
Industrial-commercial electronics	120.5	121.0	131.1
Total industry	111.5	111.3	130.0

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.

responding to the economic plight of so many of the nation's engineers and scientists. There also were demonstrations against the Vietnam war. Three protestors silently held antiwar signs at the foot of the podium during Deputy Defense Secretary David Packard's banquet speech. And some 40 others, mostly IEEE members belonging to the recently formed Committee for Social Responsibility in Engineering, held a three-day conference during IEEE week to discuss ways of converting engineers and the economy from military- to civilian-oriented pursuits. But at the show itself, direct criticism of IEEE leadership seemed muted, expressed rather diplomatically, and only by a small minority. Said one IEEE staffer, probably with relief: "They were good-quality dissidents."

At the Monday night session which considered the role to be played by the IEEE in the 1970s, a show of hands demonstrated that almost all of the 200 there agreed with IEEE management.

Communications

Large AT&T users study private networks

As AT&T's rates for bulk communications services continue to climb, some of its largest customers are starting to dig their heels in. Lower the rates, the users are telling AT&T and the Federal Communications Commission, or private microwave networks will blossom across the nation.

"It just doesn't make sense that we should be able to do it cheaper than AT&T can," says one airlines source. "But it looks like we can." He points to a 1,400-page study recently submitted to the commission by Collins Radio Co., which argues that Aeronautical Radio Inc., the airlines' communications arm, could operate a network at a fraction of the cost of leased circuits. The network would carry voice, data, Teletype, and facsimile data.

Similar claims are now being made before the FCC by spokesmen for the American Trucking Association, the National Association of Motor Bus Owners, and the Air Force. None of these groups, however, has documented its claim as extensively as Arinc.

In its report, Collins claims that it could build a 21,815-mile microwave network that would have three times the capacity of Arinc's leased lines but cost only $78.9 million a year to operate. Arinc, the second largest user of AT&T's bulk Telpak service, now pays a $60 million annual telephone bill and at present rates could expect to pay $137 million a year for capacity equal to Collins' proposed network, which includes 784 microwave stations, 197 miles of cable, 307 terminals, and 102,941 voice channel ends. And John S. Anderson, Arinc's chairman, insists that Collins' quoted price of $257 million, which is based on list price for network components, would drop sharply if Arinc were to buy the system on a competitive-bid basis and consolidate the network's operations center with existing communications centers.

Even as Arinc refines the design for its own network, however, company officials continue to say that they would rather lease AT&T facilities than be compelled to operate their own—as they will if the FCC and AT&T continue on their present course. For AT&T is threatening to withdraw its Telpak offerings—60- and 240-channel services which may be leased by any user but shared only by regulated industries and government agencies—if the FCC insists on letting all users share Telpak lines. "And that could increase our bill six or seven times," an Arinc source says.

Software

Programs aim at miniperipherals

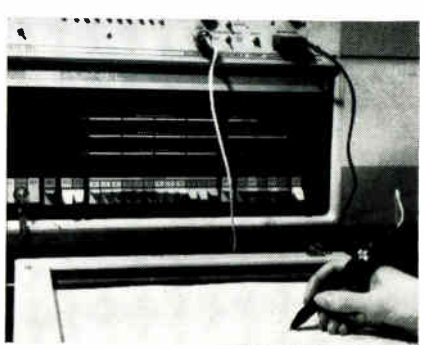
Minicomputers were about the only items brightening the gloom at last year's Fall Joint Computer Conference. Not only were new models introduced, but there was a growing trend toward low-cost peripheral equipment for minis [*Electronics*, Dec. 7, 1970, p. 34], possibly signaling expansion of minicomputers into stand-alone business systems applications.

Input Output Computer Systems Inc., a software firm in Cambridge, Mass., is one company now taking advantage of the trend to miniperipherals—it's seeking companies that make them and is developing programs that tie the peripherals in with the computers. The company recently opened its so-called Minicomputer Applications Mart, an operation offering software, turnkey systems, and contract services, plus the peripheral-cum-software systems known as Performance Pacs.

The firm now specializes in programs for Digital Equipment Corp.'s PDP-8 computers. "Initially, we thought we might do business with three or four computer manufacturers," says IOCS president Thomas A. Farrington, "but DEC has over 50% of the market, they're good to work with, and if we can penetrate their market, that's pretty good business." With more than 10,000 PDP-8s in the field, he says, it was logical to concentrate on that model, although PDP-11 programs may be developed later.

IOCS discovered that the cost of services often exceeded the cost of hardware and that to know his needs thoroughly, the user had to be familiar with many types of

Write on. IOCS Anagrafic software package in use with microsound pen and PDP-8. Firm is aiming at miniperipheral market.



Bell & Howell & Ugly

"What?"

The boys in the back had just come in with another gem.

"I said it's ugly. What is it?"

"The 1-175."

"Great name."

"It's a vibration monitor."

"Whee. That's what the world needs. Another one of those."

"This is a little different. It's derated. Sort of. You see, we took all our know-how from the hi rel, mil spec stuff we were making for the jet engine testers and put it together in this here not-so-fancy version. We figure it'll be a great industrial model."

So we looked. The thing is darn sound. Comes portable or rack mounted. Has analog output for simultaneous recording. Has an adjustable time delay (1–10 sec) so your system doesn't set off its alarm mechanisms or shut down during start up. Has a ±5% frequency response over the full range. ±2% linearity. Etc. And, as we happen to make a full line of vibration transducers, it seemed they might have something at that.

"Where do you use it?"

"Well, at last count, there were about 250K variables you could come up with based on the available options."

"And it could sell at $250. Bare bones, that is. Nice price, eh?"

"Fine, but where..."

"We don't know. We got a good idea on some uses. But not all."

"Well, what the heck am I supposed to do, run an ad and ask guys to send in for the specs and at the same time tell us how they plan on using the fool thing?"

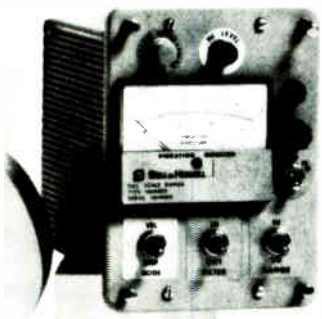
"Not a bad idea. Need some help with the words?"

"Beat it. It's still ugly."

"Great headline."

INSTRUMENTS DIVISION

BELL & HOWELL



I agree with you, it ain't beautiful, but it sounds rather good. Send me the full information packet on that 1-175 Vibration Monitor. My application is: _____

_____

Name _____

Title _____

Company _____

Address _____

City _____ State _____ Zip _____

Bell & Howell, Instruments Division, 360 Sierra Madre Villa, Pasadena, California 91109

Circle 39 on reader service card

Electronics review

peripherals. As a result, IOCS found it necessary to get peripherals it could use with modified software packages—the Performance Pacs.

So far, IOCS has agreements with three peripheral makers—Eclectic Corp. of Dallas; Science Accessories Corp. of Southport, Conn.; and Tennecorp Corp. of Oak Ridge, Tenn.—to market their products in its packages, and is negotiating with several others.

As for DEC's view of the operation, a spokesman says: "There's no formal agreement, but we're glad to work with [IOCS]. We think the Performance Pacs are a good idea, though it's too early to say if this is going to be the big wave of the future." And IOCS, which has been only a software applications house, thinks it's in a good market position because no other company is doing quite what Input Output is doing with the Performance Pac concept of minicomputer peripherals.

The major Performance Pac is the Anagrafic system, which digitizes, analyzes, and processes graphical data. It consists of a data entry tablet, the Graf/Pen by Science Accessories, and software that's interactive with the user. The software allows entry of up to 350 data points, five separate calibrations during one run, a skew check, and setting of predefined limits. Output is paper tape or teletypewriter. The package costs $7,500, and is also available as a turnkey system with a PDP-8E for $17,500. The system can be expanded to operate with DEC tape, magnetic tape, disk, and X-Y plotters. Potential customers include the military, hospitals, and scientific research labs. Other available programs include a direct mail system.

Air traffic control

FAA seeks speedup in R&D, purchases

As Federal Aviation Administration planners refine their plans for the 1970s, they are asking for faster development of a phased-array "superbeacon," much larger purchases of instrument landing systems and airport radars, and increased automation of the centers that accept flight plans and distribute weather data.

These requests emerge from the 10-year plan the FAA is now mailing in preparation for its annual planning review conference, April 26 through 29. The plan spells out how the agency will spend $2.92 billion for facilities and equipment and $1.174 billion for research and development in fiscal years 1972 through 1981. By far the largest share of the money will go toward electronics development and procurement.

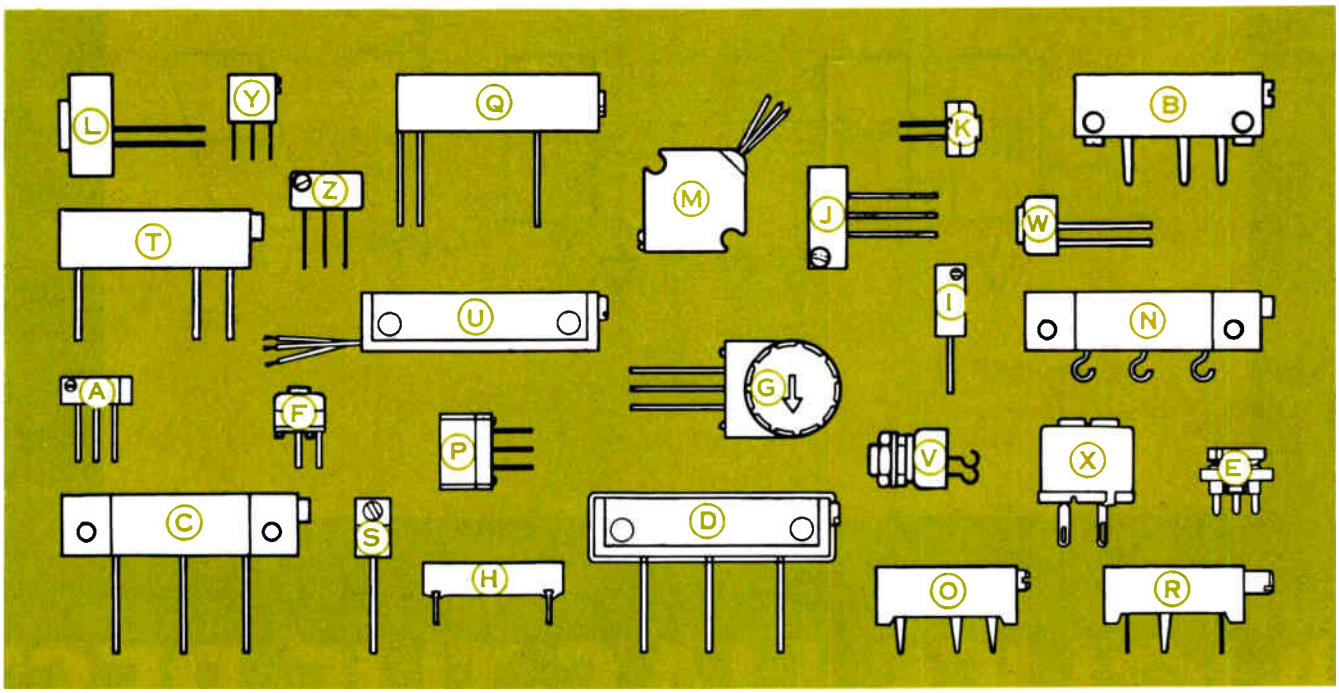
The accelerated development of an upgraded secondary radar with phased-array antennas and a digital data link capability during its dead time is one of the biggest changes in this year's plan, FAA sources say. This year's plan calls for a total of $69.9 million to be spent on the superbeacon's development through fiscal '81, of which $5.5 million is to be spent in fiscal '72 in preparation for the commissioning of the first superbeacon in '78. Another $49.3 million will go toward upgrading beacons after '77. In last year's plan, about $40 million was set aside for development of the upgraded beacon.

In response to pressures for more electronic landing aids at smaller airports, FAA planners are setting aside $17.3 million for the development and purchase of instrument landing systems and vhf omnirange units in fiscal 1972, out of a total of $282 million for the decade. This includes $41 million to develop a scanning-beam microwave landing system and $97 million to buy and install them after they become available in 1978.

For similar reasons, the FAA plans to spend $10.1 million to install the new van-mounted ASR-7 radar at high-density airports in fiscal '72. The old radars will then be refurbished and installed at lower-density terminals. The agency expects to spend a total of $181 million through fiscal '81 on this program.

A final change in this year's plan

BOURNS MAKES WIREWOUND, CERMET AND CARBON POTENTIOMETERS!



BE A WINNER... FIND THE WIREWOUNDS

Give up? We'll give you a few hints. In selecting potentiometers it's the performance that counts. When you need *high power, stability, low tempco* and *price,* wirewounds may be your best bet. Six best bets are described below and illustrated above — among a wide assortment of Bourns potentiometers. We challenge you to match the six correct potentiometers to the six descriptions. To the first 250 who submit winning entries we will send a deck of Bourns first quality playing cards. All entries will receive a packet of information on wirewounds and the correct answer. Try your skill.

The key to winning is matching identification letters with descriptions below. If you're handy with words, the six correct letters should make you win.

MODEL 3260
Very tiny ¼" square; 0.2 watt at 70°C; high temp. to 175°C; qualified as RT26.

MODEL 3005
E-Z-TRIM® ¾" rectangle for small places; 1 watt at 40°C; temp. to 125°C; sealed; very inexpensive.

MODEL 260
We'll give you a lead; 1¼" rectangle; metal cover, 1 watt at 70°C; high temp. to 175°C; self-locking adjustment for stable setting.

MODEL 3300
A 5/16" dia. single turn; ½ watt at 70°C; high temp. to 175°C; excellent shock and vibration stability.

MODEL 3290
Thin ⅜" square; 1 watt at 70°C; high temp. to 175°C; qualified as RT24. Edge mounting version is very popular.

MODEL 3057
1¼" rectangle; 1 watt at 70°C; high temp. to 150°C; temp. stability to ½%; sealed. Some users specify solder lugs.

CLIP THIS COUPON AND SEND IT TO:

WIREWOUND CONTEST

BOURNS INC

1200 COLUMBIA AVE., RIVERSIDE, CA. 92507

My winning words are

☐☐☐ ☐☐☐ **with wirewounds.**

NAME_____

TITLE_____ COMPANY_____

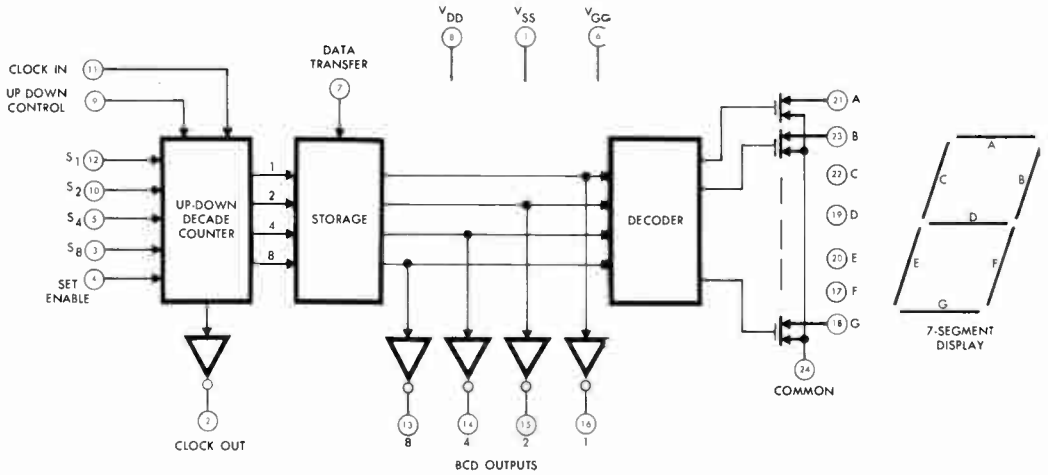
ADDRESS_____

CITY_____ STATE_____ ZIP_____

Bourns factory, representative and distributor personnel and their families are ineligible.

Contest closes May 31 (E471)

Circle 41 on reader service card



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AT THE BEST PRICE IN THE BUSINESS.

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And you save more than just money.

Our HCTR 0107 Universal Counter Display Driver does the job in one LSI package. Instead of the usual three bipolar circuits.

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All inputs diode protected. BCD outputs buffered and TTL compatible. Units may be cascaded. And a −25V rating for any input, V_{GG} and V_{DD}.

So if you've got plans to improve your electronic numbers game, write or call us at the following numbers: Hughes Microelectronic Products Division, 500 Superior Avenue, Newport Beach California 92663; (714) 548-0671. Or use the toll-free Hughes Hot Line: (800) 854-3280.

HUGHES

HUGHES AIRCRAFT COMPANY

HUGHES MCS

is in the amount allocated to automate flight service stations. "This will save us more money than anything [else will]," an FAA source says. "Flight plans and weather information will go directly to a computer instead of to an endless number of Teletype machines, turning out an endless amount of data that must be updated and filed." Slightly more than $2 million will be spent on these stations' R&D and equipment purchases in fiscal 1972. More than $32 million will be spent through 1981.

Medical electronics

Diagnostic X-ray standards ready

Performance standards for medical and dental diagnostic X-ray equipment will probably be published by August, says J. Arthur Lazell, assistant director for liaison activities for the Bureau of Radiological Health.

Most significant will be the requirement for positive beam collimation on stationary, general-purpose equipment—strict limitation of the X-ray beam to size of the film or other image receptor. Currently, four manufacturers are developing automatic collimating systems; others will use either automatic collimation or an interlock device that would prohibit X-ray production until manual collimation is completed. An earlier bureau study demonstrated that collimation to film size reduced the contribution of diagnostic X-ray equipment to the genetically significant dose by about 62%.

Other features of the standard require reproducibility and linearity for the life of the equipment, which manufacturers plan to meet by furnishing recommended maintenance schedules. Users without maintenance staff would have to buy service contracts from makers.

Enforcement of the standards will be a cooperative effort with state health departments. In addition, the bureau will maintain a laboratory in Rockville, Md., and possibly use equipped vans to follow up suspected problems. Actual enforcement, however, will be on the Federal level, through the manufacturer.

The standards "do not violate the spirit or intent of the earlier NCRP [National Council on Radiation Protection and Measurements] guidelines," says William S. Properzio, chief of the bureau's X-ray exposure control laboratory in the division of electronic products. But in many cases, he adds, standards are stricter than the NCRP recommendations. For example, bureau standards halve the permissible exposure rate for fluoroscopic tabletop units to 5 roentgens per minute.

The advisory committee that wrote the performance standards also is proposing test methods for determining compliance. The tests will be published separately, but referenced in the actual standard.

Industrial electronics

Scrambler safeguards teleprinter data

A growing problem in computer operations—particularly in time-shared systems—is how to prevent the theft of data. The theft of 800,000 names from a mailing list of the Encyclopaedia Britannica, for instance, is now a case in the courts. While many companies have tried to tighten physical security, few have worked at making stolen data unusable—but they include Datotek Inc. of Dallas, which has developed off-line scramblers for public or private teleprinter networks, and for time-shared systems.

Datotek calls its new units the DC-108 and DC-105 Datacoders, the first for five-level teleprinters, the latter for eight-level units. One is required at each end of a message link, and each can be used for both encoding and decoding. A clear paper tape is cut on the teleprinter, then run through the reader while the Datacoder enciphers the message and cuts a scrambled tape.

The enciphering scheme, which

Electronics review

Datotek will not discuss in any detail, is based on the binary codes transmitted rather than the characters and uses an involved bit generator that provides up to 32 trillion combinations. A message may contain both clear and enciphered text; running an identical message through the generator twice results in different scrambled texts. The code can be changed at will by hidden and locked thumbwheel switches.

The scrambled text then can be sent over public wires and cannot be read by anyone without both a Datocoder and the proper "combination." The Datacoder is designed to resist even fairly determined attempts to open it. The circuitry, which makes extensive use of MSI, is roughly as complex as that of a small computer, according to Jim Poux, national sales manager. The unit leases for $115 per month.

Another Datotek product, the DC-110 Datacoder, enciphers data transmitted to a central computer for storage or computation.

Materials

Gallium arsenide goes standard

At least one supplier of gallium arsenide wafers is determined not to let the business go the way of silicon—mainly a custom business dominated by the customers' specifications. The determined party is Bell & Howell's Electronic Materials division in Pasadena, Calif., which will offer standard GaAs substrates off the shelf for six devices [*Electronics*, March 1, p. 17].

Makers of such devices will be able to order standard substrates from Bell & Howell at what should be considerable savings over custom configurations. The six are: visible light-emitting diodes, infrared-emitting diodes, opaque photocathodes, thin film devices requiring an insulating substrate, microwave diodes, and injection lasers. Bell & Howell has come up with four types of substrates in each product category: 15-mil-thick units that are chemically polished, and 20-mil-thick wafers that come as sawed from the ingot. There are two substrate areas in the chemically polished or as-sawed categories.

Headed for market. Fixture in which Bell & Howell polishes gallium arsenide wafers.

The most common dopents used for each device category have been applied in the single-crystal Bell & Howell substrates. For example, for the visible light emitters, which marketing director John Nickerson expects will account for well over half the business the Electronic Materials division will do in standard substrates, the dopent is tellurium. Resistivity is less than 0.015 ohm-centimeters for the visible light-emitter substrates, and orientation of the material is 2° ± 1° off the (100) orientation toward the (110) orientation.

Further processing—diffusion or deposition, for example—will still be done by the user. But Nickerson feels there will be broad acceptance for available standard substrates that essentially "homogenize" the customer's specifications

We Interrupt Your Single-Diffused Silicon Power Designs To Bring You These 8 Advantages From EpiBase

1. COMPLEMENTARY CAPABILITY
Only EpiBase* technology possesses the inherent capability to afford you the advantages of complementary power circuitry. And only Motorola has PNP/NPN EpiBase pairs from 1 to 50 amperes in most popular voltages and packages.

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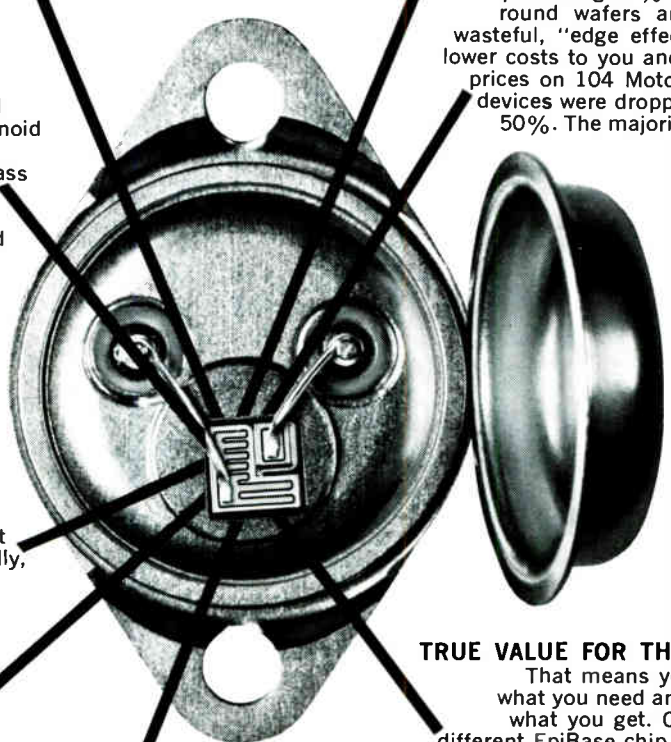
Only EpiBase can give you this revolutionary new way to go for lower-cost circuit simplicity and top performance in relay and solenoid drivers, audio amps and power supply, servo amp. and series pass regulators, etc. EpiBase now offers 13 complementary, metal and plastic Darlington pairs. And more coming.

3. HIGHER GAIN
Only EpiBase with its inherently better emitter efficiency gives you higher output current for a given area. Generally, at least twice the current gain is available at equal current levels.

4. HIGHER FREQUENCY WITH EXCELLENT SOA
You're out ahead in both amplifier and switching applications with EpiBase. This results in improved circuit performance with minimum distortion and device dissipation. Along with its top speed and efficiency, EpiBase gives you outstanding, 100%-tested, safe operating area.

5. LOWER SATURATION VOLTAGE
10 to 20% lower internal series resistance in the EpiBase chip results in lower $V_{CE(sat)}$ characteristics, consequent higher efficiency and more usable device power at higher operating temperatures.



6. HIGHER SWITCHING EFFICIENCY
The inherently faster speed of an EpiBase device offers much lower switching losses. Test one.

7. LOWER COST
Slicing silicon ingots lengthwise to make large rectangular slabs producing 30% more dice than round wafers and eliminating wasteful, "edge effects" results in lower costs to you and us. Recently, prices on 104 Motorola-registered devices were dropped as much as 50%. The majority are EpiBase.

8. TRUE VALUE FOR THE FUNCTION
That means you get exactly what you need and pay only for what you get. Choose from 8 different EpiBase chip sizes from 45 to 275 mils, design-spec'd to afford the widest choice of preferred standards and unsurpassed custom capability.

There's a group of EpiBase Silicon Power data sheets available now showing complete-line advantages of EpiBase silicon power transistors, applications-oriented to solve 95% of today's design needs . . . high-current, high frequency, Darlington, complementary and general-purpose types.

Bring a set to your desk today by writing Box 20912, Phoenix, AZ 85036. Or circle the reader number.

Motorola EpiBase
—Silicon Power At Its Best.

*Trademark Motorola Inc.

Electronics review

and Bell & Howell's own configurations for epitaxial materials developed through internal research programs. Particularly interested, he feels, will be device manufacturers already in volume production. The further processing required to make visible light-emitting diodes from the gallium arsenide wafers, for instance, dictates that a layer of gallium arsenide phosphide be deposited so that the material emits at about 6,600 angstroms.

The silicon-doped substrates intended for IR emitters will get a layer of gallium arsenide on top of the substrate gallium arsenide so that they'll emit at approximately 9,100 Å. Substrates intended for opaque photocathodes are doped with zinc; for thin film devices, Bell & Howell has used a chromium dopant to form a semi-insulating substrate. Tin is the dopant for the substrates aimed at microwave diode applications, and tellurium is also used as the dopant for the substrates intended for injection lasers.

Almost all of Bell & Howell's GaAs materials have been special orders to date, with well over half the wafers or ingots done to customer specifications. Nickerson expects the availability of standard substrates will mean that half his business will be in off-the-shelf wafers, all carrying standard specifications. The division is quoting standard prices per wafer or for boxes of 10 wafers.

For the record

By the trillion. Ampex Corp., Redwood City, Calif., intends to build and market a tape memory system that can store up to 3 trillion bits of data. Called the Tera-Bit Memory, it provides from 90 billion to 3 trillion bits of random access data on line, and can be made plug-compatible with any computer system announced to date. The TBM requires some special access programs, but no changes in the computer or its basic operating system are necessary. The first system will be delivered to the Pentagon.

MOS emphasis. One of the more significant moves in the recent top management realignment at Motorola's Semiconductor Products division in Phoenix makes Jack C. Haenichen vice president and director of operations for MOS, underscoring Motorola's seriousness about becoming a potent factor in the MOS market. Haenichen had been vice president and director of operations and services.

Successor. Knowledgeable observers expect Walter Burke to succeed the late Sherman M. Fairchild as chairman of Fairchild Camera & Instrument Corp. Burke, a member of the board and Sherman Fairchild's financial adviser, had managed his affairs for the past year. C. Lester Hogan, Roswell Gilpatric, another member of the board, and Burke make up a majority of the directors of the Sherman Fairchild Foundation, which will administer the late chairman's holdings.

Run of the store. The Sweda International division of Litton Industries, Orange, N.J., has entered the competition for retail point-of-sale terminals with the Series 700 system. Included in the line are stand-alone and minicomputer-controlled electronic cash registers, a hand-held magnetic reader to pick off sales information from coded tags and credit cards, and a processing center that can control up to 256 on-line terminals. Rejecting the optically encoded tag approach favored by NCR and Pitney-Bowes Alpex, Litton also is marketing magnetically encoded tags through its Kimball Systems division. Price for the dedicated terminal is $2,800 and for the stand-alone version, $3,000.

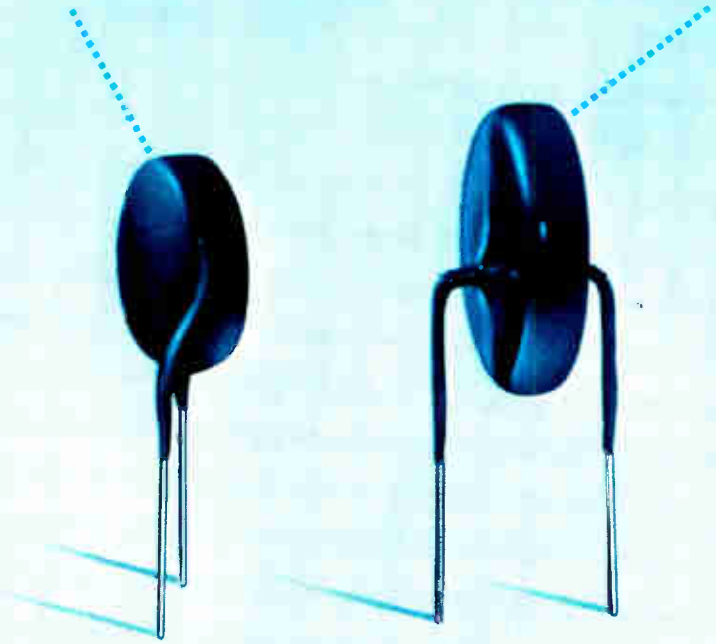
No end of terminals. Burroughs Corp. has signed an agreement to build and sell point-of-sale credit card authorization terminals designed by Penril Data Communications Inc., Rockville, Md. A mag-

"We're just two in a new series of d-c high voltage multiplier ceramic capacitors from Aerovox."

"We're great for TV and CRT power supplies and any other applications using high-voltage diode combinations."

"And, we can save them all kinds of money."

"You'd better let them in on a little more than that."*



*Rugged, dependable high voltages up to 10 Kv d-c * Excellent temperature stability and anti-corona properties * Capacity: 500, 1000 & 2000 pf — other values on special order * Insulation resistance: 20,000 megohms min. * Capacity tolerance: ±20% * Dissipation factor: 2% max. * Temperature characteristics: ±15% change in capacitance from 10°C to 85°C. * Corona voltage: 2500 VRMS @ 60 Hz * Corona level: 100 pico coulombs * Special epoxy coating, compatible with potting and molding compounds * Complete data available on 10 Kv discs and similar units in differing voltages. Just write:

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PLANTS IN: NEW BEDFORD, MA., OLEAN & FRANKLINVILLE, N.Y., MYRTLE BEACH, S.C. AND HAMILTON, ONT., CANADA

Circle 47 on reader service card

Electronics review

netic-code-reading unit, the Penril terminal is directly competitive with the magnetic-stripe-reader recently announced by IBM [*Electronics*, Mar. 15, p. 34]. The agreement covers a family of products for reading and transmitting credit card transactions from point of sale to computer center. Prices range from $500 to $2,000.

Tricap. An expansion and variation of Army ground forces, to be explored later this year when the 1st Cavalry Division is brought back to Ft. Hood, Texas, from Vietnam, "will likely produce a major change in field communications requirements," says an Army source. He adds, "more units will have radios to improve mobility and reaction time." The division will be called Tricap—for triple capability—and will add an armored brigade to Airmobile and Air Cavalry brigades of the division.

Computer switch. The narrow line that separates computers from telephone switching equipment will become even narrower when ITT starts to deliver its minicomputer-controlled electronic PBX.

ITT will decide which company will get the award for what may be as many as 2,000 minicomputers over the next 15 years. The competing minis are General Automation's SPC 16, DEC's PDP 11/15, and Data General's Nova 800 and 1200.

Self-help. Most of the $42 million technology mobilization and reemployment program recently announced by Labor Secretary James D. Hodgson is earmarked for professionals who have tangible job offers that are impeded by education or residence requirements, says a top-level department source.

For example, the $5 million allocated for a "job search" will be made available through public employment offices as grants to individuals to defray transportation costs "to be interviewed on bona-fide job offers," the source explains. The grants will average between $250 to $500, and so could aid up to 20,000 applicants.

RCA knows how to make triacs—at the right prices!

RCA TRIAC PRICES (1000-UNIT LEVEL)

PACKAGE	RATING	200-V TYPE PRICE	400-V TYPE PRICE	600-V TYPE PRICE
Press-fit	10 A	2N5567 $1.85	2N5568 $2.22	40795 $2.78
Stud	10 A	2N5569 $2.05	2N5570 $2.42	40796 $2.98
Isolated-stud	10 A	40799 $2.75	40800 $3.12	40801 $3.68
Press-fit	15 A	2N5571 $1.97	2N5572 $2.36	40797 $2.95
Stud	15 A	2N5573 $2.17	2N5574 $2.56	40798 $3.15
Isolated-stud	15 A	40802 $2.87	40803 $3.26	40804 $3.85
Press-fit	30 A	40660 $2.74	40661 $3.28	40671 $4.10
Stud	30 A	40662 $2.94	40663 $3.48	40672 $4.30
Isolated-stud	30 A	40805 $3.64	40806 $4.18	40807 $5.00
Press-fit	40 A	2N5441 $3.42	2N5442 $4.10	2N5443 $5.13
Stud	40 A	2N5444 $3.62	2N5445 $4.30	2N5446 $5.33
Isolated-stud	40 A	40688 $4.32	40689 $5.00	40690 $6.03

It takes a leader in triacs to meet the challenging demands of an ever-increasing industrial market. And RCA has the product line to supply this market—here and now—at economical prices!

RCA's strong volume production at the right price is only part of the story. The assurance of quality, dependability and diversity of product is also vital to the designer in the long run.

RCA triacs are second to none in range of types, packages and performance ratings! (See chart for representative triacs in RCA's broad line.) RCA triacs are as rugged as they come... with capabilities that readily assure reliable performance despite demanding applications.

This wide range of triacs was specifically developed for an equally broad spectrum of industrial application areas including: industrial controls · avionics · high power lamp controls · motor speed controls · power switching.

If you are lcoking for high quality triacs—priced right to allow new systems use and still assure the best systems performance and economy—then look to RCA. For more details, call your local RCA Representative or RCA Distributor. Or write: RCA, Commercial Engineering, Section 70D-12/UR11, Harrison, N.J. 07029. International: RCA, Sunbury-on-Thames, U.K., or 2-4 rue du Lièvre, 1227 Geneva, Switzerland, or P.O. Box 112, Hong Kong.

RCA Solid State

Circle 49 on reader service card

Gunn and Impatt diodes. What you need is what you get.

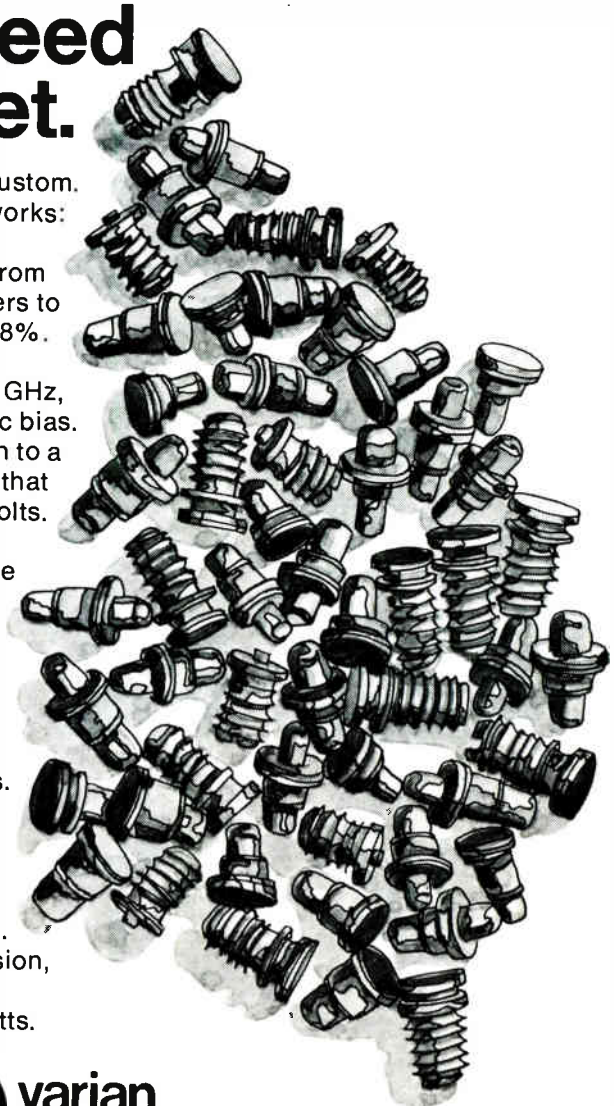
Impatt or Gunn, standard or custom. Varian sells the works:

Impatt diodes at frequencies from 3.2 to 22.0 GHz. Powers to 1 watt. Efficiencies to 8%.

Gunn-effect diodes up to 60 GHz, putting out 5 mW on a 4 Vdc bias. 200 mW at 10 GHz. Down to a 100 mW, 6 GHz diode that operates on only 11 volts.

Varian has more experience than any other supplier, and sells the most complete line of both types of diodes. For off-the-shelf delivery or fast prototype design, we'll work with you to find the best answer for your design problems.

Talk to the man who sells 'em all at more than 30 Electron Tube and Device Group Sales Offices throughout the world. Or contact our Solid State Division, Palo Alto, California; or Beverly, Massachusetts.



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solid state division

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Sorensen ACR's hold line voltage where it does you the most good.

Power brownouts cause electrical and electronic equipment problems. Economic, efficient operation requires rated AC input voltage — an off-voltage source can shorten equipment life, degrade performance, even cause catastrophic failure.

Sorensen ACR line voltage regulators eliminate the problems. Available in 8 models covering the 0.5 to 15 KVA range, all ACR's feature remote sensing and programming, fast response time, wide power factor range, built-in voltmeter, and are capable of 3-phase operation.

Sorensen POWER SUPPLIES

For information and prices on ACR's, and our economical VR Series ferroresonant regulators, contact Raytheon Company, Sorensen Power Supplies, 676 Island Pond Rd., Manchester, N.H. 03103. Telephone 603-668-1600.

Sue, from the harnessing department says:

"Spot ties...cut lengths of tape...new knot... harnessing's a breeze!"

(She's really talking about GUDEBROD'S SYSTEM "S")

Sue's department had tried all kinds of harness tying materials and methods but they recently switched to Gudebrod's System "S". This uses cut lengths of lacing tape (in a size and coating to suit the cabling) . . . with an easily learned knot that takes only seconds to make a spot tie. To bring every section of the harness within easy arm reach, harness boards are on Gudebrod Swivel-Tilt-Mounts. That's all there is to it!

Except, of course, the satisfaction from the swiftly made, firm neat harnesses that hold up under handling—and the money saving per harness. For details, talk to our Technical Representative.

Naturally, Gudebrod has a System "C" for continuous lacing.

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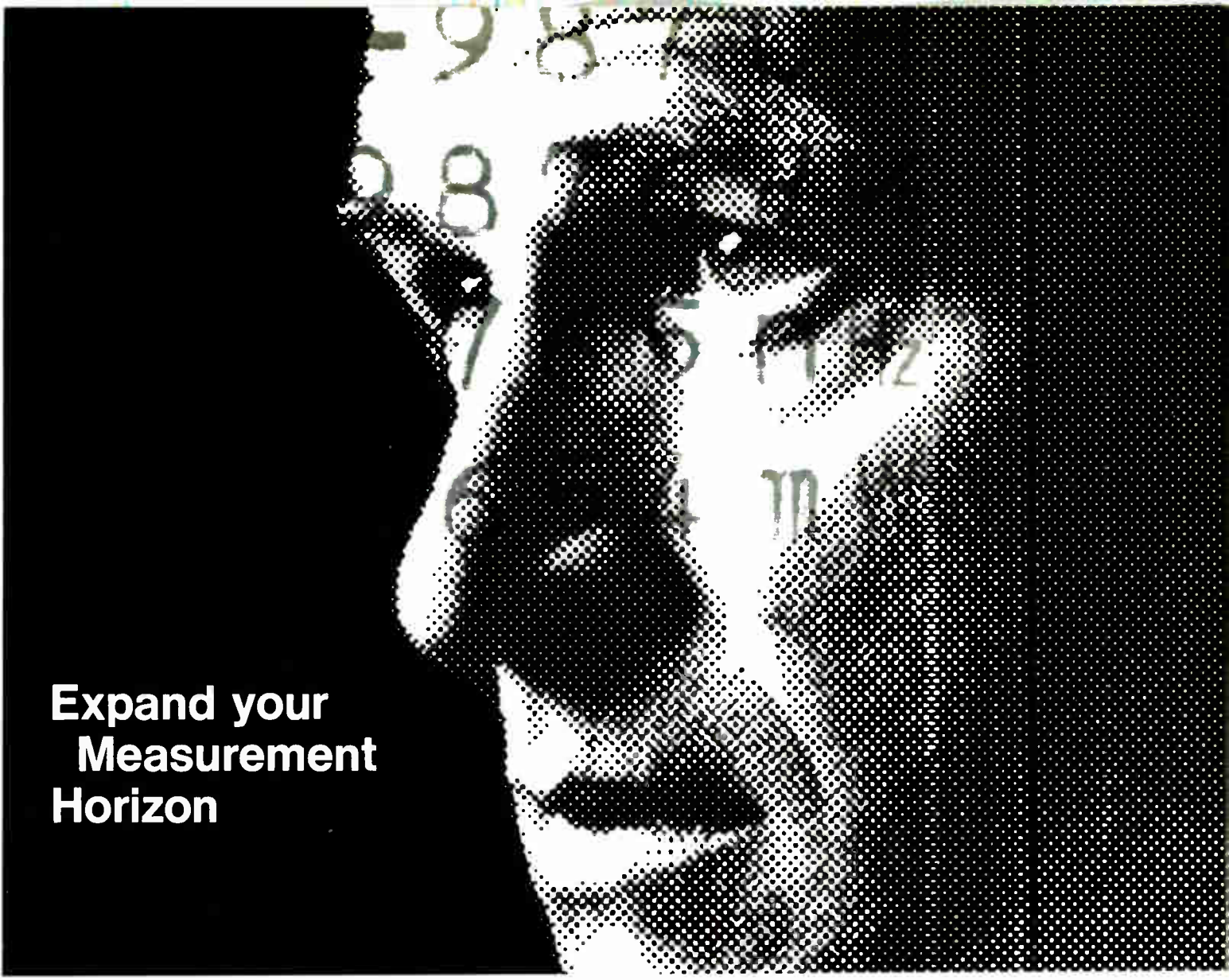
Circle 52 on reader service card

Circle 53 on reader service card→



Expand your Measurement Horizon

with Beckman's new Digital Printer

The Model 1454 Digital Printer accepts inputs from all logic forms — MOS, IC, and Transistor. It has an expandable capability of 1-to-21 BCD columns accomplished by the simple selection of optional plug-in modules... perfect for OEM applications. And the unique ability to accept inputs from as many as 3 different data sources, with up to 16 characters per column. Couple this with a printout in red and black on the same line, the ability to accept standard calculator or pressure sensitive paper, and you have the ideal printer for systems application. ▫ The instrument is so compact that two units can be mounted on a standard 19-inch rack. Weighing only 20 pounds, and with optional battery pack, you can easily take your 1454 into the field. Beckman has made this printer with few moving parts and generous use of integrated circuits. The results: a highly reliable and low-cost-to-maintain instrument. Power: 115 V/50 Hz to 400 Hz. ▫ Now, compare its low price, $1,095* with similar printers! You'll buy the Model 1454/1 Digital Printer. Or, as with all Beckman EID products, it's available through our new factory direct rental and lease program. Ask your local Beckman representative for details or call us direct (312) 671-3300.

Beckman

INSTRUMENTS, INC.

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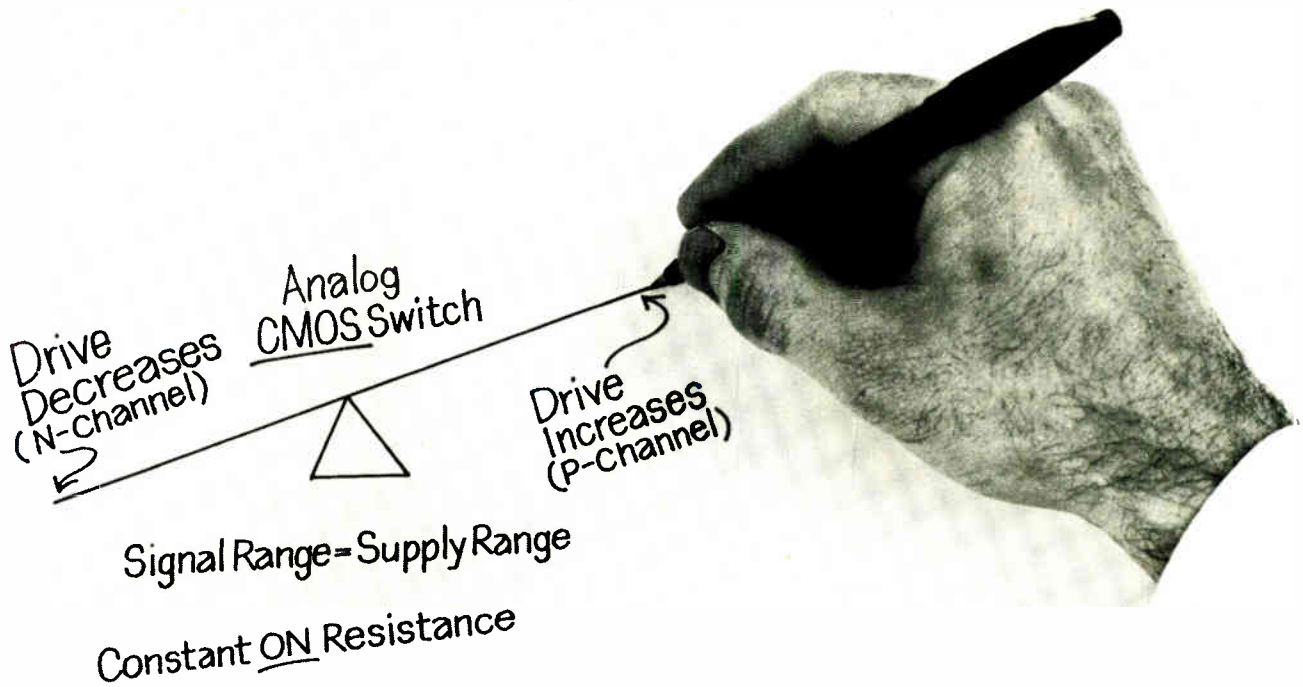
Siliconix explains the CMOS Seesaw Effect



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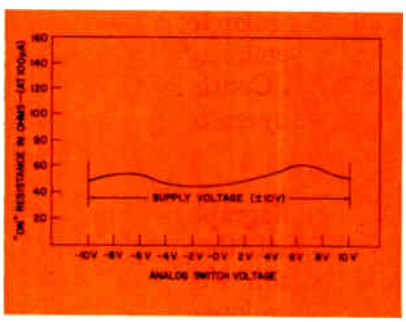

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Washington Newsletter

April 12, 1971

IR&D costs go on dropping, DOD says

In its first-ever downturn, Defense Department reimbursement to contractors for independent research and development, bid and proposal costs, and "other technical effort" last year **dropped to $695 million from $754 million in calendar 1969,** according to DOD's first breakout on the costs to Congress. Military sources add that data for **the first two months of this year show a continuing decline.** "Not everyone expected the turnaround," says one official. "With R&D contract awards declining along with everything else, some of us thought more would be charged off to independent efforts. But apparently the money just wasn't there [in the companies] . . . in the first place."

A more detailed picture is expected by March 15, 1972 when the second report to Congress is due, since DOD will then be able to draw on a new IR&D data bank to identify levels of effort and kinds of technology involved.

General Dynamics to build first national data buoys

General Dynamics Corp.'s Electro Dynamics division, San Diego, Calif., has won the National Oceanographic and Atmospheric Administration competition to build the first test buoy in the national data buoy program [*Electronics,* April 27, 1970, p. 46]. **The award of "about $3 million" covers "about six" experimental engineering phase buoys, says NOAA** (precise figures are subject to negotiation). The company will provide mooring and system integration for the unmanned buoys, scheduled to begin deployment in the Gulf of Mexico by year end. Telemetry will be a single sideband, pulse code modulated, phase shift key system; onboard minicomputers will control acquisition and dissemination of data on either a predetermined or interrogation basis.

Mitre tests computer-linked CATV services

A prototype device that enables a cable television subscriber to telephone for specific fields of information to be displayed on his TV receiver has been developed by the Mitre Corp., McLean, Va. The computer-based system can accommodate as many as 60 different displays per second. Besides keyboard and data couplers to communicate with the computer over regular telephone lines, subscribers would need a device to capture and retain display frames. Mitre is presently connecting its IBM 360/50 with Continental Telephone Corp.'s Reston, Va., cable distribution system by an 8-mile microwave link.

Navy pushing acoustic holograms as sonar successor

Since **acoustic holography, unlike sonar, is unaffected by water turbulence and sediment,** the Navy is pushing its development for eventual submarine detection. Following successful demonstration of an experimental system developed by Bendix Research Laboratories, Southfield, Mich., for the Office of Naval Research, the Naval Ship Systems Command (Navships) is seeking new money for the program in fiscal 1972. One source says **Navships wants to spend more than $2.5 million next fiscal year, in addition to the fiscal '71 money, on further tests of an experimental operational version** of the Bendix system.

Acoustic holography's present range is limited to several hundred feet, making it impractical as yet for submarine detection, the Navy says. However, **in its existing form it is regarded as useful for bottom**

search and rescue, mapping, and navigational aid in narrow channels. Major components of the Bendix system are a sound transmitter, receiving array, signal processor, and a real-time image reconstruction device with the image displayed on closed-circuit TV. A key component developed by Bendix is the square planar hydrophone receiver array containing 400 individual hydrophones in less than 2 square feet.

Expanded Awacs stirs dispute within Air Force

Efforts to expand the Airborne Warning and Control System, so that it could accept input from unattended tactical ground sensors, are generating another debate within the Air Force. **The issue has reached the Department of Defense and could jeopardize the whole program if,** as one service source puts it, "the thing slops over into Congress like it did a couple of years back." The necessary additions, say opponents of the expansion, would not only escalate the complexity and cost of Awacs, but transform it into "a complete flying command post."

The comparatively austere Awacs now proposed is expected to run to upwards of $2 billion if first operational capability is to be attained in 1976. And the Air Force Systems Command, which wants a $58-million boost in fiscal 1972 to raise its Awacs budget to $145 million, is anxious to adhere to that schedule and avoid further cost increases.

TACV work survives setback

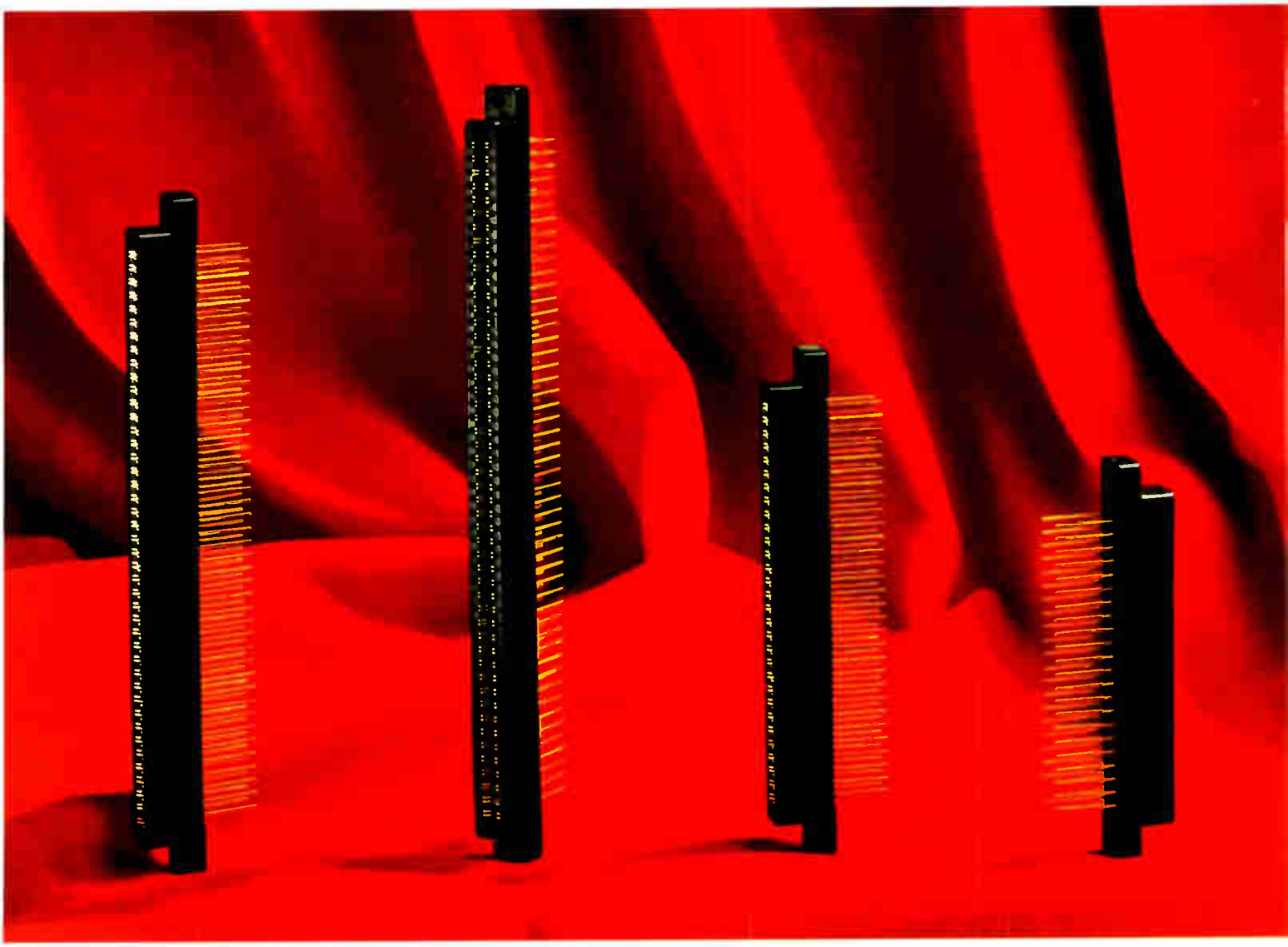
The Department of Transportation will go ahead with two programs for developing tracked air cushion vehicle systems, say DOT sources, **despite the House Appropriations Committee's decision to terminate a third—Transportation Secretary John Volpe's personal plan for a TACV serving Dulles Airport in Washington, D.C.'s Virginia suburbs.** Instead, DOT will give even higher priority to the $50-million program at the Los Angeles airport and to experimental TACV development at the Department's testbed in Pueblo, Colo. Capitol Hill sources point out that the **cancellation was not a slap at TACV technology but rather at the politically inspired haste and poor planning of the Dulles system** [*Electronics,* March 1, p. 31]. The program is being followed closely by the electronics industry because of the sophisticated controls and high degree of automation needed by the vehicles.

Industry says no to NASA plan for joint STOL venture

Antitrust problems, lack of proprietary rights, and shortages of cash are three reasons cited by aerospace firms for rejecting a NASA plan to develop a short take-off and landing aircraft jointly with industry [*Electronics,* March 1, p. 22]. Following a recent two-day meeting, **executives from 25 companies told NASA that if it wants to build an experimental STOL it should ask industry teams to bid for contracts with competitive designs.**

The plan's rejection comes two months after its first proposal by Roy Jackson, chief of NASA's Office of Advanced Research and Technology. He had suggested that NASA open its extensive wind tunnel and computer simulation facilities to the various firms who would be asked to develop subsystems of the craft. **The new generation of avionics required for the plane, however, would be largely developed with NASA funds. NASA is budgeting $3 million for STOL avionics** and $15 million for STOL airframe and engine development in fiscal 1972—only a fraction of the money industry sources say is needed to initiate the program.

A new cost-saver...



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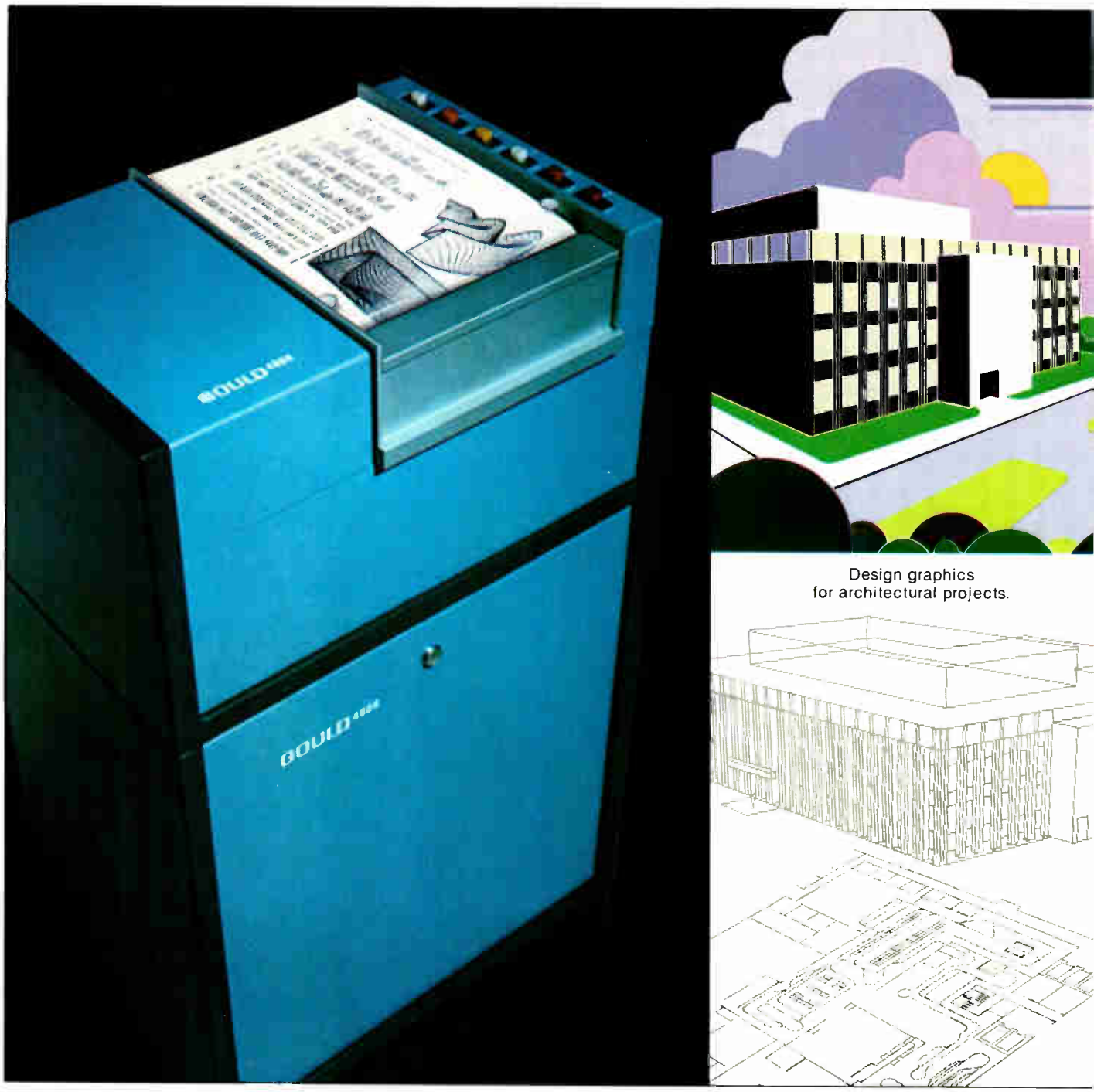

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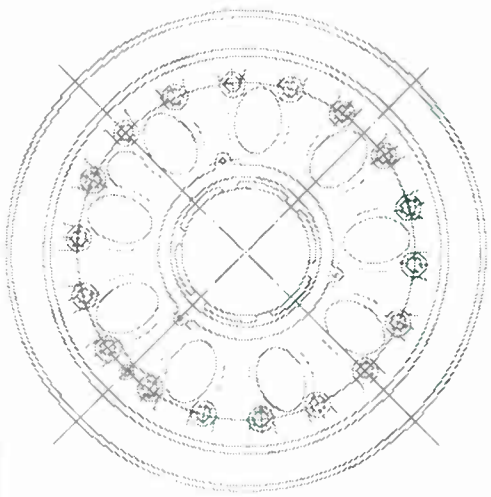

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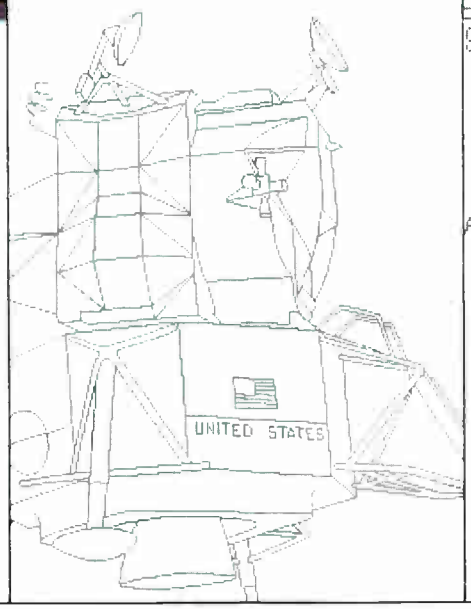

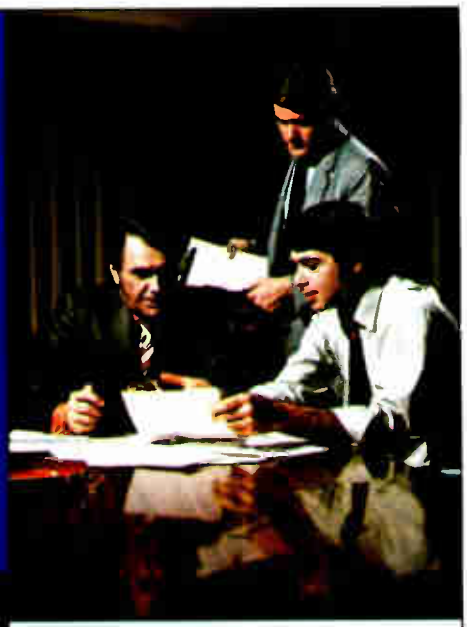

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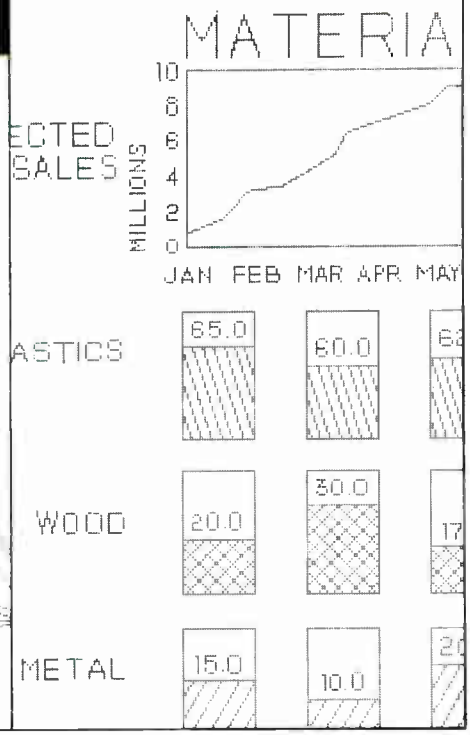

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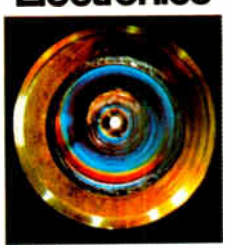

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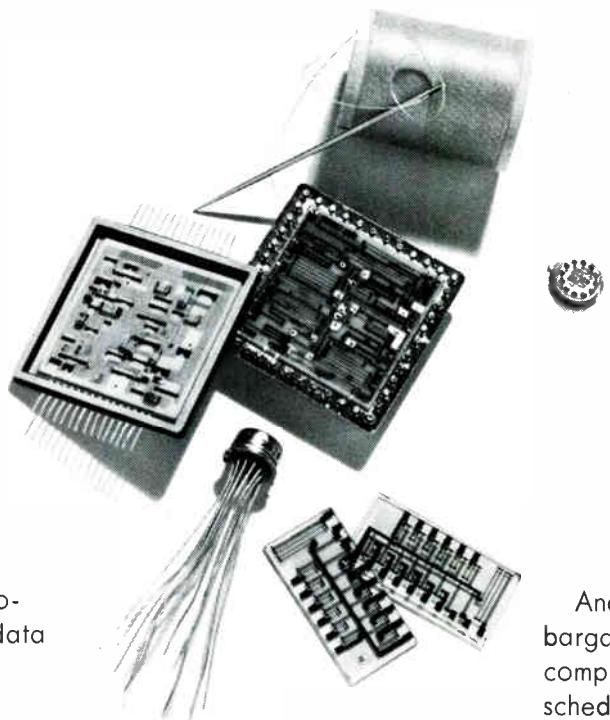

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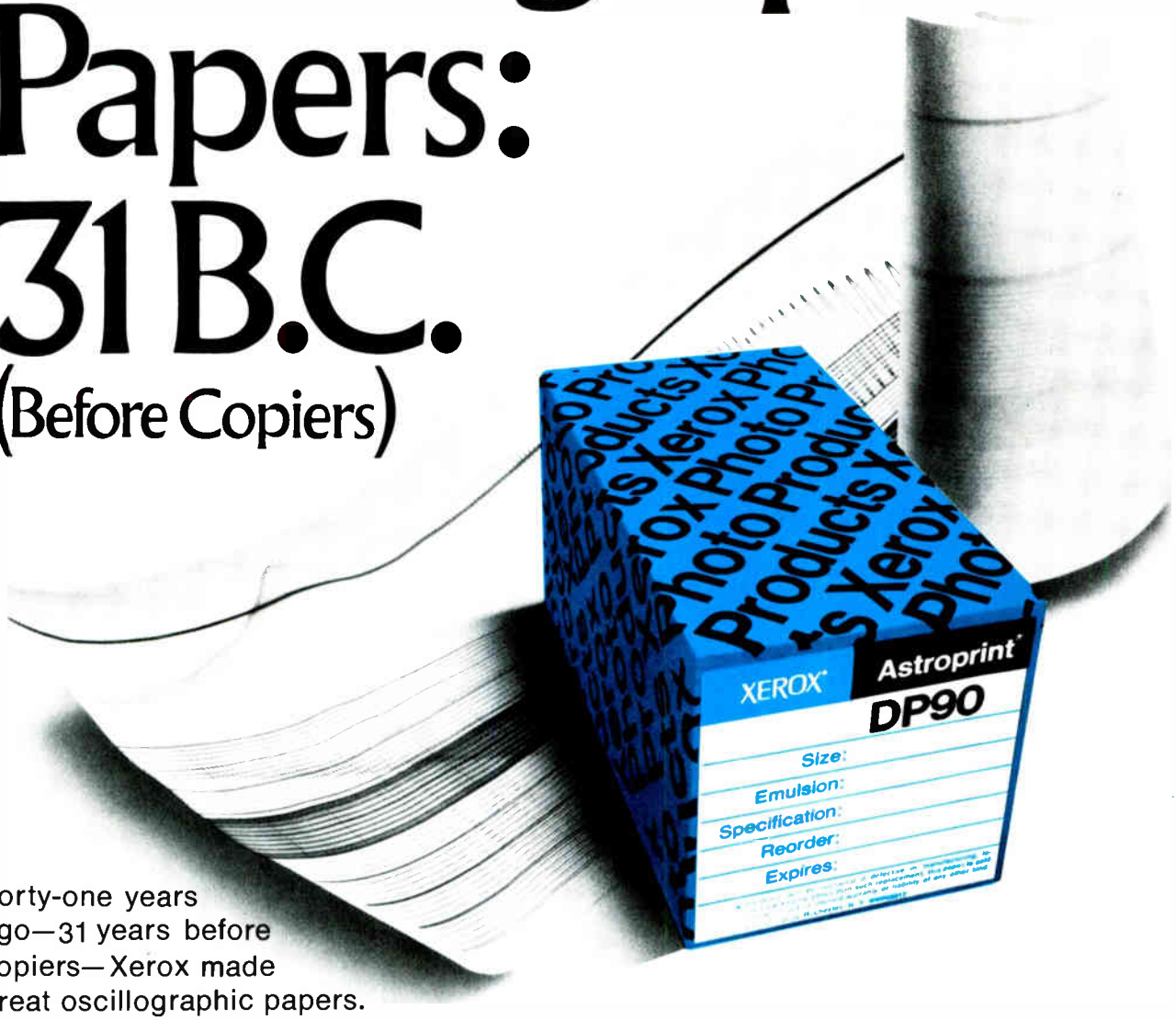

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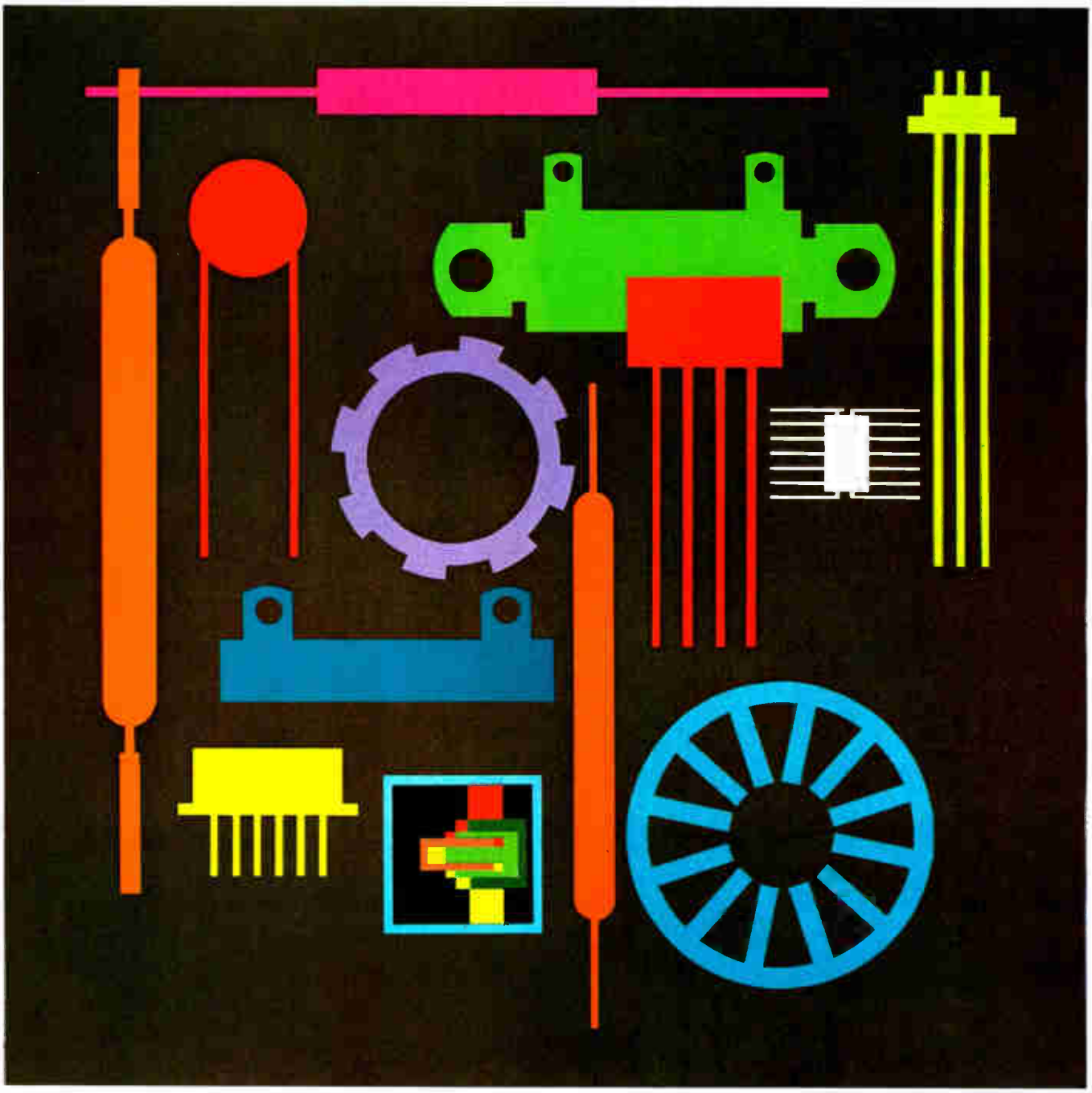


Technical articles

Through moly gates pass faster MOS memories: page 68

Another development in the continual search for improved MOS materials is refractory molybdenum. As in the familiar silicon gate process, moly gates are self-aligning, but sheet resistance is extraordinarily low—only 0.15 ohm per square—and voltage drops across electrodes are minimal.

Looking for an LSI package? Select, don't settle: page 75 (cover)

The engineer who has been less than happy with his LSI packages will be pleased to note that competition in the field has stirred up a host of new and better designs. As we show in the first of a two-part series, he can now choose from a variety of plastic and ceramic packages in various configurations, many at reduced costs. And edge mount and other leadless approaches signal further cost savings.

IC testing by laser is gentle—but thorough: page 92

Crude and costly are the words for many conventional mechanical and input-output IC testing procedures. A better approach could be a laser-based test system in which a light spot is focused on the chip; it penetrates the semiconductor material, changes its conductivity, and displays a variable current on a TV monitor as a picture of the chip. The procedure is quick and thorough, and its light touch does away with chip damage from the pressure of mechanical probes.

Micropower makes it in electronic watches: page 97

Now that the hunger for power in quartz-crystal timepieces has been conquered, a big new market could be taking off for both the watches and the electronics that drive them. And there's plenty of innovation in the field, especially in the integrated circuits that replace the conventional movements. It all adds up to greater reliability and accuracy in timekeeping.

And in the next issue . . .

New trends in instrument technology . . . 110° tube flattens color TV bulge . . . more on LSI packaging . . . designing with emitter-coupled logic . . . receiver control by computer.

Molybdenum gates open the door to faster MOS memories

Gates of refractory moly are self-aligning, have very low sheet resistance, and cause minimal voltage drops across electrodes; these benefits add up to a 5-MHz shift register that's the fastest MOS device in production

by W. J. Laughton, *General Electric Co., Syracuse, N.Y.*

☐ Improvements in MOS materials and processes have led to a significant narrowing of the speed gap that separates MOS and bipolar devices. Polycrystaline silicon gates, for example, have boosted MOS speed by a factor of two or three. Now the gap is narrowing even further by the use of refractory metal molybdenum for gates. Already in production, the technology, called R/MOS, is producing devices with a significant speed advantage over silicon gate circuits.

Though the process is yielding high-speed devices —one of them, a dual 100-bit R/MOS dynamic shift register that can typically operate above 5 megahertz, is the fastest MOS circuit in regular production—there are other significant benefits as well. Among them: R/MOS requires no additional fabrication complexity and should result in yields that are on a par with those of conventional MOS techniques. And the low-threshold devices produced by R/MOS are fully compatible with bipolar voltage levels.

Being a refractory metal, moly can take the high temperature (1,100° C) of diffusion furnaces; molybdenum gates, like silicon gates, can be applied before diffusion, and then the gate material itself can be used as the diffusion mask. Thus, like polysilicon, it yields self-aligned gates between diffused source and drain regions and the same low gate-to-source and gate-to-drain capacitance required for faster devices.

But molybdenum gates provide an important advantage over silicon gates: they have very low gate-conductor sheet resistance. This results in reduced voltage drops across the gate electrodes and shorter delays through the circuit. Moreover, the molybdenum gate metal layer, the top aluminum layer, and the p-diffused layer in the gate region provide a triple-level chip interconnect capability for layout flexibility and reduced circuit size.

As shown in Fig. 1, there are three basic steps in the R/MOS process. First, oxide is grown and molybdenum is deposited. Then doped glass is deposited and diffused. Finally, contact holes are opened and aluminum is deposited.

The process begins with a 1.3-micron-thick field oxide film grown on an n-type silicon wafer. Next, an etch selectively removes this oxide where the source, drain, and gate of the R/MOS transistor will be formed. A 0.1-micron gate oxide then is grown in these windows and molybdenum is deposited over the entire wafer. The moly then is etched to form the transistor's gate metal and the first metal interconnect layer, as shown on the thick oxide (Fig. 1, top).

Next, boron-doped glass is deposited on the wafer, which is diffused at 1,100°C (Fig. 1, middle). The boron diffuses through the thin gate oxide into the silicon substrate, but cannot pass through the moly or thick field oxide. Thus, because they restrict the boron to the substrate region under the thin oxide, both the moly and the field oxide act as diffusion masks. The unmasked, boron-doped regions form the drain and source of the transistor.

The process is self-aligning—the moly gate metal serves as a mask on the gate side of the drain and source regions, so these areas are automatically aligned with the gate. And, as in silicon gate, the only gate-to-drain or gate-to-source overlap is the minimal lateral diffusion which extends under the gate metal. Speed thus is enhanced because the gate-to-drain or gate-to-source overlap—the major contributors to Miller capacitance which degrades speed—is kept to a minimum.

Finally (Fig. 1, bottom), contact holes are simultaneously opened to the moly and p-diffused regions, and aluminum is deposited and etched to form the final interconnect layer. In sum, four masking steps are required in the R/MOS process, the same as in silicon gate and conventional MOS.

However, because the gate conductor doesn't have to be diffused in the R/MOS process, as it does in silicon gate, R/MOS holds a potential edge in over-all yield. In silicon gate, the simultaneous gate-conductor and p-region diffusion represents a possible hazard: if the wafer is over-diffused, the boron dopant will go through the gate oxide and reduce the threshold below the minimal value. Likewise, if the wafer is insufficiently diffused, the gate conductor will have inadequate conductance, causing excessively high transistor threshold. But in R/MOS, since the gate conductor is a metal that doesn't have to be diffused, this limitation doesn't apply.

Still another R/MOS feature is that photoresist is never applied to the gate oxide, as is required in conventional MOS. This reduces the chances of contaminating the critical gate oxide, which can lead to unstable threshold voltages.

The table on page 70 compares the threshold volt-

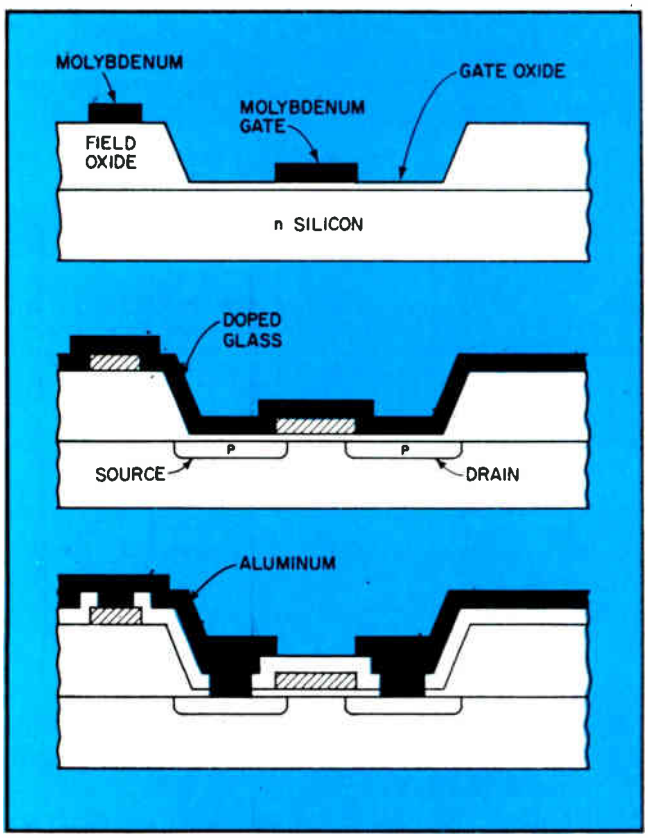
ages and sheet resistances of a transistor made by R/MOS, silicon gate, and conventional MOS, all using a <111> crystal orientation. The table indicates that active and parasitic field thresholds in R/MOS are identical to those of silicon gate devices; both are lower than conventional MOS thresholds. If the figure of merit is defined as the ratio of minimum field threshold to maximum active threshold, the R/MOS and silicon gate value will be 25/2.5 = 10, while the figures for conventional MOS will only be 30/5 = 6. These numbers indicate that both R/MOS and silicon gate circuits offer a greater design margin over conventional MOS circuits.

The table shows a clear advantage for R/MOS over silicon gate in sheet resistance values. The low gate resistance (0.15 ohm per square for R/MOS against 40 ohms/square for silicon gate) is particularly significant for circuit noise immunity and transient response. For example, a typical circuit interconnection run in the gate conductor layer is 0.4 mil wide and 4 mils long for a total of 10 squares of resistance The current in the run is 1 milliampere. Therefore, resistance for the R/MOS circuit interconnection is 10 squares x 0.15 ohm/square or 1.5 ohms. A silicon gate circuit of the same area would have a resistance of 400 ohms.

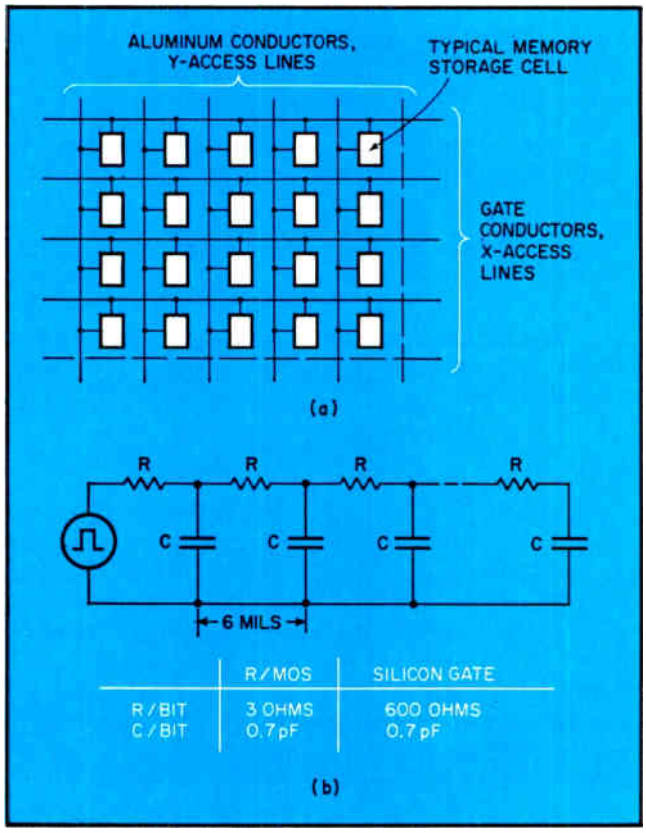
The resulting voltage drop in the run is 1.5 millivolts for R/MOS and 400 mV for silicon gate. The relatively large silicon gate voltage drop could reduce the signal level down to a value approaching circuit threshold, resulting in net noise immunity of zero, while the R/MOS circuit still has almost 400 mV of noise immunity remaining.

The low resistance of moly gates also gives R/MOS the edge in circuit transient response. This is especially important in random access and read-only memories where parallel access to individual storage cells requires long interconnections and therefore higher memory access and cycle times.

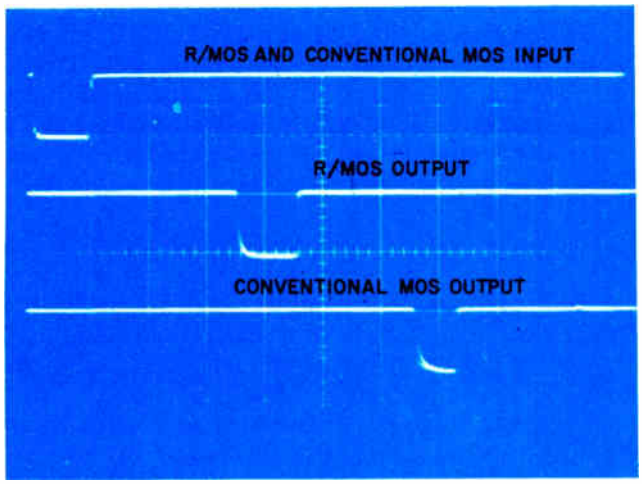
The typical memory interconnection matrix shown in Fig. 2a, and the equivalent circuit for one line, shown in Fig. 2b, illustrate in detail how gate resistance affects transient response. Storage cells are located in an X-Y matrix with separate X and Y access lines. The number of cells in the X direction is assumed equal to the number of cells in the Y direction to minimize that total length of the X and Y lines. Further, a typical capacitive loading of each bit is assumed to be 0.7 picofarad, which would include the



1. **Making it.** The R/MOS process starts (top) with an oxide layer on which molybdenum is deposited; boron is diffused (middle) into the p-regions of the source and drain via layers of boron-doped glass, which also serve as an insulator. Opening contact holes in the oxide and depositing the aluminum electrode pattern complete the process (bottom).



2. **Storage cells.** In an R/MOS interconnection matrix, storage cells have separate X and Y access lines. Because of the reduced sheet resistance of moly gates, R/MOS circuits have lower gate-electrode voltage drops than silicon gate circuits, giving R/MOS better noise immunity and transient response. Shown below is the equivalent circuit for one gate conductor access line.



(ALL TRACES AT 0.5 μs/DIVISION AND 10 V/DIVISION)

3. Making time. Scope photos show speed of R/MOS. After passing through a series of 200 inverters of a standard shift register circuit, R/MOS output delay is only 1.8 microseconds, while conventional MOS delay is 3.3 μs.

interconnecting line capacitance for each bit.

In a lumped constant transmission line of this type, total delay time between the input and output 50% voltage points is approximately:

$$t_D = \frac{CRn^2}{2} \quad (1)$$

where n is number of bits along one line, C is gate capacitance per bit, and R is line interconnect resistance per bit.

If N is the total number of bits on the memory chip, and if the number of bits on the X and Y access lines are equal, then:

$$n = \sqrt{N}$$

and

$$t_D = \frac{CRN}{2} \quad (2)$$

For a 256-bit memory, N = 256, and from (2), the total line delay time for silicon gate (using 40 ohms/square for R) would be 54 nanoseconds, whereas in R/MOS (0.15 ohm/sq) the delay time would only be 0.20 ns. Likewise, a 1,024-bit memory in silicon gate would have a line delay time of 216 ns, while the equivalent figure for R/MOS would be only 0.8 ns. Not only do silicon gate conductors have longer access and cycle times but they run the risk of logic sequence errors: long interconnecting lines can result in time delays greater than actual time between logic intervals, and this condition could cause serious circuit malfunctions.

The same low voltage-drop and short transient-time characteristics of R/MOS devices apply equally to conventional MOS, because aluminum interconnections have excellent resistance properties. But conventional MOS has only one metal level, against two basic interconnect levels for R/MOS. This feature could mean increased flexibility in circuit layout and a possible increase in packing density.

But probably the most interesting R/MOS characteristic is that its internal logic speeds, like those of silicon gate, are substantially higher than in conventional MOS, due to low Miller capacitance. This is demonstrated in the waveform photographs of Fig. 3, which compare R/MOS and conventional MOS propagation delays through a series of 200 inverters of a typical 100-bit shift register. It's clear from the delay traces that the total delay for the R/MOS input pulse is 1.8 microseconds, while for conventional MOS the

Why moly blooms at GE

Although molybdenum is not a new material in semiconductor technology—it's been used for years in semiconductor power devices—its self-aligning gate feature, high melting temperature, high electrical and thermal conductivity, and good match of thermal expansion with silicon make it ideal for use in digital integrated circuits. That's why moly was selected for use in a new dual 100-bit shift register, one circuit in a new MOS product line.

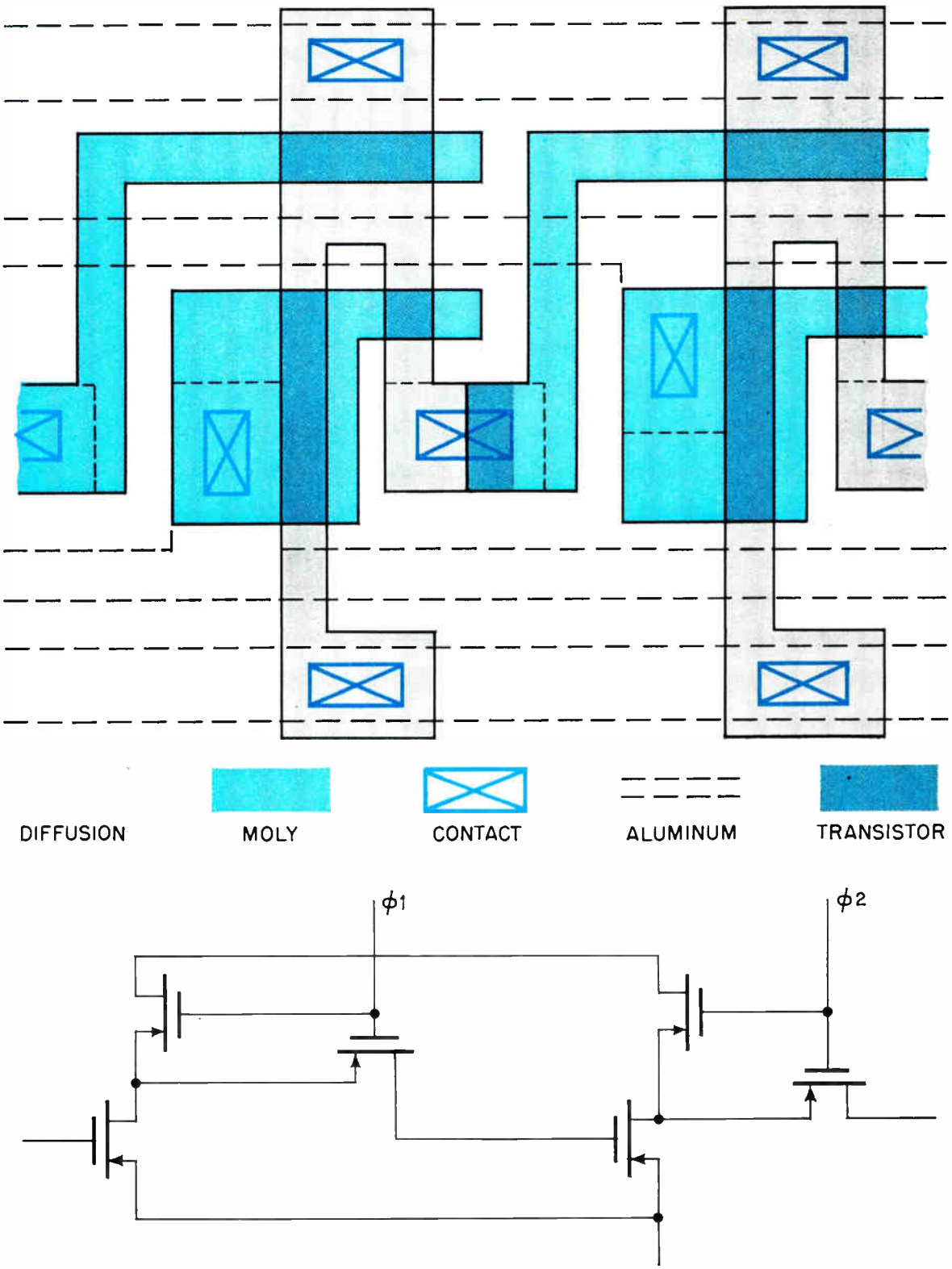
The major benefit of the self-aligning gate process is that the gate acts as a diffusion mask. Molybdenum serves this purpose excellently because it prevents diffusion of boron into the gate oxide. If the gate is not satisfactorily masked against boron diffusion, the boron can diffuse through the gate oxide and form unwanted p-regions in the silicon. And moly, with its 2,600°C melting temperature, stands up well to the 1,100°C temperature of diffusion furnaces.

Another big feature of moly is its excellent conduction—sheet resistance is only 0.15 ohm per square. In fact, the figure for moly nearly matches the 0.05-ohm sheet resistance of aluminum, so moly, as an electrode, can serve as a general signal and power conductor without incurring excessive voltage drops.

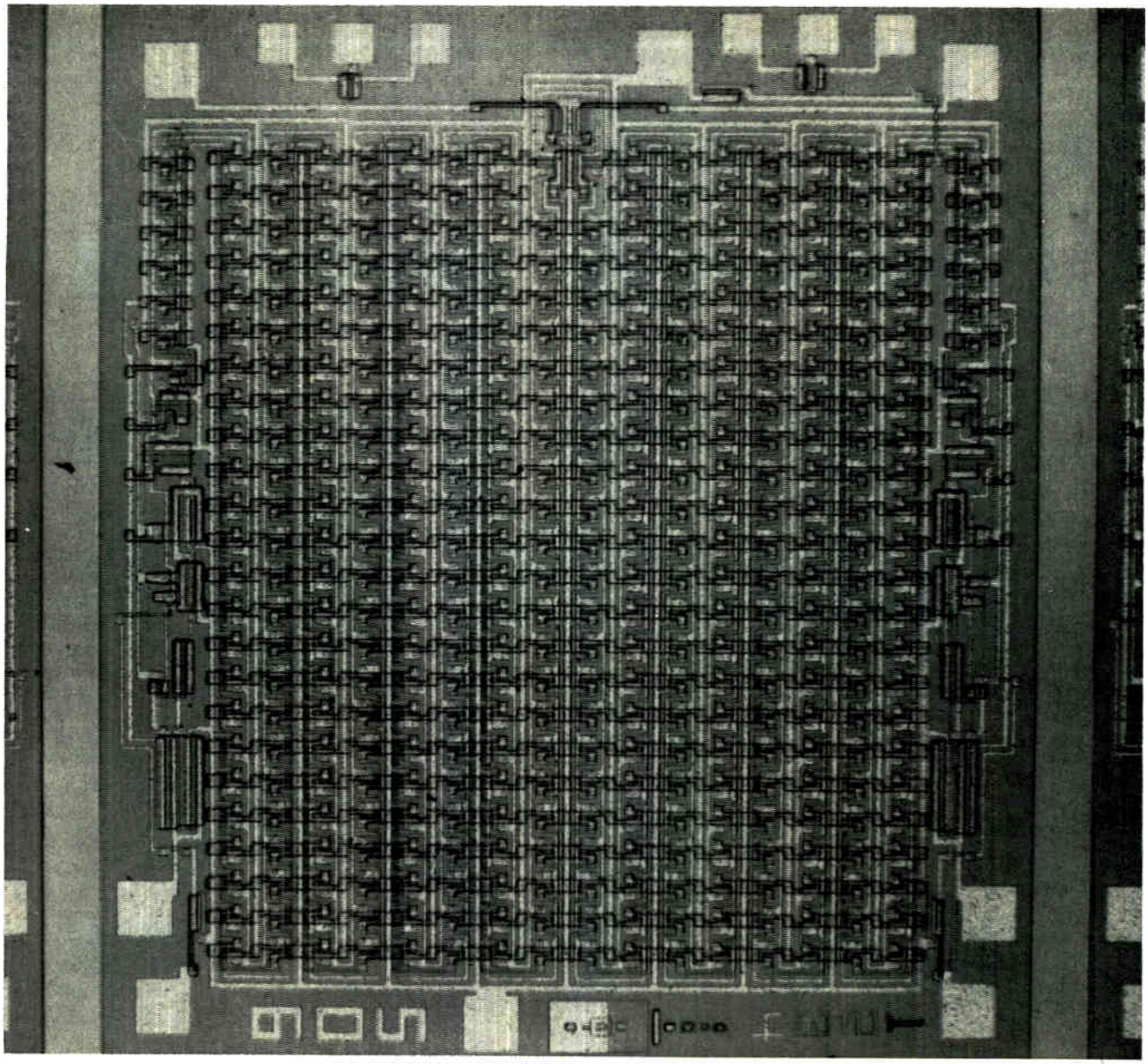
Moreover, moly gates are highly stable. Unlike the aluminum gate in conventional MOS, moly doesn't react with silicon dioxide at high temperature. Thus R/MOS provides more freedom in high-temperature chip-assembly operations.

Comparison of MOS process parameters

	<111> R/MOS	<111> Silicon Gate	<111> Conventional
V_{TO} (active transistor threshold voltage)	1.5-2.5	1.5-2.5	3.0-5.0
V_{TF} (parasitic field device threshold voltage)	25-40	25-40	30-50
ρ_P (p-diffused region sheet resistance)	10 Ω/square	30 Ω/square	100 Ω/square
ρ_G (gate conductor sheet resistance)	0.15 Ω/square	40 Ω/square	0.05 Ω/square
ρ_{int} (second-level interconnect sheet resistance)	0.05 Ω/square	0.05 Ω/square	Non-existent



4. Ground rules. Layout considerations for a two-phase R/MOS circuit are identical to those of silicon gate. But a double-level metal interconnect system, combined with the p-diffusion interconnect layer, gives R/MOS three levels of interconnect and a potential size edge over silicon gate—gate conductor is used for power, ground, and clock bussing.



5. Chips are down. The first R/MOS product, the GER 2507, is a dual 100-bit dynamic shift register, specified at 5 megahertz, and made from basic R/MOS memory cell.

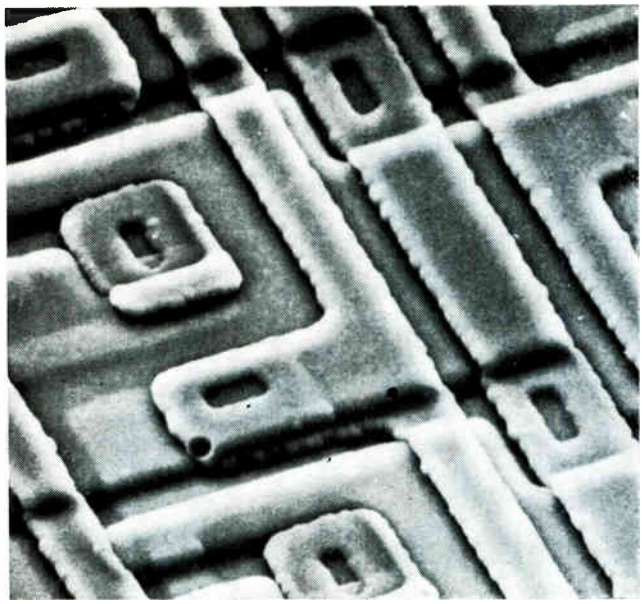
total delay is 3.3 μs, almost twice as long.

What's more, this R/MOS speed advantage is expected to hold for all logic and memory circuits. In fact, delays as low as 10 ns have been measured on some R/MOS logic circuits with low fan-out.

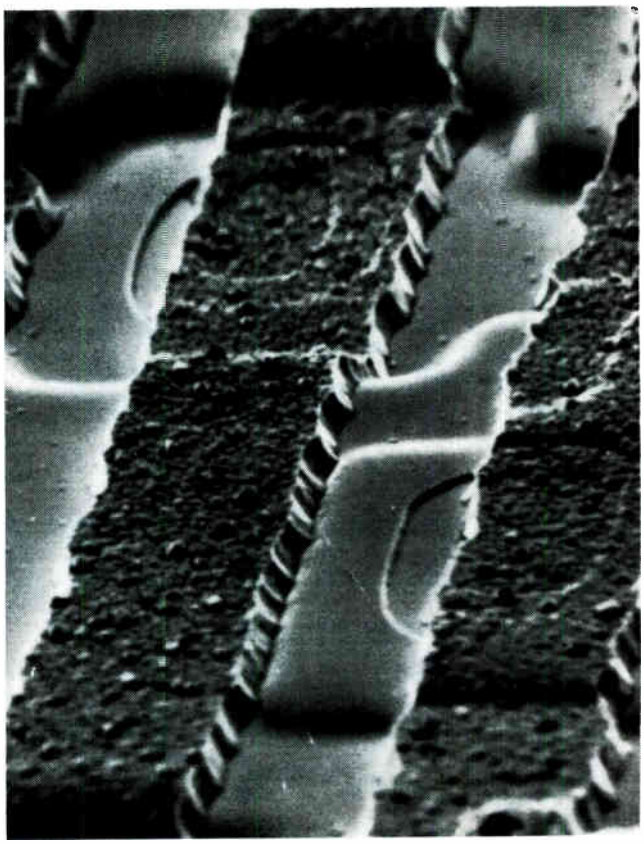
Layout rules for designing R/MOS circuits are similar to those of silicon gate, and like silicon gate, R/MOS circuits occupy about 20% less area than equivalent conventional MOS devices. This size reduction in R/MOS is achieved three ways. First, the double-level (moly and aluminum) interconnects, combined with the p-diffusion interconnect layer, provide three levels over-all, conserving chip area in some connections. Second, the self-aligning moly gates can be smaller than those of conventional MOS, where overlap is required to assure alignment over the diffusion regions. Third, thanks to the shallow p diffusion and lower operating voltage of R/MOS, diffused regions can be closer together.

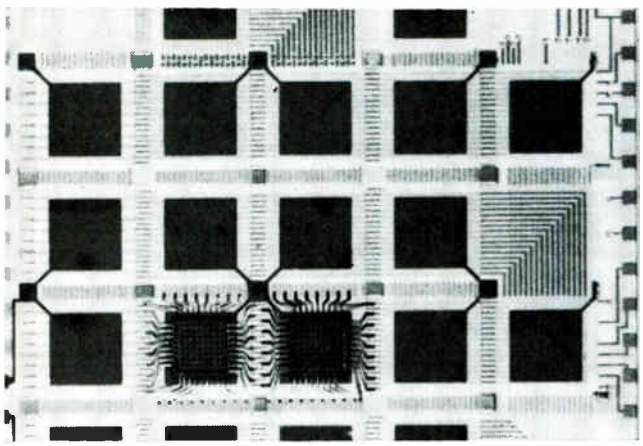
A typical one-bit layout in an R/MOS dynamic shift register is shown in Fig. 4. Note that in R/MOS, clock signals can be distributed either by moly or aluminum paths, providing an additional degree of freedom in layout over silicon gate circuits, where clocks must be distributed by aluminum only. If clocks were located in the silicon gate conductor layer, the chip clock distribution system would encounter excessive delays.

Using the design rules and the basic cell layout shown in Fig. 4, one of the products rolling off the R/MOS production line is a dual, 100-bit dynamic shift register, cataloged GER 1507. This circuit, compatible with diode-transistor and transistor-transistor logic, is designed for general digital storage applications such as data terminals, displays, and refresh memories.



Well-defined. This scanning electron microscope photograph of an actual R/MOS cell shows the good definition and continuity of the aluminum metal pattern on an oxide step. Inherent beveling of the glass at the step edge will make a strong contribution to the high yields of the R/MOS process.





Out of the lab. Molybdenum gates are finding their way into a rapidly growing family of products. Photomicrograph above is a typical moly run in an actual shift register in regular production. This close-up shows the straight-line conductors that are possible with this material. One of the standard R/MOS products is a 256-bit RAM. Labeled the GER 1101, it's designed as a small buffer store; it's fully decoded and compatible with TTL. Another product soon to be seen is a 4,096-bit R/MOS hybrid RAM (left) called the GER 1036; it has 16 R/MOS chips and four bipolar chips on one substrate. Included are decoding, digit driving, and sensing chips. In addition, the 1036 offers maximum flexibility: 2,048 by 2 or 4,096 by 1. It has a cycle time of 125 nanoseconds.

Structural details are delineated in the scanning electron photomicrograph shown at top of page.

Metal discontinuity over thick-oxide steps is a major cause of fabricating faults and low yields in both conventional and silicon gate MOS. The photograph shows that one of the key features of the R/MOS process is its inherent beveling of oxide edges at thick oxide steps. This beveling permits the aluminum conductor runs to traverse the thick oxide steps with good edge definition.

Another R/MOS device in production is the GER-2507, as shown in Fig. 5. The 2507 makes full use of the high speed potential inherent in the moly gate's low sheet resistance—it's specified at a clock rate of 5 MHz, about twice as high as silicon gate shift registers in production. And the 2507 can be operated typically above 5 MHz without requiring multiplexing that's needed for silicon gates at these frequencies.

Also coming on stream is the GER 1036, an R/MOS hybrid RAM with storage capacity of 4,096 bits and cycle time of 125 ns. The basic element, a 256-bit R/MOS storage chip, is made in the new film package format [*Electronics*, Feb. 1, p. 44]. □

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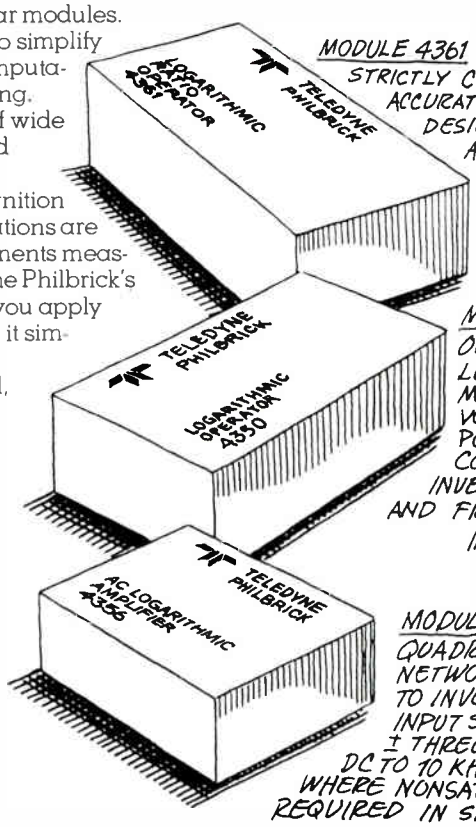

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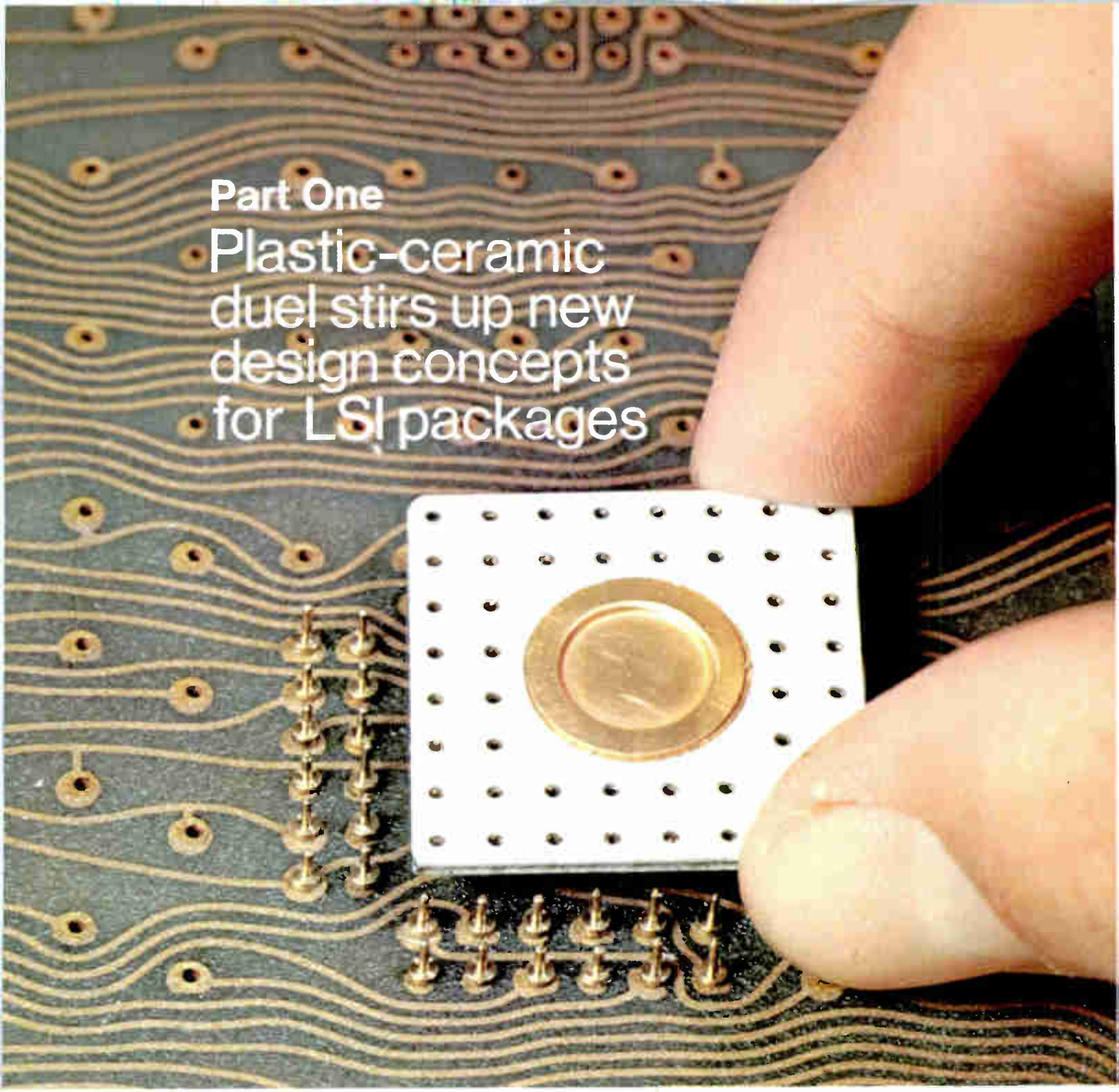


Part One

Plastic-ceramic duel stirs up new design concepts for LSI packages

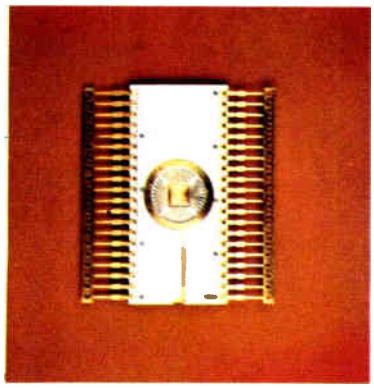
Developments in materials, shapes, processing techniques, are rapidly increasing the variety of packages available to the equipment designer; the edge mount and other leadless approaches also offer new benefits

by Stephen E. Scrupski, *Packaging & Production editor*

☐ For the equipment designer, faced with the special economic and technical requirements of LSI system design, choosing the right package is becoming almost as important as producing the electronic function itself.

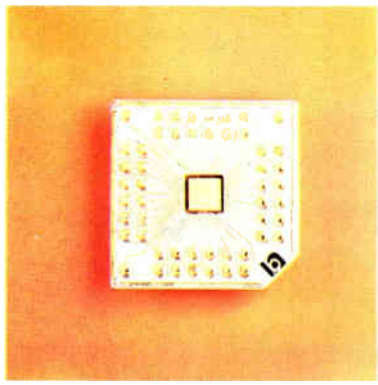
Happily, even at this early stage, a great variety of shapes, dimensions, materials, techniques and degrees of complexity is being made available. Competition between plastic and ceramic is also forcing prices down. And new package concepts are being introduced almost daily, though these will have to be evaluated by system designers, who have had reason to be less than pleased about package quality and prices in the past.

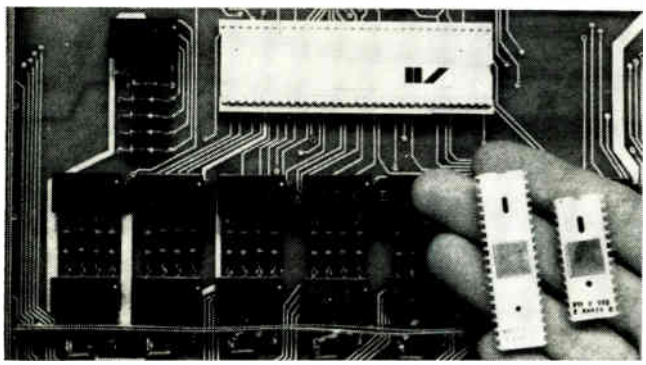
Nevertheless, among the new concepts they'll be



Frenchtown CFI—In the 40-lead dual in-line, made with three layers of ceramic, the leads are brazed to pads on the second layer, which carries the conductive pattern. The leads bend on 1-inch instead of 600-mil row spacing.

National Beryllia—The 51-pin unit measures about 1⅜ in. square. The Kovar die-attach header is mounted on a ceramic disk inserted in a hole in the center of the alumina substrate. The die attach pad is 200 mils square. The lid could be epoxied down, or a metal lid could be sealed by applying a low-temperature glass frit. The package is intended to be inserted into a socket and wave-soldered onto the pc board.





Big one. The 64-lead ceramic DIP, which measures 3 by 0.9 inches, was developed by American Lava for a Four-Phase Systems timing circuit.

able to choose from are:

- The edge mount package, which eliminates the lead frame in favor of an edge connector, giving designers a pluggability feature that's suitable for easy maintenance;
- A leadless package that has a foil diaphragm sandwiched between two ceramic substrates and that mounts on pins stacked into the pc board;
- Plastic dual in-line packages that use chip cavities and lids rather than full encapsulation of the chip;
- Lead bonding schemes and conductive-ink screening methods that lower costs.

Summing up all these trends, Robert Applewhite, sales supervisor for American Lava Corp., Chattanooga, Tenn., says: "40-lead ceramic package prices will come down this year, and the laminated-tape package will still be on the scene by the end of 1971; however, new packaging concepts to cut ceramic costs below $1 are being developed by just about every ceramic package manufacturer. Semiconductor makers will perform transfer molding of plastic packages up through 24 leads. New packages such as the edge mount will require a total change of thinking on the system designer's part, and their future is uncertain."

System designers obviously stand to gain from the battle shaping up between ceramic and plastic package suppliers. "We dearly love to be romanced by two beautful women. It took competition from plastics to make the ceramic manufacturers improve their quality and lower their prices. The price battle has started—we see it happening now," says a packaging specialist at a major systems house. He adds that ceramic prices are already coming down close to plastics, even in the 24-lead package: "One leading plastic-packaged-device manufacturer charges about 50 cents each in quantities of 500,000; we can get the same package in ceramic, hermetically sealed, for about 53 cents in the same quantity, and that includes lids."

In the larger picture, however, there still is a considerable gap between ceramic and plastic prices. For instance, Richard Presby, marketing manager of TI's hermetic seals department, says that the cost of a plastic package is typically about one fourth that of ceramic, but by the end of the year ceramic will have come down so that it will be roughly only twice as expensive as plastic.

The pressure of plastic on ceramic prices is also stressed by J.C. Thompson, sales manager for electronic ceramic packages, Centralab, Milwaukee, Wisc. A year ago, he says, the drive was toward the $1.00

40-lead ceramic package, but now the push is to the 50-cent ceramic package—and unless this is reached next year, he feels interest will shift even more strongly to plastic. However, Thompson doubts if anyone will reach the 50-cent level "legitimately" this year, though some suppliers on the way out may cut prices to cost level or even below.

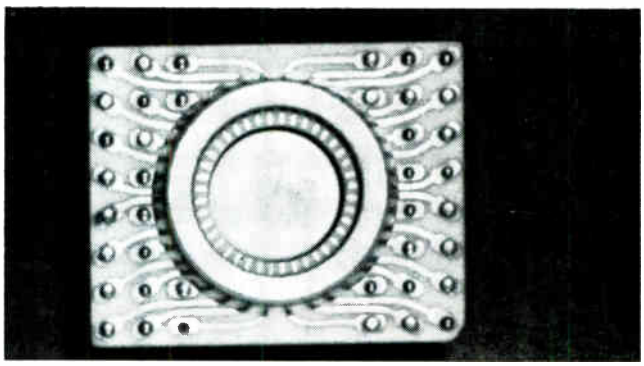
Agreeing with Thompson, Frank Rydwansky, applications engineering manager at Metalized Ceramics Inc., Providence, R.I. (Metceram), is positive that "plastic is rumbling." Rydwansky sees the semiconductor companies going on an "economy kick" in the next three months, with erosion of the price level for 40-lead ceramic packages down to the 60- to 80-cent level, and eventually to the 50-cent range.

He's quick to point out, however, that such price cuts are not to be interpreted as meaning that the package makers were making a killing at the previous $1-plus prices. Rydwansky says that such cuts are coming about because processes are being trimmed up and economies are being made in package design. He does feel, however, that there's enough resistance to plastic packages among systems houses to give ceramic packages a steady market for a long time.

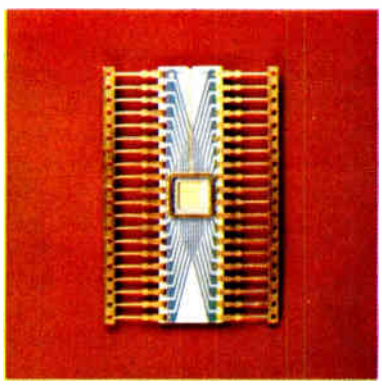
Another reason for switching to plastic is given by Jack Haenichen, Motorola Semiconductor's vice president of operations. He points out that, with MOS costs coming down, the package is becoming a larger percentage of the cost, and the way to reduce this percentage is to use plastic. But he thinks there's an alternative to putting expensive 40-lead chips in plastic packages, and what may lie ahead is the much larger question of how to partition for lowest cost—with cheap 24-lead plastic packages readily attainable, it may be more economical to use several 24-lead packages rather than a few 40-lead packages. Thus, package and device costs will be traded off against each other even more in the future.

Another who, like Haenichen and American Lava's Applewhite, stresses the 24-lead breakpoint between ceramic and plastic packages is James V. Barnett, packaging development manager, American Microsystems Inc., Santa Clara, Calif. He points out that in plastic packages with more than 24 leads two problems have still to be overcome: "One is wire movement during encapsulation, and the other is bonding a chip to an unprotected lead frame—the frame bends and twists and so sometimes the bonds don't hold. AMI and others are looking for a way to solve this."

Apparently, however, Texas Instruments feels it

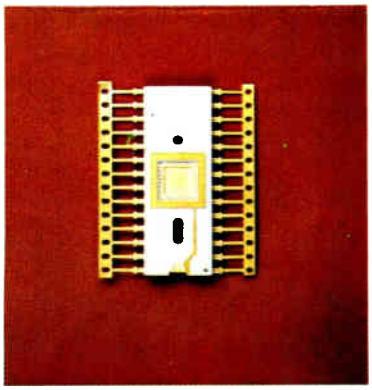


Pin-Pack. National Beryllia's 40-pin package, for rugged applications, measures 1 by 0.8 inch and occupies less board space than a 40-lead DIP.

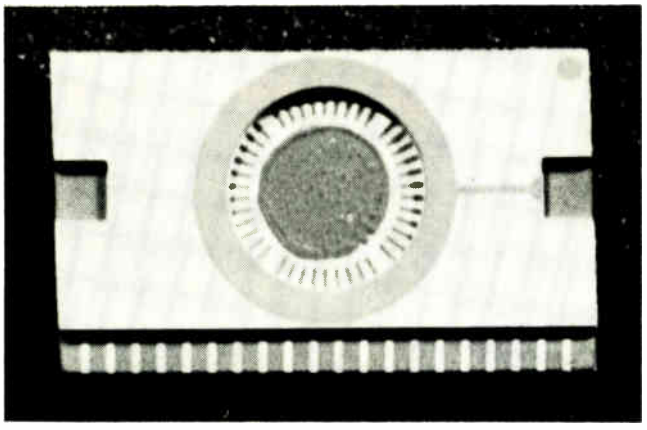


SCS—The chip cavity in this 40-lead screened dielectric package is gold-plated. The lid seal ring is made of gold-plated Kovar and is high enough to allow room for the lead wire bonds. The cavity is formed in the substrate and fired, and then the conductive ink and the dielectric are screened on and fired.

Metceram—The leads of the 42-lead Quip (quad in-line package) are on 50-mil centers and, when inserted in a pc board, bend down in staggered fashion to make four rows of leads (hence the name of quad). This unit is coated with black alumina to prevent light transmission to the chip. Most packages of this type have gone to North American Rockwell Microelectronics Co. for use in the Sharp calculator.



American Lava—The laminated tape, co-fired process, by which this 28-lead package is made, is one in which American Lava specializes. It requires three layers of ceramic—the lower layer holds the die attach pad, the middle one holds the conductive pattern to the chip cavity, and the top one holds the seal ring. The thickness of the middle layer allows up-hill bonding. The lead frame is bonded on the underside of the package.



Mini edge mount. Metalized Ceramics' first entry into the edge mount field is this 40-lead package with metalization on both sides. It's made with two layers of ceramic tape and measures 1 by ¾ inch. It will handle the same size chip as the earlier 1-by-2-inch single-sided package. This version is made with shorter connector fingers than will be used on the final version.

has overcome such problems, because last month they announced the availability of MOS devices in plastic packages with up to 40 leads, at prices 25% lower than the same circuits in ceramic packages [*Electronics*, Mar. 29, p. 20].

There's also the question of just how reliable plastic packages are or can become.

Presby of TI's hermetic seals department notes that plastics still are not usable where there is extensive temperature cycling or high humidity and corrosion, but they are tougher against shock. "The market will never be all plastic, but plastic is the trend of the future," he says. Gerald L. Cheney, manager of assembly packaging and development in the department, adds that Mil-Std 883 gives a "fixed target to shoot for in plastics, whereas before, the target was moving."

"As far as the military is concerned, I don't think anything has changed since my paper at the Reliability Physics Symposium a year ago," says Joseph Brauer, Rome Air Development Center. In the paper, Brauer recommended that a safety factor be applied by assuming that plastic failure rates will be at least four times greater than those commonly achieved with the equivalent dual in-line hermetic device.

One major problem with MOS in plastic has been the MOS surface's sensitivity to ionic contamination. TI therefore passivates the devices with a quartz layer to prevent sodium ion contamination, and also uses an epoxy-based plastic rather than the newer silicones on the grounds that the silicones are more porous to sodium. "These plastic devices are as reliable as ceramic ones," says Daniel Baudouin, MOS standard products program manager. He explains that they were subjected to extensive testing to verify integrity: temperature cycling, thermal shock, and 85° C, 85% relative humidity with reverse bias. Satisfactory results on these tests led to tests at 125° C with only one failure for 134,000 device hours. Storage tests at 150° C produced one failure in 358,000 hours.

This shift to plastic is not due only to a simple desire to offer lower-price parts. It's also due to the companies' desire to raise their own value-added portion in their products by making the packages in-house, and so to exercise as much control as possible over the manufacture of the device that they sell their customers.

Companies such as Texas Instruments and Motorola have gone so far as to set up ceramic package making facilities, and TI even sells its packages as separate units. Motorola will be making about 20% of its own ceramic packages, according to Haenichen. The decision to establish the Motorola facility was made about 18 months ago when it was difficult to get packages, and it is now coming on line.

Intersil Memory Corp. is another semiconductor house with its own plastic package development program. It has developed a combination ceramic-plastic approach—a silicone package for which it has applied for a patent. Bonded to a lead frame is a small alumina disk which is slightly larger than the chip bonding area and overlaps the mounting and bonding pads. This lends strength to the structure during bonding and helps to eliminate the twisting of the lead frame. After the chip is mounted and its wires are bonded, a round alumina cap is placed over it and sealed to the bottom disk to form a hermetic seal around the chip. The completed structure is encapsulated in silicone.

All this implies, and correctly, that there have been problems with the price and quality of ceramic packages. Last year, semiconductor makers were complaining of packages that were cracked, leads that fell off, and seals that leaked. In order to get enough

packages with the quality they needed, they placed double or triple orders, so inflating the potential market figures by a factor of two or three. This in turn spurred established suppliers to invest in extra equipment and new suppliers to enter the field.

This new investment plus the general slackening of MOS sales has by now resulted in an overcapacity for production of ceramic dual in-line packages. Whereas a year ago demand outweighed supply by a four-to-one ratio, today supply outweighs demand by six to one, says Joseph Marcello, packaging consultant from Providence, R.I. (Marcello until recently was vice president of Metceram.)

William Everitt, Coors product sales manager, is typical of package suppliers. He readily admits that there were problems: "They had a legitimate beef on quality then, but they were pushing the ceramics vendors hard. Quality is much better today, though."

However, complaints of poor quality still persist among semiconductor makers. A major problem, according to one systems house packaging specialist, is the lack of uniformity in lead strength and the tendency of gold plating to fail during bake tests. Murray Klavens, manager of manufacturing engineering at General Instruments, Hicksville, N.Y., agrees on the problems with gold plating, saying that it tends to bubble up and lift off the lead frame. He attributes this to the effort to reduce package costs by using thinner platings.

Moreover, complaints about the price of ceramic packages are even louder. One semiconductor maker puts it this way, perhaps stretching an analogy to make his point: "How come we go through hundreds of operations to produce an integrated circuit and we can sell it for pennies, and it only takes a few steps to make a package and yet it costs ten times what the chip does?"

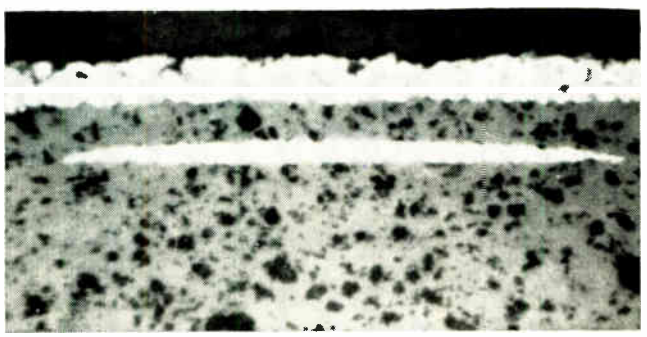
The reason, according to package suppliers, is not hard to understand. Lead frames account for 5 to 10 cents, and the seal ring for about 3 cents. Gold adds about another 25 cents to the package if the lead frame is completely plated. Thus, the package maker has nearly 40 cents invested in package materials even before he begins figuring in his labor costs and yield factors.

To cut costs, ceramic package makers are beginning to redesign the packages, either by going to selective deposition of gold in the wirebonding areas in the chip cavity, or by cutting back on such components as seal rings.

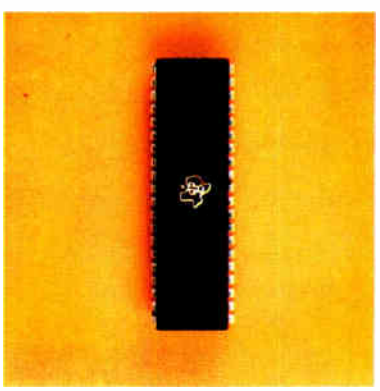
Frenchtown CFI, Frenchtown, N.J., for example is offering selectively plated packages with gold only on the die attach pad and on the edges of the conductor fingers for wire bonding. The lead frame is a nickel-plated Kovar. Although it hasn't been produced in enough volume yet to fully evaluate cost savings, it would save about 8 cents a package, according to John Fredericks, Frenchtown vice president for marketing and sales.

Fredericks points out that the lead frame usually takes more gold than is really necessary during plating. To get 80 microinches of gold on the die attach pad, the lead frame sometimes ends up with 120 microinches of gold, because of the unavoidably higher plating current densities at the lead frame. Because of this variation in plating, if the customer asks for only 60 microinches on the lead frame, Fredericks says it is difficult to give it to him and still maintain enough gold thickness on the die attach pad.

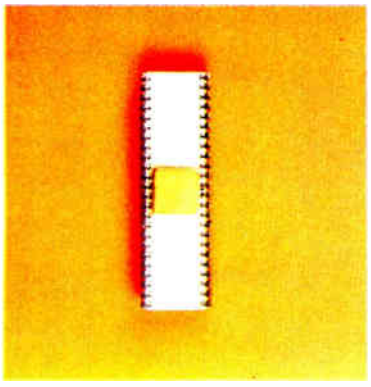
"Semiconductor companies may think the packages are expensive, but package manufacturers are not reaping a bundle of money on them," says Jack Cox, manager of Multilox packages in the Electrochemical division of E. I. du Pont de Nemours & Co. Du Pont's new "lead frame last" package offers many opportunities to cut costs, he adds. Up to now, he says, package makers have used refractory metals—tungsten, molybdenum, and moly-manganese—for the screened metal conductor paths, because they coudn't braze to



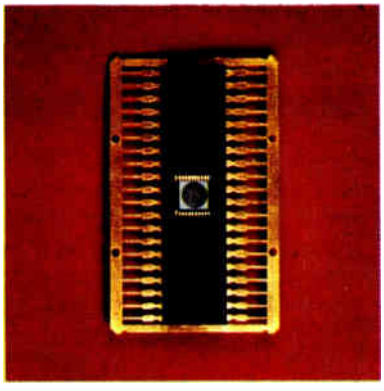
From two, one. Cross-section of a Metceram package made with tape and screened alumina shows no interface at edges of metalization (lighter area), after being fired.



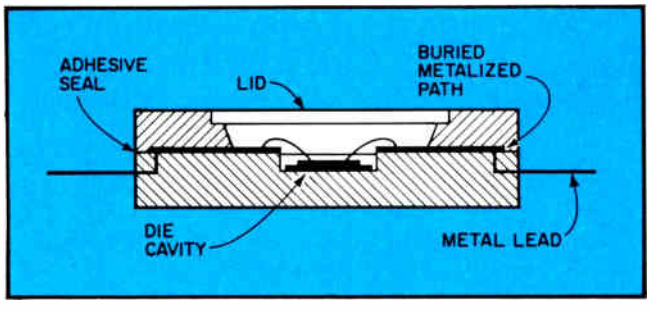
TI—The new Texas Instruments 40-lead encapsulated plastic package uses epoxy plastic for its protection against sodium ion penetration. Leads are solderable and bend on standard 600-mil spacing. It will be priced 25% below circuits in 40-lead ceramic packages.



Du Pont—"Lead frame last" package with 40 leads is a standard size with leads bending on 600-mil centers. Note the soldered lead frame and the thick film conductor pattern visible through the 1-mil screened dielectric. The gold-plated Kovar cap, which is sealed to a gold seal-ring metalization 1-mil thick, covers a die attach cavity measuring 200 mils square and 15 mils deep for up-hill bonding.



Interbond—The 40-lead dual in-line package has 600-mil row spacing on the leads. In the die attach cavity, which is 230 mils square, is an aluminum insert for conductive epoxy die attach. The lead frame extends into the chip cavity. A self-aligning metal lid can be epoxied onto the recess around the cavity.



Plastic cavity. USES package has lead frame tips bent up to meet metalized path, making a bond to the plastic substrate to inhibit moisture penetration.

common thick film materials, such as gold. This has limited the metallurgical systems that could be used in the package, he says.

Although many people consider any material that's screened a thick film material, Cox points out a distinction: properly, a thick film is paste that can be fired in air, whereas refractory metals, though they may be screened, must be fired in a reducing atmosphere because they oxidize in air. Precious-metal thick film materials, Cox says, may be more expensive than refractory metal pastes, but could offer lower total-process costs, since they can be soldered.

The du Pont package uses a pre-fired alumina substrate with a cavity in its center at the chip location. Bonding pads at the edge are solderable metal. A conductor pattern connecting the bonding pads to the center cavity is screened on and fired, and then dielectric is screened over the conductors and fired again. The chip can now be bonded to the die attach pad without the lead frame being applied. (This isn't done in other packages because their metallurgy forced the use of lead-frame brazing, an operation that would loosen the eutectic bond of the chip.)

With the chip in place and the wire bonding done, the package can be sealed and tested, still before the lead frame is attached. Thus, if it fails testing, it can be thrown out without the lead frame and thus saves that cost plus the cost of the attachment labor.

The lead frame, which comes in strip form, has C-clamp type leads that grip the thick film pads along the edge of the substrate. The frame is pushed onto the edges and then reflow soldered (wave soldering could also be used if the substrate is masked during the process). This structure, Cox says, gives a 10-pound lead strength, whereas brazed lead frames have a 4-lb pull strength. The solder is at a 300°C melting point, higher than regular solder at 240°C, so that it doesn't melt when the package is soldered into the pc board.

Cox lays out a scheme for cost cutting using his new package as an example. Basically, a package might consist of the following elements:

- pads at the edge for lead frame attachment;
- metal conductor paths into the center of the substrate to connect to the chip;
- cavity, with metalization for die-bonding;
- insulation over the metal conductor lines to protect them and to insulate the metal cap, if used;
- metal sealing ring;
- cap.

If the user decides he needs all these elements to make his package as reliable as possible, but wants to use aluminum, rather than gold, wire bonds, then du Pont can choose the metallurgy of the lead-frame

Going, going . . . gone

With the oversupply of ceramic packages, there has already been some attrition in the ranks of package suppliers. The latest to close is the Varadyne Industries Mitronics division, Murray Hill, N.J. Mitronics, which got its start with glass-to-metal seals, had been supplying glass-filled ceramic packages. The responsibility will be picked up by Varadyne's Hanibal division in Santa Ana, Calif., a company spokesman states.

Fairchild Semiconductor's packaging operation in San Diego also shut down about the same time.

The recently closed Philco Ford operation in Lansdale, Pa. has been bought by National Beryllia, Corp., Haskell, N.J., which will run it as its Lansdale division. It will supply glass-filled ceramic and ceramic packages, adding to National Beryllia's Sealox line.

bonding pads to be solderable. Likewise, the conductor paths will be aluminum-wire-bondable. The pad will accommodate standard eutectic die bonding, and the insulation will protect the wiring and also reduce capacitance between lines. The cap will be sealable with a gold-tin alloy.

Now, if the user wants a lower-cost package, he can save about 20 cents by eliminating the brazed cap, using instead a ceramic cap sealed with an organic adhesive. This also could eliminate the screened insulation, since he no longer has to insulate the conductors from a metal cap.

He might also eliminate the cavity. The cavity was first used because semiconductor makers wanted to bond "up-hill" to prevent shorts between the wires and the edge of the chip. However, wire-bonders now are available that put a little loop in the wire for co-planar bonding (the edge mount package, for example, doesn't use a cavity). If he's tooled up for co-planar bonding, then du Pont would simply apply the conductor screening to the flat side of the ceramic substrate, rather than the cavity side. This means that a single stock of alumina substrates can be maintained.

The cheapest package, according to Cox, would have only the first two elements—the edge pads and the conductor paths, and perhaps a dot of epoxy on the chip for environmental protection. This would run about 25 cents. With this package, tooling costs for design changes would also be low—from $300 to $400 for the screen and about $700 for the masks for the conductor paths on the substrate.

Eventually, Cox feels, the semiconductor companies will want to do more of their own packaging. In this case, Cox says, du Pont will supply lead frames, equipment, and, most important, the thick film pastes. (One of the goals of the program is to get du Pont's thick film conductive pastes into the packages.)

With hand tools that have been developed for the du Pont package, the semiconductor makers could package about 100 devices an hour, but with semiautomatic machines, the rate could go up to 1,000 an hour.

Earlier this year, United States Electronic Services (USES), Clifton Heights, Pa., and Interbond Systems, Sunnyvale, Calif., announced packages in which the plastic substrate contains a cavity for the chip. Both are presented as lower-cost alternatives to the ceramic packages.

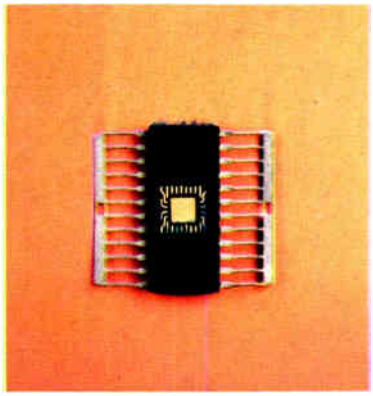
The Interbond package is made with a plated lead frame that carries the die attach pad. The lead frame and an anodized aluminum insert are placed in the mold and the plastic body is molded, with the lead frame extending into the die attach cavity. The bonding pad is coined into the insert for good strength before molding. The metal insert provides good support when an all-aluminum system is used and the wires are ultrasonically bonded.

For final lid sealing, Interbond supplies either a metal lid (aluminum is a good low-cost choice, according to Interbond president Jack Beal) that has B-stage epoxy screened on it or a B-stage epoxy screened on the lip of the die attach cavity. The lid then is dropped into the self-aligning cavity, heated and sealed. The plastic is impregnated with another material to reduce moisture penetration.

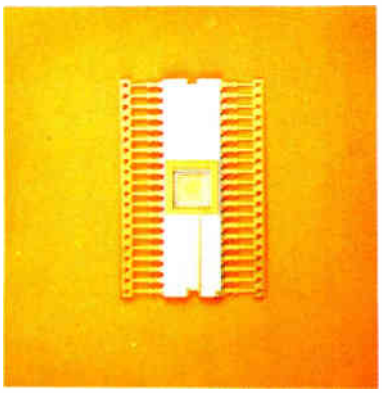
For a 40-lead package, Beal says price is currently less than 50 cents in large quantities.

The USES process starts with a lead frame, the ends of which are bent upward. The lead frame then is placed in a mold and the substrate is molded. The tips of the bent-up leads are kept aligned with the top surface of the plastic. The top surface of the plastic is sensitized and plated selectively with 50 microinches of nickel and 60 microinches of gold in a chemical deposition bath. This metalization makes a bond with the tips of the lead frame.

It's at this bond that moisture penetration stops, according to dye-bomb-tests, says Raymond Martino,

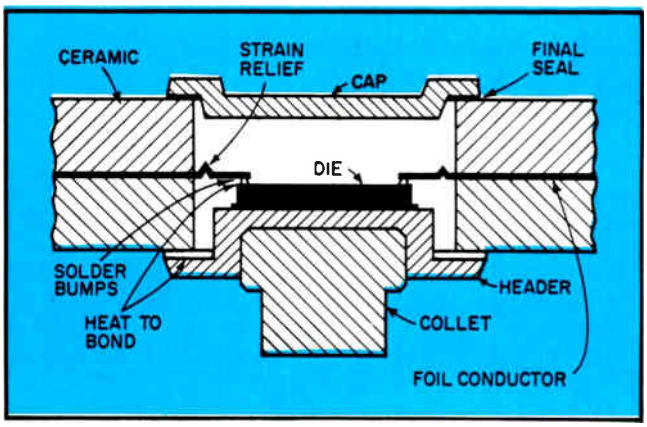


USES—The 24-lead dual in-line package with 600-mil row spacing has gold leads and a 205-mil square die attach pad in the cavity that are the result of selective deposition of gold on the top surface of the bottom layer of plastic. The lead frame is left as copper nickel without gold plating. A ridge around the cavity edge is for self-alignment of an epoxy-attached plastic lid.



Centralab—In the 40-lead dual in-line package, the use of underside lead frame attachment allows more space for larger chips. The leads, which bend on 600-mil spacing, are brazed to the underside of the top layer and make contact to the conduction pattern on the top surface of the middle layer. The chip cavity measures 250 mils square; 310-mil-square cavities also are available.

Coors—Measuring 1 by 2 inches the 40-lead edge mount package has a conductor pattern with gold-plated edges for good contact with the edge connector. The glass seal ring is also gold-plated for lid attach. The die attach pad and the conductor tips are co-planar so up-hill bonding is impossible.



Heat and cool. In the Diacon package, the chip can be attached with heat applied to the bottom insert. The collet also can be used to cool the chip during final lid sealing.

the cavity, or an epoxy pre-form could be used.

For lower costs, Martino says that new polymers could come along to allow shortening of molding time or of the chemical deposition time. Right now, completely gold-plated lead frames are used, but by the end of May, Martino expects to be able to offer tin-plated frames with gold selectively deposited in the center.

In 1-million quantities, Martino says the price of his package is 26 cents for a 40-lead unit. He now has 24-, 28-, 40- and 48-lead packages, and is gearing up for 14-, 16-, and 18-lead packages. By mid or late '72, he expects to have the new polymers that could cut costs to 10 or 12 cents for a 40-lead package by reducing molding cycle time from 3 minutes to 30 seconds and by allowing aluminum to be used rather than gold.

Comparing his package to completely molded units, Martino points out that with a chip cavity there is no ionic contamination of the leads from the encapsulating plastic, since it's not in contact with the leads. He acknowledges, however, that the encapsulating package might help a little with moisture, which conceivably could collect in a cavity.

The edge mount package, which evolved last year from a joint development effort by American Microsystems Inc., Mountain View, Calif., Coors Porcelain Co., Golden, Colo., and Texas Instruments, Attleboro, Mass., is a leadless package that plugs into an edge connector similar to one used with a pc board. It eliminates the lead frame but, since it requires a connector, the combination isn't much cheaper than a standard dual in-line unit. Typical prices are about 50 cents for the edge mount and about 50 cents for the connector. However, although the package-connector combination might not be much less costly than an equivalent dual in-line, only the edge mount package itself must be thrown out if the chip is found to be bad, so yield losses could be half those of dual in-lines.

The Coors edge mount starts with a pre-fired ceramic. A metalization pattern and glass are screened on, an alumina seal ring is metalized on, and the whole assembly fired. Metceram's package is made a little differently: metalization is screened on green ceramic tape, next alumina is screened on and the assembly fired, and finally a sealing ring is brazed on.

The edge mount offers the systems designer some

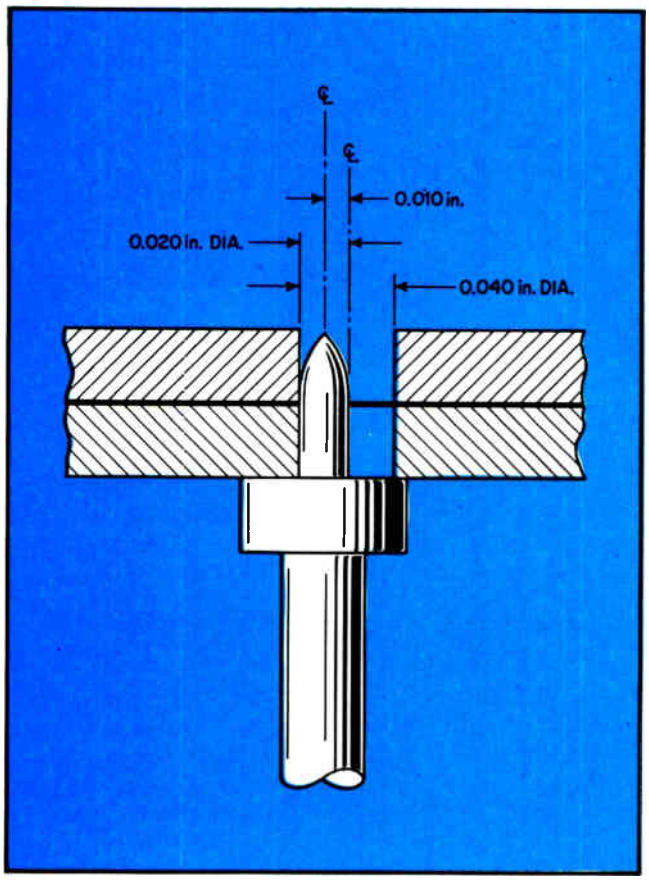
unusual options. One feature is that it uses less board space and could make cooling more efficient since it mounts vertically on the board. However, the equipment configuration must be able to take advantage of this. A right-angle connector that allows the packages to mount parallel to the board surface about a half-inch off the board, could be developed to save height if necessary.

Moreover, if the equipment isn't too complex and uses only a few packages, the pluggability feature makes servicing easy: all the maintenance technician has to do is replace packages until he finds the bad one. (Of course, this might not be practical for complex systems comprising a hundred packages or more.) "Users are still wondering about field repairability," asserts Mel Bowman, manufacturing manager for LSI for Fairchild Semiconductor. Bowman feels that the edge mount is the best practical idea to come along in a long time. "We like it," he says, while acknowledging the modest, if any price advantage.

Ray Larsen of TI says that, with volume production, price of the connector will drop to below 1 cent a contact within a year or two. It's supplied by connector makers such as Amp, Cinch, Burndy, Berg, and Litton-Winchester as well as TI. (TI, Coors and Metceram have formed a small association to promote use of the edge mount, funding a public relations operation.)

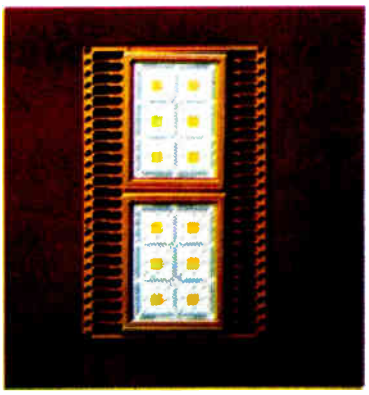
Metceram also has a new edge mount package, which the company calls the Miniconnect. It's a 40-lead edge mount that measures about 1 by ¾ inch and has double-sided metalization. Rydwansky says it could be priced below 40 cents in 1-million quantities.

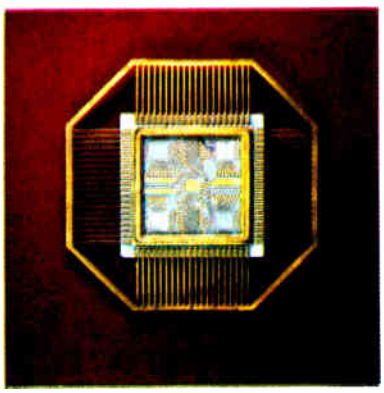
Joining the edge mount in the leadless package



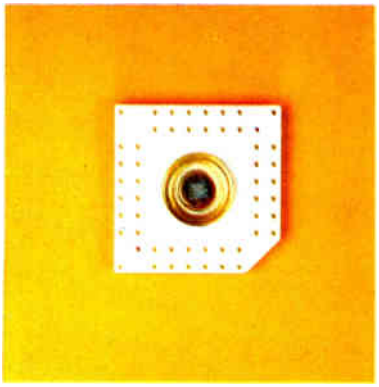
Loose tolerance. In the Diacon package, the pins may be as much as 10 mils off center and still puncture the diaphragm. This overcomes lead alignment problems of dual in-line packages.

Du Pont—The new multilayer, multichip package (which will, along with others, be covered in Part II in the next issue) is a standard item holding twelve chips. Internal layers carry ground, power, x-direction and y-direction conductive patterns or "vias." Each conductor is brought to the surface with z-direction vias. The user would wirebond his chips to the tops of the vias, and also interconnect them with wire-bonds.





Metceram—For use with beam-lead chips, the five-layer package holds four chips, each with 40 leads. It has three metalized layers, 80 buried interconnects, and 80 leads brazed along the edge. The square seal ring is Kovar for welding or brazing.



Diacon—Visible through the holes in the ceramic of this 51-lead contact leadless package is the gold-plated Kovar diaphragm, which will be punctured by pins staked into a pc board. The chip, which may measure up to 250 mils square, rests on a Kovar header sealed to the bottom layer of ceramic. The top seal ring has a self-aligning lip for the lid. The whole package measures about 1 3/16 inches square.

field is the new punctured-diaphragm unit, developed by Diacon, San Diego, Calif. The Diacon is the first female-type IC package, plugging into pins staked into a printed circuit board. The package is composed of two ceramic alumina slabs sandwiching a Kovar foil lead frame that connects to the chip in the center bonding area. Holes in the slabs allow the pc board pins to puncture the diaphragm for contact.

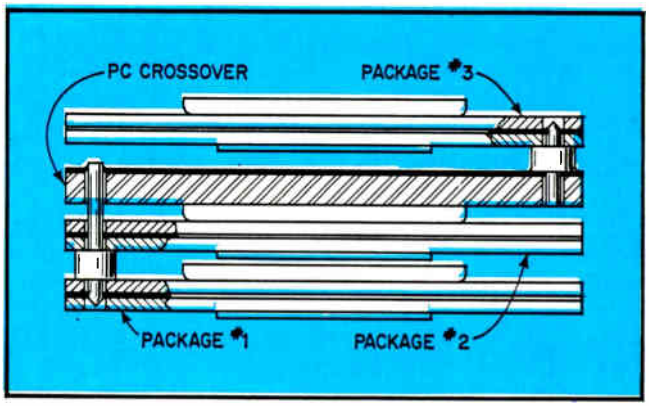
Bryant C. "Buck" Rogers, Diacon president (Rogers was a leader in the development of the dual in-line package at Fairchild Semiconductor), claims the following advances for his new package: as a leadless package, it eliminates the costly lead frame and the problems of lead alignment and handling; the hermetic cavity is made so as to reduce the die attach and bonding costs and permits final sealing of the cavity without high temperatures; and the package allows more heat dissipation from the chip.

The package assembly begins with green-state ceramic tape in which are punched the contact holes, although Rogers says that substrates could also be made in a dry press that has pins in it to form the holes in the substrates. These holes are 0.040 in. in diameter, and each substrate also has a large hole in its center for the chip. The lead frame is stamped from 1-mil-thick Kovar, and a Kovar disk header is formed separately. The parts then are assembled with a glass preform (Owens Illinois Type CV-97, which is in common use with the Cerdip package) and put in the furnace to fire the glass. Gold plating then is applied to the Kovar header for die attach and to the parts of the Kovar lead frame exposed in the holes.

The semiconductor chip is bonded to the header, which has a recess for insertion of a heated collet. After wire bonding, the chip is sealed with solder to the seal ring previously brazed to the ceramic.

Although the systems user must puncture the diaphragm in use, Rogers says that it's not necessary to puncture it for testing. He points out that spring loaded pins (like the "pogo" type made by Pylon Co. Inc., Attleboro, Mass.) can be used.

Pins then are staked into the board. Rogers says that Diacon designed its own pins to begin with, but at least one company, Berg Electronics, New Cumberland, Pa., has equipment that could be easily modified to perform the staking operation. Berg makes a pantograph-operated machine capable of 2,500 insertions an hour. A numerically controlled version could handle up to 10,000 insertions an hour, says Berg's engineering manager, Fred Wigfield.



Stack 'em. The Diacon package lends itself to stacking because of its flat shape and its pin insertion concept. Here, three packages are stacked on a single pc board.

The pantograph machine would be installed in the user's plant for a charge of about $1,000, and Berg would then sell the specially designed pins—probably at between $5 and $10 a thousand for gold-plated pins and below $5 a thousand for tin-plated pins.

When the package is placed over the pins, they rupture the diaphragm and make a low-resistance contact to the rolled-up edge of the diaphragm, forming a collet during the puncturing action. The advantage is that with a 40-mil hole and a 20-mil pin, there's a loose tolerance on the pin positioning since each pin makes its own contact. The package can be inserted and retracted on the same set of pins up to 10 times without losing the contact, according to Rogers. When the package is inserted on a different set of pins, contact resistance below 1 milliohm is achieved even when they make contact on only one side of the diaphragm in the second larger hole.

For final systems use, the pins would be soldered to the diaphragm, by using a hot nitrogen jet to reflow the plating on the pins and the diaphragm. □

Additional reporting on this article came from James Brinton, Boston, Lawrence Curran, Los Angeles, Stephen Wm. Fields, San Francisco, Paul Franson, Dallas, Marilyn Howey, San Francisco, and Judy Phelps, Los Angeles.

The second part of this two-part special report will appear in the next issue. Reprints of the entire report will be available for $3 a copy. Prices for quantity order on request. Address all orders to Electronics Reprint Department, P.O. Box 669, Hightstown, N.J. 08520.

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Circle 87 on reader service card

Designer's casebook

Ac transfers dc between two isolated instruments

by Stig R. Hjorth
SATT Elektronik AB, Stockholm, Sweden

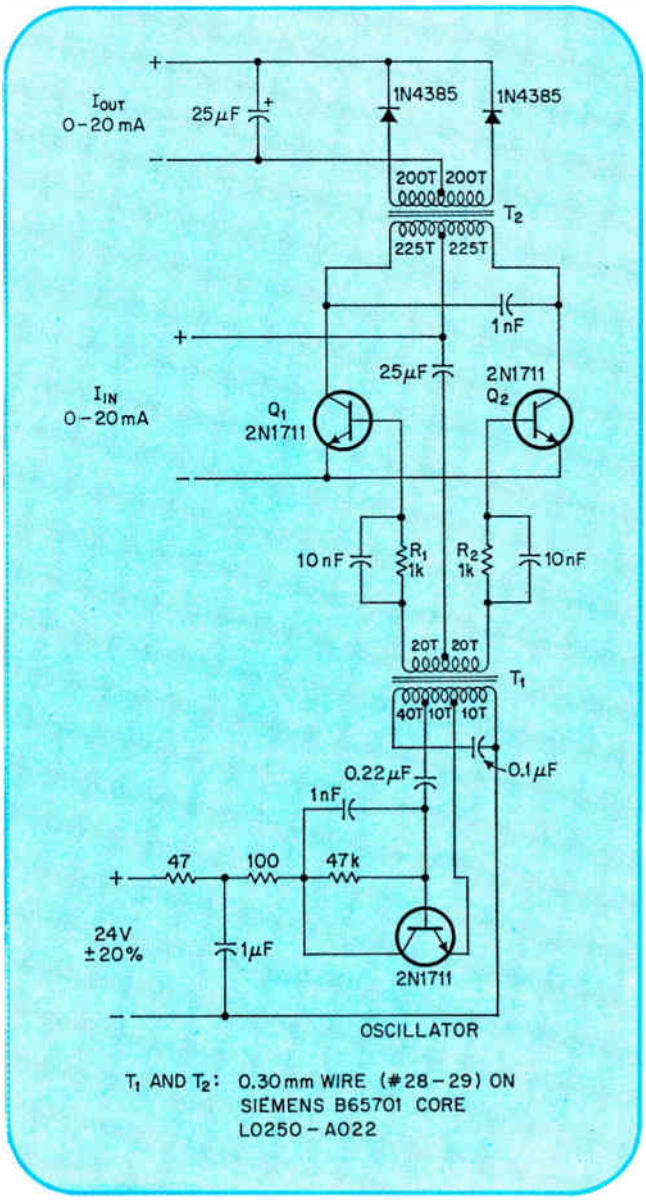
Transferring direct current from one circuit to another without a direct coupling is relatively simple. Much less simple is transferring dc to instrument outputs without degrading signal accuracy.

One solution is to use a chopper operated by an oscillator but isolated by transformers from both the load and the oscillator. Because the chopper itself is isolated, it can transfer both positive and negative currents, depending on the polarities selected for the input and output terminals.

A class-C Hartley oscillator generates the alternating voltage for the chopper section. The peak-to-peak voltage across the secondary of transformer T_1 is about 10 volts. The resulting base currents through R_1 and R_2 alternatively saturate Q_1 and Q_2 at a frequency of about 18 to 20 kilohertz.

This couples the dc input I_{in} to the output through both windings of transformer T_2. The input current determines the amplitude of the voltage transferred to the secondary winding; the current source sees the secondary's impedance through the chopper. Thus, the output current depends directly on the input current.

After rectification, the secondary current flows through the load. The load may be an instrument or another signal source such as an analog-to-digital converter.



Non-direct coupling. Transformers isolate the chopper, allowing it to transfer dc signals from source to load without any direct coupling.

Twin-lead tunes foreshortened balanced loop antenna

by James E. Taylor
Xerox Corp., Rochester, N. Y.

A compact low-frequency antenna using a balanced dipole loop configuration can provide efficient performance even when mounted close to ground. Capacitive tuning eliminates the lossy coil-loaded arrangement and provides a superior performing 4-MHz antenna[1] with a maximum dimension of less than 25 feet instead of the usual 120 feet needed for the linear dipole. Moreover, the loop concept has also proved viable for mobile operation.[2]

The antenna's performance compares favorably with that of a well-match resonant dipole place well above ground. Comparative tests using single sideband voice transmission with an input power of 200

watts peak envelope power indicated that the received power levels from the high dipole antenna were only 5 to 10 decibels higher than those of the simple dipole loop. For low-power transmission (10 W peak envelope power) good voice intelligibility was reported at distances up to 250 miles.

When mounted in a wood frame building, the antenna, had an input resistance of 59 ohms, exhibited a unity standing wave ratio at a resonance frequency of 3.942 MHz and a SWR of 1.5:1 ± 50 kilohertz off resonance.

The loop antenna is formed by bringing the ends of a dipole close together to form a circular, square, or a rectangular loop. As the loop is made smaller, its capacitance increases and radiation resistance decreases. To provide resonance, a tuning capacitance is placed in series with the ends of the bent dipole.

The RG 8/U cable and common 300-ohm twin-lead are used. The RG 8/U isn't used because it's coaxial cable, but simply to provide a large-diameter conductor; the twin-lead is easily trimmed and eliminates the need for a high voltage variable capacitor at that point. Opposite wires at each end of the twin-lead are attached to the open end of the loop; the unconnected ends of the twin-lead then are symmetrically trimmed until resonance is reached.

The impedance match at the feedpoint can be improved by adding a 1,500-picofarad 500-volt capacitor across the feedline. This arrangement is adequate to handle power levels up to about 500W. The entire loop structure should be mounted vertically—horizontal polarization will produce an overhead null in the radiation pattern.

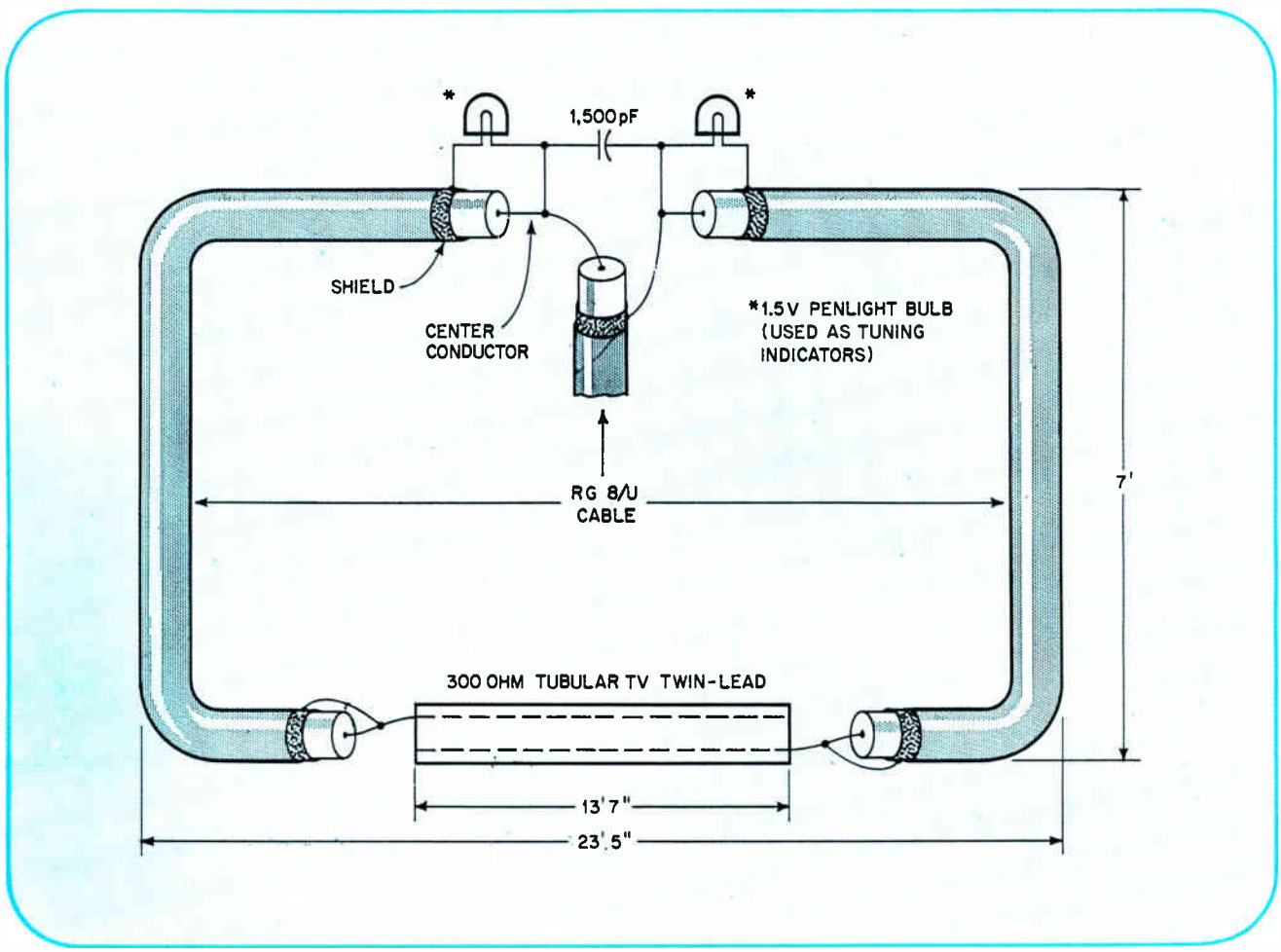
Most efficient operation is obtained when radiation resistance is greatest. For the dipole loop, the radiation resistance is

$$R_r = 3.1 \times 10^4 \ (A^2/\lambda^4) \text{ ohms}$$

where A is the effective area of the loop in square feet, and λ is the wavelength of the transmitted radiation in feet. Constructing the antenna with a circumference equal to about $\lambda/4$ at 4 MHz and A = 165 square feet yields $R_r = 0.27$ ohm. Assuming an rf resistance of 3 ohms for the RG 8/U cable, antenna efficiency is 8 %, or about 10 dB down. This is consistent with observed signal strengths.

1. K.H. Patterson, "Down to Earth Army Antenna," Electronics, Aug. 21, 1967.
2. J.E. Taylor, "The Mobiloop," QST, November, 1968.

Low-cost loop. Balanced loop antenna is tuned to resonance by symmetrically trimming open ends of 300-ohm tv twin-lead. RG 8/U cable is used as large-diameter conductor. Capacitor at freepoint improves input impedance match; flashlight bulbs, which indicate current balance, are brightest when the antenna is at resonance.



FET multiplies pulse time of IC one-shot

by Phil M. Salomon,
Pasadena City College, Pasadena, Calif.

Field-effect transistors with low threshold voltages can really stretch the output pulses of IC one-shots. Low threshold lets a FET operate within the logic voltage range, while the FET multiplies the effective RC time constant. Pulses up to several minutes long—orders of magnitude longer than before—can be obtained easily and repeatedly.

Transistor Q_1 in the circuit below is a p-channel enhancement-mode MOSFET with a threshold voltage (V_{th}) of 2.5 volts—the gate must be at least 2.5 V more negative than the source for conduction.

In the one-shot's quiescent state, the FET channel is pinched off. The output of resistor-transistor logic NOR gate A is at the positive logic level because the trigger input is low and the output of gate B is at ground. With timing capacitor C_1 charged, the gate of Q_1 is at ground potential while the source (and substrate) is at about +1 V due to the input current of gate B. This puts the gate-to-source bias at only about −1 V.

One-shot action begins when the trigger input goes high. Gate A's output switches low, causing the gate of Q_1 to be pulled negative and allowing the FET to conduct. The active input of logic gate B is clamped negative by an amount equal to the forward diode drop of D_1. Now the output of gate B goes high, holding gate A's output low after the trigger pulse ends.

This state is maintained until C_1 discharges through resistor R_1, reducing Q_1's gate-to-source bias to below V_{th} and returning the circuit to the quiescent state.

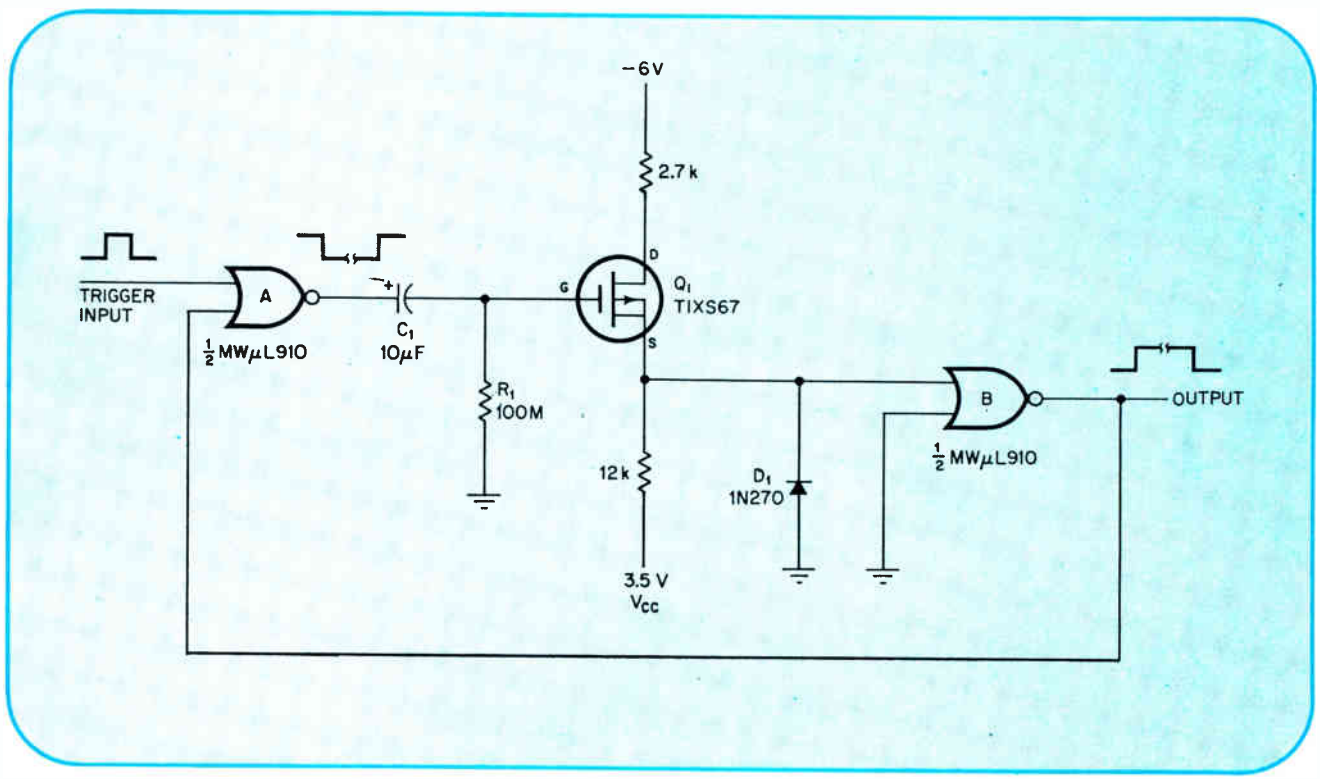
Thanks to the FET, the circuit can operate out on the long, flatter part of the time-constant curve where the capacitor discharges very slowly. Conventional IC one-shots must limit the size of R_1 since turn-on base current is supplied through that resistor. Thus, the FET provides very long pulse times because it allows an extremely large value of R_1 to be selected. The pulse duration is:

$$T_p = R_1 C_1 \ln\left[\frac{V_{CC}}{V_{th} + V_{D1}}\right]$$

where V_{D1} is the forward voltage drop across D_1. With D_1 a germanium device having V_{D1} of only about 0.2 V and the RC values shown, $T_p = 260$ seconds. In contrast, a conventional IC one-shot would limit R_1 to about 50 kilohms and would have an output pulse duration of only about 0.4s with the value of C_1 shown.

Designer's casebook is a regular feature in Electronics. Readers are invited to submit novel circuit ideas and solutions to design problems. Descriptions should be brief. We'll pay $50 for each item published.

Pulse stretcher. Trigger input pulse, which is inverted by the RTL gate A drives transistor Q_1 into conduction, thus allowing gate B to switch. The output of gate B keeps gate A's output low until capacitor C_1 discharges enough through resistor R_1 to switch off Q_1.



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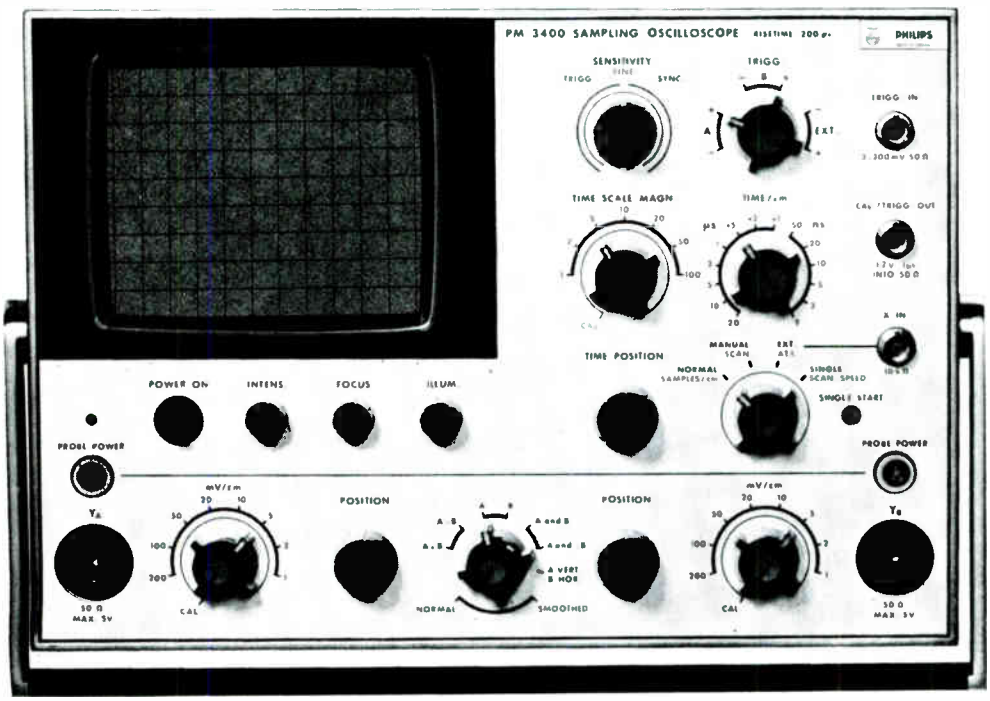

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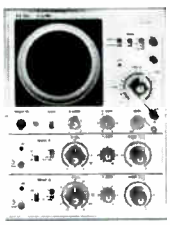

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Laser tests ICs with light touch

Scanned by a laser beam, an IC—faults and all—shows up on the video display; the contactless system could replace testers that use clumsy mechanical probes

by Robert E. McMahon, *Massachusetts Institute of Technology, Lincoln Laboratory, Lexington, Mass.*

☐ Testing integrated circuits is often more of a problem than making them. Mechanical probing and input-output testing are relatively crude and costly procedures that provide at best an incomplete evaluation of IC performance.

The pressure of mechanical probes on chip pads can, if too heavy, cause damage or, if too light, result in poor electrical contact and unwarranted rejections. Besides, circuit geometries are getting smaller, making it increasingly difficult to position the probes quickly and accurately. Electrical tests are usually performed by exercising the IC states through input connections and observing output signals. But as the IC becomes more complex, this procedure becomes uncomfortably like checking out a computer via input and output terminals only, and not being able to examine its internal circuitry.

What is needed is a method that allows electrical testing of internal IC elements with minimal probing and relatively high speed—and a laser scanning system like the one that's at the prototype stage at Lincoln Laboratory could satisfy these requirements.[1] It does away with mechanical probes, gives an instantaneous display of an IC's surface, revealing flaws and anomalies, and also measures the gain of transistors in an IC.

For the immediate future, this approach holds promise for production line monitoring of ICs. In the longer view, there's the possibility of connecting a laser system to a computer to form part of a completely automated IC fabrication setup.

The system, shown in Fig. 1, employs a commercial helium-neon laser with a 4-milliwatt power level. The two-axis scanning system consists of a small mirror supported on a tungsten wire at right angles to an arm projecting from a small motor. An electromagnetic arrangement rocks the mirror about the axis of the wire, the X axis. The motor, or mirror drive, rotates the mirror-and-wire assembly about the Y axis. The X-axis scan operates at 600 hertz; the Y-axis scan rate, or frame rate, is variable from 1 to 10 Hz. A standard microscope focuses the beam to a 1- to 2-micron spot on the chip.

As this spot travels over the chip, it penetrates the semiconductor material and changes its conductivity. The change is reflected in variations of the current passed from a power supply through the chip by two mechanical probes, one of which is attached to the power-line connection of the chip, the other to its ground pad. The current, when displayed on a TV monitor synchronized to the laser scan, generates a picture of the chip.

Figure 2 on page 94 illustrates the technique. At the left is an optical view of a transistor with a break in its metalization. On the right is a picture formed by scanning the device with the laser and displaying the resultant current variation on a monitor. The laser picture affords a cleaner view of the metalization break and suggests the usefulness of the technique for detailed device inspection.

The beam should penetrate the material to a depth of no greater than 2 microns. Otherwise the current changes produced at the bottom of isolation regions begin to mask the changes produced at more interesting locations, like junctions, which are closer to the surface. For the helium-neon laser of Fig. 1, its 6,328-angstrom light flux is essentially absorbed within 1 to 2 μm of the surface of typical silicon semiconductor material.

How deeply the beam penetrates depends on the circuit material and on the wavelength of the laser beam. Metalization reflects the beam. Semiconductor material lets most of the light through when the material's band gap is greater than the energy of the beam ($h\nu$, where h is Planck's constant and ν is beam frequency). The material absorbs much more at higher frequencies, where the band gap is less than $h\nu$. Doping levels apparently have little effect on absorption, particularly at the high doping levels (around 10^{20} atoms per cubic centimeter) characteristic of most integrated circuits.

The laser-induced variation in the power supply current, which is the basis of the test system, is caused by a combination of simple photocurrents, photovoltaic effects, and photocurrents induced at junctions. The first occur almost anywhere the laser beam strikes. The second refer to the voltage that the light produces across high-value resistors such as the base region of an OFF transistor.

As for the third, junctions in an IC generate and collect photocurrents efficiently. Near reverse-biased junctions, the depletion region contains high-intensity electric fields. They prevent most of the laser-generated pairs of carriers, which separate very rapidly

at these junctions, from recombining. These carriers therefore contribute to the photocurrent seen on the power-ground line. Forward-biased junctions, particularly those with one heavily doped region, have a high injection efficiency for carriers of one sign which, when they cross the junction, will induce additional carriers of the opposite sign.

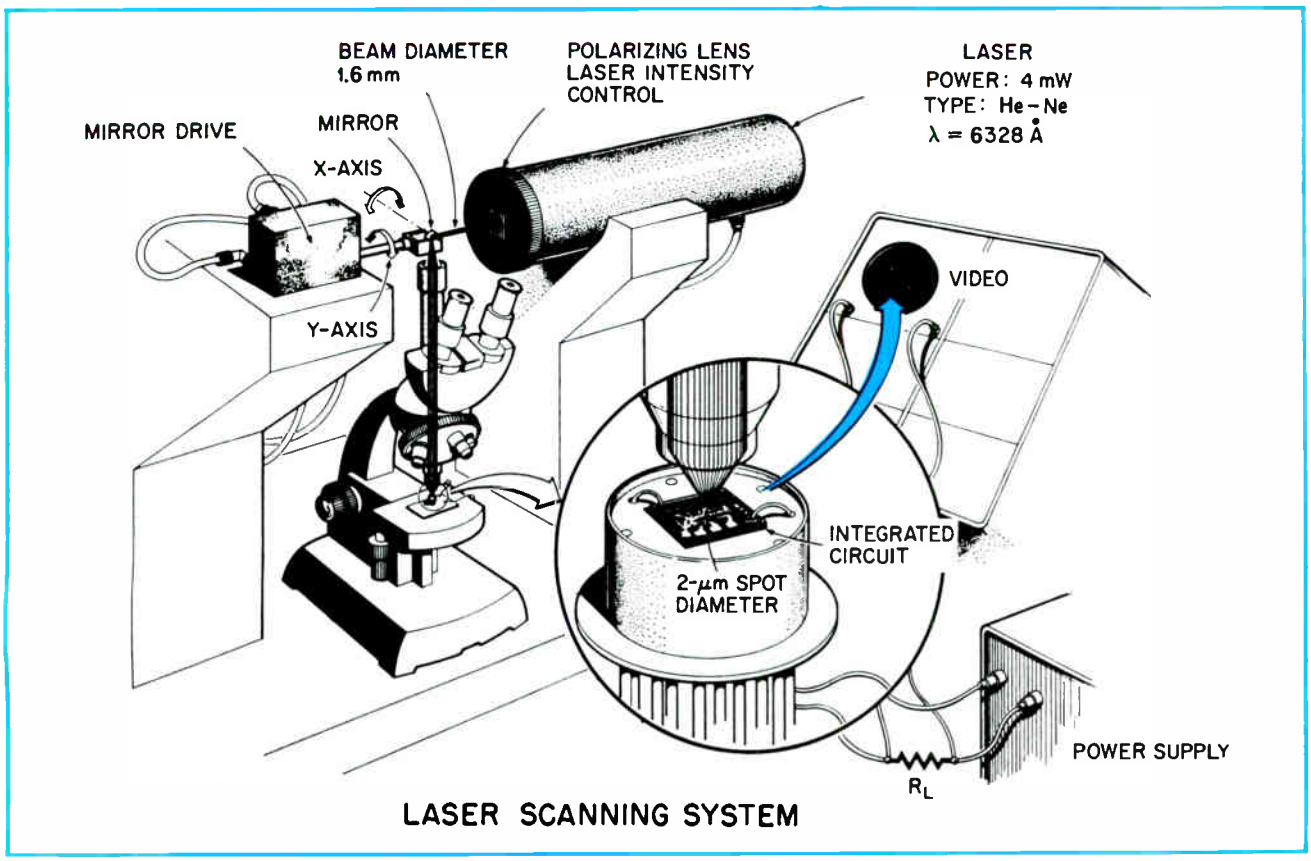
Besides generating clear and detailed pictures, the laser scanner can also produce pictures in which some circuit features are enhanced and not others. Two rather convenient ways of doing this are by varying the intensity of the laser beam and by adjusting the supply voltage.

Enhancement is particularly useful for structural identification and for the separation of output data for computer processing. For example, the scanner could conceivably be programed to make a number of passes over an IC, the first time generating data on transistors, the second time on resistors, and so on.

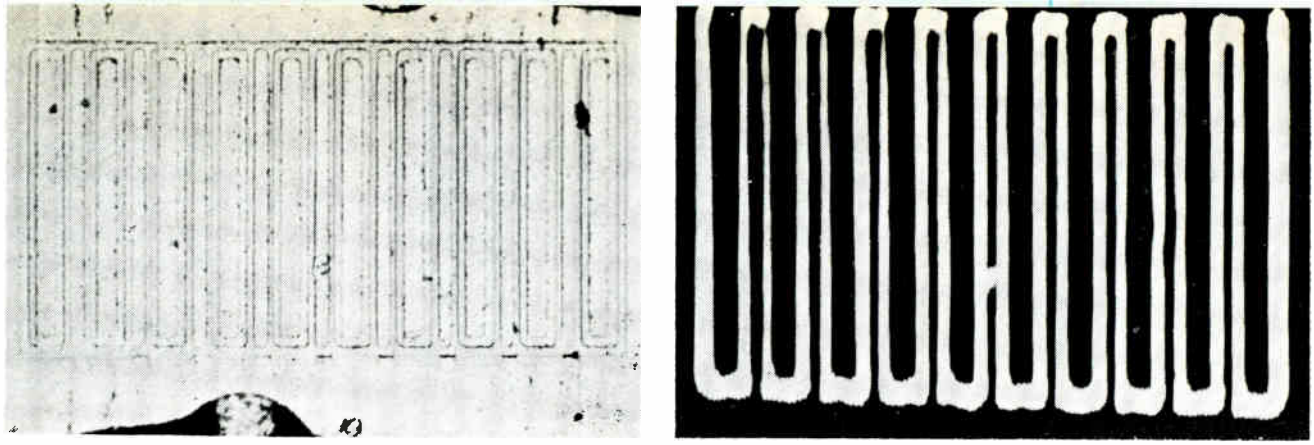
Figure 3 shows an example of this enhancement capability. On the left is an optical picture of an RTL dual three-input gate IC. Next to it is the laser-induced picture. In the display, the resistors have been enhanced, and the transistors and isolation junctions diminished. The long white rectangular regions in the upper and lower sections are base and collector resistors. The circuit metalization shows up as gray features that cross some resistor areas. The six transistors are seen in the center as white squares, which represent the base collector junctions.

Since each of these transistors amplifies a laser-induced current, the scanner can measure their gains. If the signal resulting from a single scan across the six transistors in the circuit in Fig. 3 is observed as a function of time, the output appears as shown in Fig. 4. The gain of each transistor can be determined by calibrating the laser input and measuring the height of the peak corresponding to that transistor. Results obtained in this way correlate to within 3% of gains measured by applying voltages and measuring responses through mechanical probes.

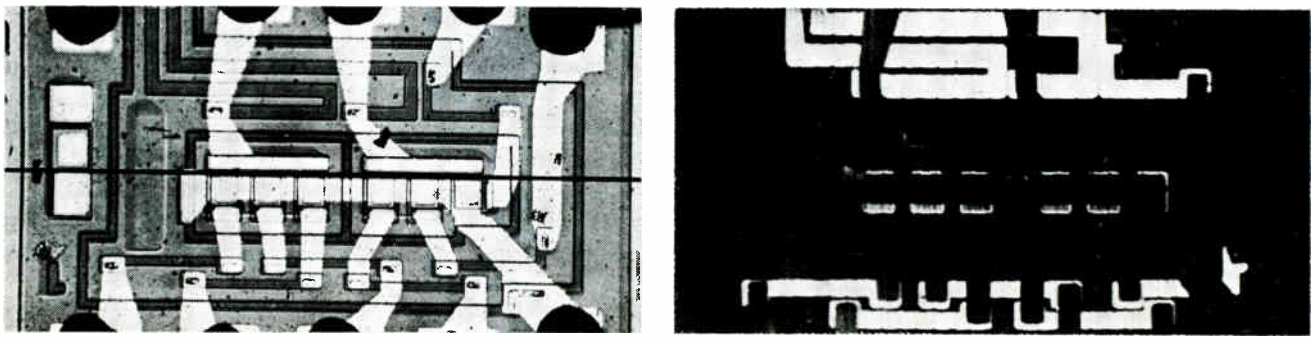
Under the right conditions, the scanning laser can force a transistor into the ON or saturated state. This suggests the possibility of testing various logic conditions in a localized area. Figure 5 gives the laser-scan picture of a transistor-transistor-logic IC. The bright areas are transistor pairs while the rectangles are isolation junctions. The circuit metalization



1. Spotlight on ICs. Diagram shows how laser system generates IC display. Beam reflects off mirror and through microscope which focuses it onto IC . Mirror is rocked about X and Y axes, moving beam across circuit in raster pattern. As laser beam scans the chip, it modulates current flowing through circuit from power supply. Signal goes to monitor where horizontal and vertical deflection sweeps are synchronized with mirror motion. Result is TV-like picture of circuit. One application for system is finding fabrication flaws. Another is probing surface of an IC. System above, for example, can measure gain of individual IC transistors. In recently developed setup, high-speed mirrored rotor replaces drive-and-mirror assembly. Result is faster scan, and the possibility of measuring transient characteristics.



2. Unconcealed defect. Comparison of microphotograph and laser-scan picture shows how latter clearly reveals fabrication flaws like metalization break in transistor. Semiconductor material is white, metal black.



3. Highlighting. Adjusting laser intensity or supply-voltage level makes some parts of a circuit stand out. In laser-scan picture of three-gate IC (right), base and collector resistors appear as white areas, metalization as gray. IC's transistors are the six white squares at center.

can be seen to shadow some of these regions but has been diminished as have the resistor regions. The ON transistors are displayed as white. Some, with high-impedance base connections, have been turned on by the laser, while others are on because of the particular supply voltage chosen and the related circuit balance.

For many digital ICs, all or nearly all transistors can be forced into the ON state either by the laser light acting as a pseudo-base current or by an appropriate setting of the supply voltage. In a digital circuit where transistors cannot be turned on by either method, they can still be logically set by the use of additional probes, over and above the two used to contact the power-ground terminals.

Another form of scanner presentation is possible in which the varying supply current is mixed with the display monitor's vertical drive to provide the three-dimensional effect shown in Fig. 6. Here two photodiodes from a strip of 64 are scanned, and the results displayed on the monitor. Surface defects are readily apparent and the fall-off of response between diodes is clear. Bonding wires, which overhang the active cell regions, account for the shadowing effect visible in the foreground.

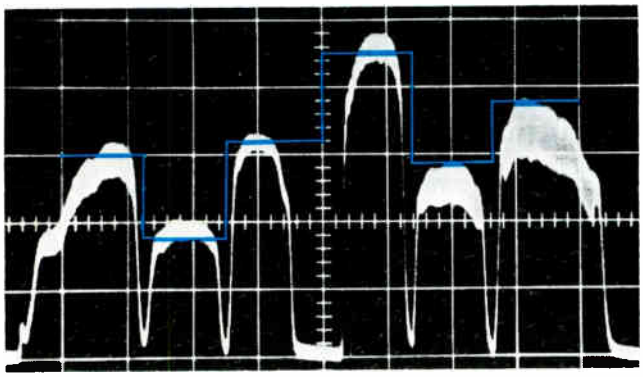
The present laser-scan system has been successful in locating faults in complex integrated circuits. Faulty transistors show up conveniently as an absence of the bright areas typical of active devices. Isolation regions are easily inspected, and the scanner has detected in them the kind of defects that can increase IC power dissipation but can't be easily located by conventional electrical testing. In addition, the system can uncover various faults in metalization, resistors and diodes.

The sensitivity of the system is not yet fully explored, but recent measurements of material life time made with it suggests it may be capable of measuring impurity concentrations, and hence resistor values.

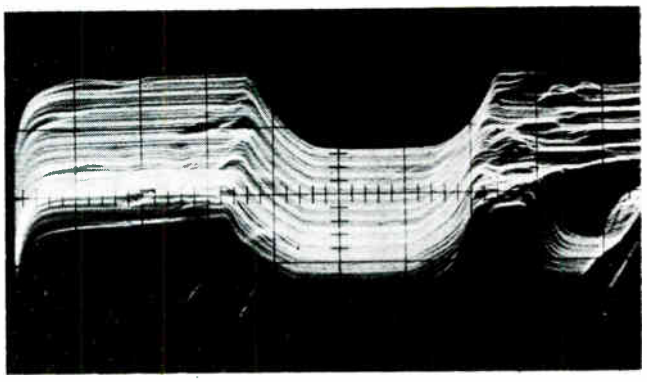
The laser scanner has several obvious advantages as a diagnostic tool for in-process as well as for final testing. But what are its prospects for either supplementing or perhaps in the long run replacing conventional electrical test equipment?

Although the laser scanner has been used successfully to detect faults and marginal device performance, in the near future it will probably be more effective if it complements conventional electrical testing. By being employed in the early stages of fabrication to avoid processing costs of undetected defective units, or to locate faulty cells in discretionary wiring applications, the technique could reduce testing time and costs.

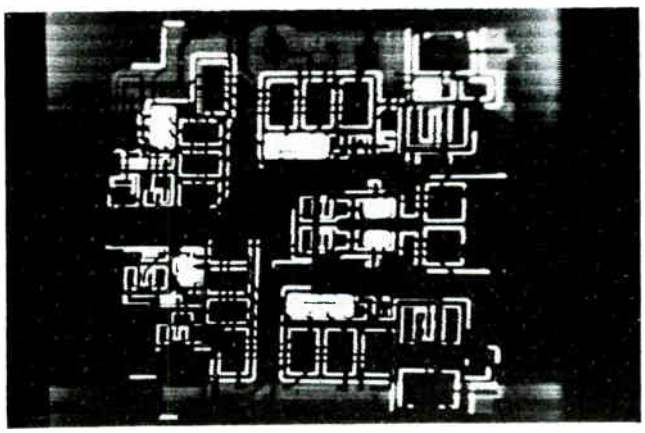
A limitation of the present system is that it can't turn on every transistor on every chip. Only in the case of transistors with high-impedance base circuitry can the laser develop sufficient voltage to do so. Moreover, varying supply voltage, which turns on most transistors, is inconvenient. Because of this inability to turn on IC transistors selectively, it's unlikely that the scanner will soon be able to totally replace conventional testers.



4. Finding gain. Laser system can measure characteristics of an IC's internal elements, such as the gain of each of the six transistors in IC of Fig. 3. Trace above is generated when laser makes single scan of transistors. Individual transistor gains are found by measuring heights of six peaks, which result from transistors amplifying photocurrents induced by beam.



6. Photodiodes in 3D. When laser-modulated current from device being scanned is mixed with vertical deflection signal of monitor, the result is a three-dimensional representation of device. Trace above shows pair of supposedly identical photocells. Laser scanning proves, however, that diode on right is much less flat than one on left.



5. Transistor turn on. Besides imaging ICs, laser system can turn on indivicual transistors. Base currents needed for this switchng come from power-supply current or photocurrents induced by laser. In laser-scan picture above, bright white rectangles are transistors in ON state.

A promising direction in which to develop the present system appears to be to add lasers that would activate various portions of a circuit simultaneously and would have variable wave lengths for controlling penetration. According to a preliminary study of a multi-laser extension to the present system, thermal problems may not be serious if the beam powers are kept low and overall test time is short. The ability of such a multi-laser system to inject currents anywhere in an IC without probes or contact pads should considerably reduce testing time for many complex LSI circuits. The extra lasers would not have to be focused as sharply as the scanning laser—beams as wide as 1 mil would be satisfactory.

An improvement that has already been made is increasing the scanning speed. In a recently built system the single mirror-and-drive assembly has been replaced with a 10-sided, mirrored rotor. The advanced system has a frame rate that's variable up to 20 frames per second, with approximately 500 lines per frame. With such a speed and resolution, an evaluation of device transient characteristics may prove possible. For example, the laser could turn on the transistors in Fig. 3, and the display could indicate their switching times. In the slower system, the rise time is just a function of scanning speed.

Interpretation of the results of laser scanning could be simplified by employing a computer-aided circuit analysis program called CIRCUS [*Electronics*, Feb. 2, 1970, p. 86]. Developed by Boeing Corp. to predict radiation effects, it seems well matched to the effects of a laser input—specifically it can predict reasonably well the polarity of the change in dc offset and the amplitude of the ac current that are developed by components scanned by a laser. (Positive offset change produces a white image, a negative change a black image on the monitor, or vice versa depending on the polarity of the supply current.) But not enough work has yet been done on different types of integrated circuits to assess with what degree of accuracy the CIRCUS predictions can be related to the real data derived by the laser scan.

Nonetheless, this combination of the laser system with a computer points to the growing likelihood of automated, closed-loop IC fabrication. The laser scanner could offer in-process testing similar to that offered by electron-beam devices but at a much lower cost and with a field of view and speed consistent with production requirements. □

Acknowledgement

This article is based on work sponsored by the Department of the Air Force, Daniel Smythe, now of Nova Devices, Inc., Wilmington, Mass., developed and designed many of the features of the laser scanner while employed at Lincoln Laboratory as a visiting scientist. William McGonagle of Lincoln Laboratory designed and built the high-speed system.

Reference

1. C.N. Potter and D.E. Sawyer, Review of Scientific Instruments, Vol. 39, No. 2, p. 180, Feb. 1968.

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Inside electronic watches: a micropower movement

Now that power consumption has been reduced to acceptable levels, a variety of bipolar and MOS counter/divider/driver circuits offers greater accuracy and reliability than do mechanical approaches

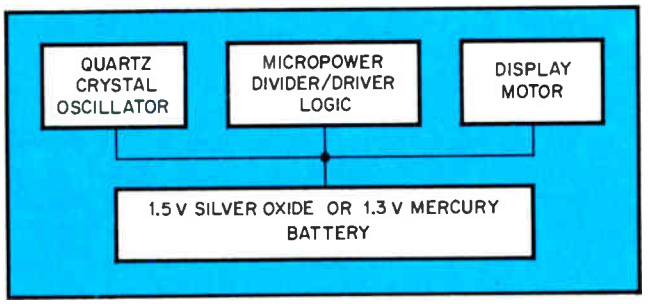
by Gerald M. Walker, *Consumer editor*

Although the quartz-crystal watch seems to be the lever that is finally opening wide the watchmakers' doors to electronics, there were many knotty problems to be solved before a watch company would give an IC the time of day. The biggest obstacle was power consumption: the limited power available from tiny batteries had to be balanced against a reasonable battery lifetime. Circuit stability over a long time span and prices suitable to a mass-produced consumer product were equally important.

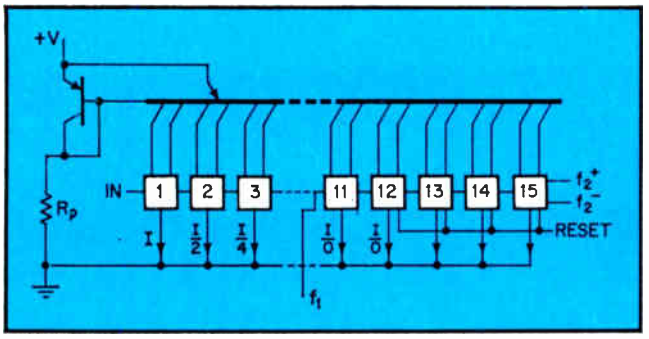
Both bipolar and MOS ICs have been designed to meet at least the first two of these demands in the initial high-priced watches to reach the market. As sales build up and watch ICs are produced in large quantities, the price requirement should also be met. Many watch manufacturers are now turning their attention to replacing the hands and pulse motor with light-emitting diodes and liquid crystal displays. Watches with those novel readouts should further broaden the electronic watch market and, in the long run, widen the penetration of semiconductor firms [*Electronics*, Dec. 21, 1970, p. 83].

A typical movement, depicted in Fig. 1, is composed of four basic parts: the quartz-crystal oscillator, the IC binary divider and motor drive circuit, 1.5-volt or 1.3-volt power cells depending on whether it's for the American or European market, and an electromechanical indicator drive mechanism or electronic readout assemby.

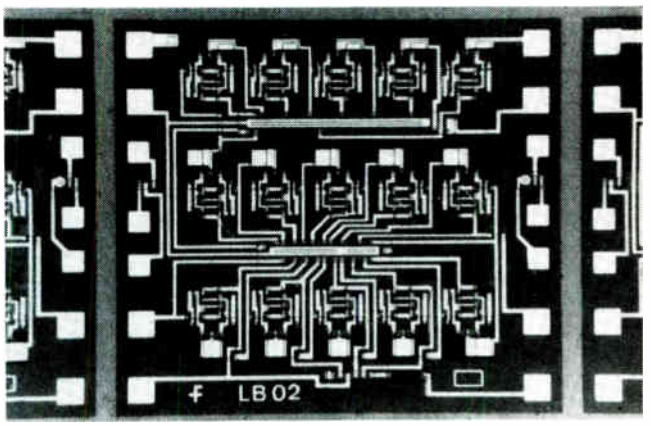
To interest watch manufacturers, the electronic approach must offer improvements over existing timepieces. And the two points where electronics can provide this difference are in accuracy and reliability. (Not to be discounted, of course, is the element of prestige that the word "electronics" brings to the job of catching the consumer's fancy.) By using a quartz watch as the basic timing element, the elec-



1. Making time. A typical quartz-crystal watch has these four main parts in addition to a display. The micropower circuit may be a bipolar IC or a C/MOS or P/MOS device.



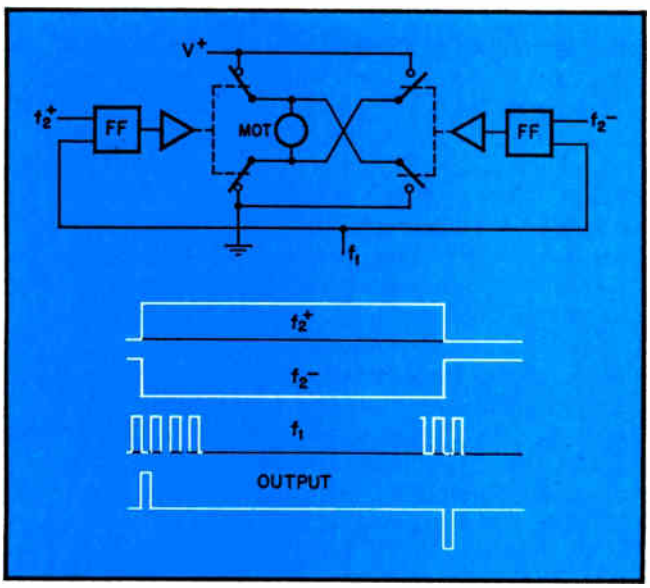
2. On stage. Faselec's bipolar watch circuit is a 15-stage frequency divider. The output is 0.5 hertz with an input frequency of 16.384 kilohertz at an operating current of 5.5 microamperes.



3. Watch it. The long structures in the center of this Faselec divider circuit are the pnp current sources. Besides the true and inverted output after 15 stages, the LB-02 pictured here provides an output after the 10th stage, which can be used to reset the flip-flops.

tronic watch offers a considerable gain in accuracy over the mechanical movements. (A 16.384-kilohertz frequency has been used successfully to date, but crystals oscillating at up to 131.072 kHz can be used.) Because electronic circuits reduce the number of mechanical parts, reliability is improved.

Yet there are still about as many ways to design circuits for quartz-crystal watches as there are IC vendors—and more than a little controversy over which is the best way to go. What's more, despite their potential edge in accuracy and reliability, electronic watches still face competition from well-established mechanical and electromechanical types.



4. Driver's seat. The Faselec driver circuit, top, produces the waveform for a stepping motor, below, requiring polarized pulses. Signals from the flip-flops are amplified and drive two sets of cross-coupled switches.

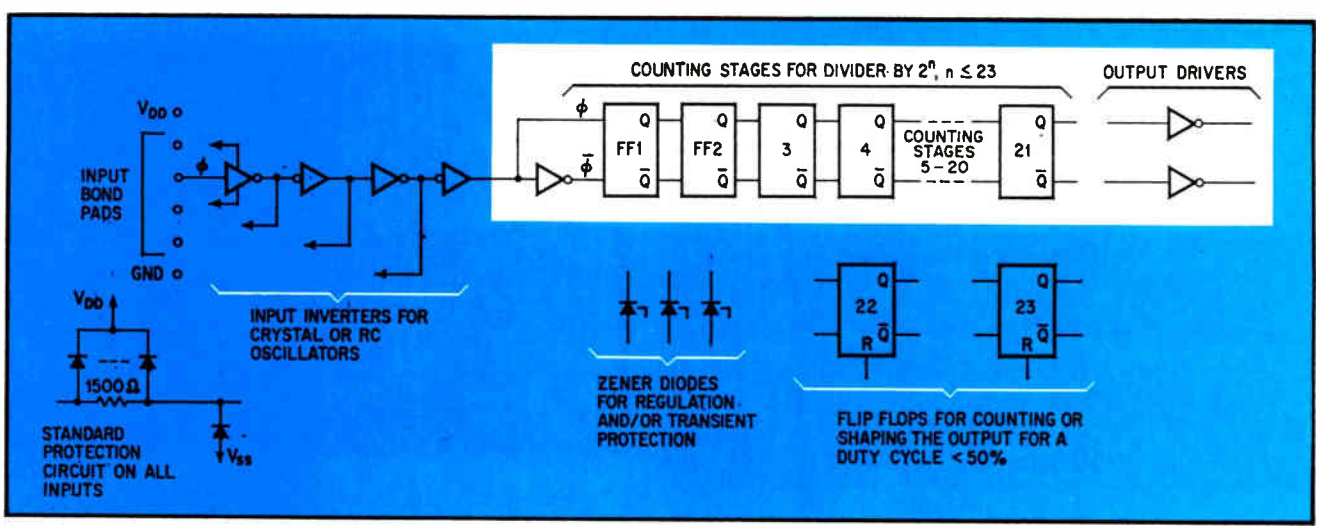
A number of companies are betting that their ICs are the ones that will win the competition, boosting quartz-crystal watches to a hefty market share despite their relative newness. Weighing in with MOS micropower devices are such makers as RCA's Solid State division, Somerville, N.J.; Motorola's Semiconductor Products division, Phoenix, Ariz.; Intersil Corp., Cupertino, Calif.; Texas Instruments, Dallas; and Mostek Corp., Carrollton, Texas. Companies that offer bipolar ICs include TI, Intersil, and Faselec, Zurich, Switzerland.

The Faselec design stands out because it takes an unusual, power-stingy, approach to voltage control. Instead of controlling voltage with resistors, a major power-consuming part of a conventional bipolar IC, Faselec does the same job with the main flip-flop transistors together with lateral pnp transistors as active loads. The lateral pnp is in cutoff as long as the npn is not in saturation. As soon as the npn enters saturation, carriers can be supplied out of the pnp collector, or, if left open, the pnp also saturates and has the potential of the npn base, except for an offset voltage.

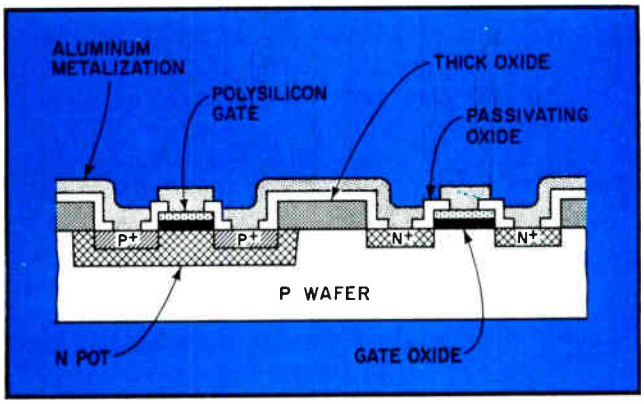
Faselec's frequency divider LB-02 developed by H. Ruegg, W. Thommen, and P. Sauthier, consists of a cascade of 15 binary cells of these low-voltage flip-flops. This divider circuit has 0.5-hertz output at 16.384-kHz input with 5.5-microampere operating current. The current in the first five stages has been weighted in an approximately binary way to conserve power. A single lateral pnp transistor with 30 collectors provides the current for the binary cells.

Ruegg explains: "The advantage of this weighting method—using the lateral pnp transistor—over the use of resistors in the emitter branches is that the current ratios are maintained independent of the current level. The current level is determined by an external programing resistor, R_p." (Figs. 2 and 3.)

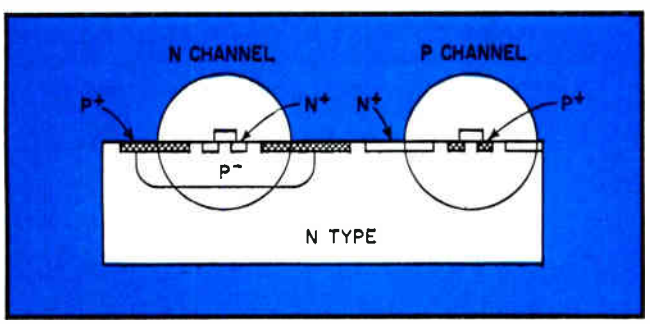
Another part of the Faselec bipolar watch circuit is the driver LK-01 (Fig. 4) which provides amplifica-



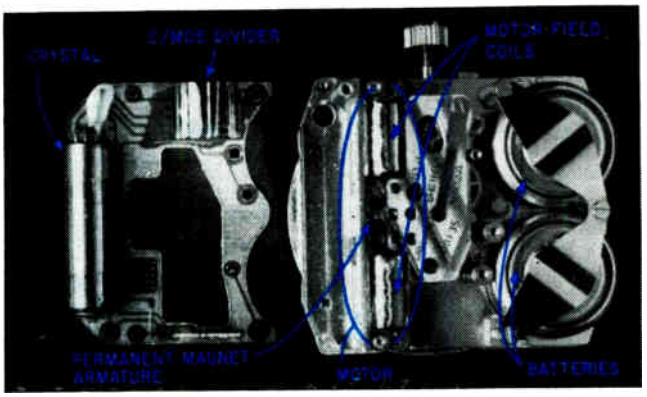
5. Timing options. The RCA Universal Timing Circuit shown with 21 counting stages, may be specified with 23 stages if needed. Zener diodes also optional, provide regulation for 5.5 volts, 11 V, and 16.5 V. This circuit is intended for clocks as well as wristwatches.



6. Gated structure. Motorola's silicon-gate C/MOS IC is fabricated to allow diffusion of the source, gate, and drain regions of the p channel over the n pot. After the p channel is completed, the wafer is covered with an oxide layer and the n-channel devices are exposed to allow for an n-type source, gate, and drain diffusion. After this is passivated with an oxide layer, contact areas are opened for interconnection.



8. Once upon a time. Intersil's n- and p-channel layout is designed to have a threshold of 0.3 V to 1 V for the n and 1.15 V for the p at 1 μA minimum operating current.



7. Inside Seiko. Placed in the case of the Seiko quartz watch is the crystal, left; C/MOS divider, upper left; motor, center; and batteries, right.

tion, pulse shaping, and the required polarized pulses taken from the divider, to energize a stepping motor. This motor drives the second hand of the watch. The positive edge of the circuit's square wave, f_2 + frequency, sets the left-hand flip-flop in Fig. 4, and the positive edge of the square wave, f_1 frequency, resets it every 2 seconds. The right-hand flip-flop in Fig. 4 is also set every 2 s, but 1 s after the left, if f_2 — is the complementary output signal from the frequency divider.

Amplified signals from the flip-flops drive two sets of cross-coupled switches, so the motor terminals are connected to the power supply for 32 milliseconds of the 1-s period, and then are connected to the supply with reversed polarity 32 ms of the following 1-s period.

In a paper delivered at the recent International Solid State Circuits Conference, Ruegg pointed out that an advantage of these divider and driver circuits for a quartz-crystal-controlled watch is their flexibility. Though capable of low-power operation, the divider can be adapted to any frequency up to several hundred kilohertz, and the driving circuit can be used for different types of stepping motors. The idea is to allow watchmakers, still unsure of the best electronic designs, leeway to try a number of configurations which then can be implemented on custom circuits. This will give manufacturers the opportunity to zero in on their specific requirements by providing a wide range of options.

A similar approach has been followed by RCA Solid State division in its recently announced TA6030 Universal Timing Chip. This complementary MOS circuit has specs designed to permit watch and clock companies to work out their own choices of performance criteria within wide boundaries. For example, the TA6030 is capable of operating from 1.3-V to 15-V power sources for watches, battery-powered wall clocks, or auto clocks. Metal mask options include: push-pull or single inverter output drive; zener diode regulation at 5.5 V, 11 V, and 16.5 V, to accommodate voltage variations of typical batteries used in powering clocks; extra bond pads for intermediate stage availability or specialized applications; and all leads brought to one side.

Quiescent dissipation of the TA6030 at 1.3 V is 25 nanowatts (in 14-counting-stage version), and noise immunity is 0.45 of the drain supply. Output drive capability is ± 0.3 mA when drain supply minus source supply is 1.3 V. RCA also has a 21-stage version of the TA6030, which can be supplied in flatpack, dual in-line ceramic or plastic, or TO-5 style packages.

The TA6030 is a follow-up circuit to the C/MOS TA5938 and TA5939, the 14-stage, ripple-carry binary counter/dividers announced a year ago. The TA5939 is a customized version of the TA5938 and features reduced operating power consumption made possible by the elimination of the reset function and the use of one output from the fourteenth stage. Both circuits can be supplied in ceramic dual in-line flat packs or on 89-by-92 mil chips.

Another C/MOS micropower circuit for quartz-crystal watch application has been developed by Motorola's Semiconductor Products division. In wristwatch applications, the divider requirements lend themselves to silicon-gate C/MOS technology, R.G.

Daniels and R.R. Burgess of Motorola's Central Research Laboratory reported at the International Solid State Circuits Conference. And by using C/MOS inverters, power consumption is cut to a minimum.

Using polysilicon for the gate material permits reduction of threshold voltage to around 0.5 V, so the circuit operates from a single-cell battery. According to Motorola, the self-aligning gate feature offers the additional advantage of reduced gate-to-drain capacitance, which both reduces power dissipation and increases operating speed.

Another advantage of the polysilicon gate is that it permits use of smaller device geometries, which increase device packing density and reduce parasitic capacitances. This gate material may be used for crossunder connections, which simplifies IC layouts. And because the critical gate oxide is immediately passivated by the polysilicon gate material, a stable, high-yield process is possible. Such a circuit, Fig. 6, can handle maximum input frequency of 1 MHz, has a power/frequency ratio of 50 nanowatts per kHz, and has a quiescent power consumption of 10 nanowatts per flip-flop stage. Minimum supply voltage is only 1.2 V at 131-kHz input frequency. □

What makes the Seiko watch tick

by John Marshall, Intersil, Inc., Cupertino, Calif.*

Seiko Watch Co. of Japan late last year began producing a quartz-crystal electronic watch using a complementary MOS integrated circuit as its frequency divider/driver. This circuit, the result of a joint engineering development program between Seiko and Intersil, is a 14-stage divider that uses about 1 microwatt. It can be produced in volume at a moderate cost, and the low-voltage C/MOS process permits locating both the divider and the driver circuits on two silicon chips.

There were a number of problems, however, in making a C/MOS circuit that would operate below 1.3 volts. First, the p-channel transistor must have a threshold of less than 1.15 V at 1-microampere minimum operating current. A very clean oxide silicon-nitride aluminum substrate and a silicon gate structure produce a threshold under best conditions of around 1.0 V. This calls for an oxide surface state density as low as 2×10^{10}. And the device must be free of mobile charges in the gate dielectric to preclude threshold drift.

The second problem, controlling the n-channel transistor threshold, was solved primarily by controlling the surface concentration of the p-moat in which the n-channel is made. For the circuit to work at 1.3 V, the n-channel had to be between +0.3 V and +1.0 V at 1 μA.

Now that these problems are solved, the C/MOS binary divider offers a significant advantage in power dissipation over P/MOS or bipolar ICs. The C/MOS divider cell dissipates power only when it changes state, while the P/MOS and bipolar cells always have quiescent currents. In addition, the bipolar circuit usually requires large-value resistors (1 to 10 megohms) to keep the current low. These resistors also require room on the chip that the C/MOS type, without resistors, does not need.

Because stages six through 14 of the C/MOS divider operate at less than 1 kHz, there is very low average power consumption since the other eight stages change state less frequently. The output of the fourteenth stage of the divider provides separate 8-millisecond pulses 1 second apart. These output pulses drive the motor drive circuit, which provides a bi-directional drive signal to the motor.

The 16.348 kHz crystal oscillator is unique in that it has essentially a three-terminal crystal to reduce the required value of the external capacitors (see oscillator circuit diagram). The crystal, which has a negative parabolic temperature coefficient, is compensated by a capacitor with a positive parabolic coefficient connected with the crystal. Capable of driving the MOS frequency divider directly, the output of the oscillator is a modified square wave.

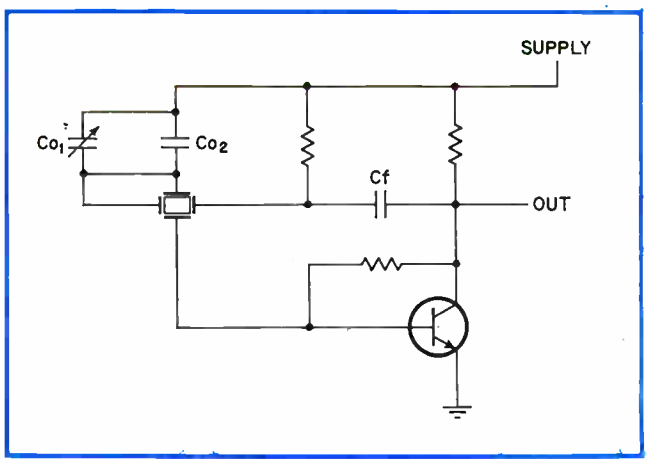
While the oscillator circuit and the divider/motor-driver circuit were important electronic contributions to the watch, the motor developed by Seiko plays a vital part in the overall efficiency. This motor consists of two field coils and a permanent magnet armature that provides a low-reluctance magnetic path. When the first 8-ms pulse is applied to the field coils, the motor armature rotates approximately 15° where it meets a stop pin. The second 8-ms pulse then causes the rotor to return to its original position. This 15° motion is sufficient to operate the mechanism that advances the watch hands in precise increments. This short arc motion also helps the watch resist mechanical shock, which throws off the accuracy of movements with longer armature rotation.

Two silver oxide batteries in parallel provide about 3.5 years of operating time between changes. Current required for the oscillator is 2.5 μA, the frequency divider requires 1 μA, and the motor drive, 6 μA, for a total of 9.5 μA. Each battery has a life of 165 microampere-hours.

The combination of stable C/MOS circuits and precise mechanical watch hands has created a timepiece with an average error of ±0.07 seconds a day at 25°, or ±0.5 s a day from −10° C to +60° C.

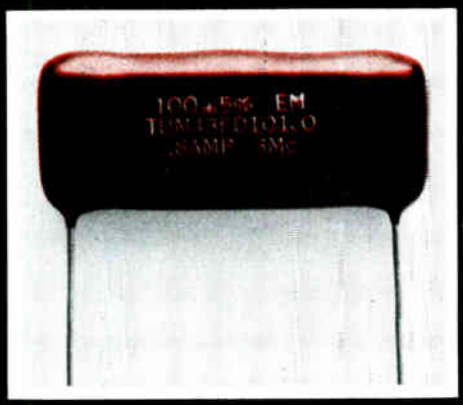
Other watch variations using electronic readouts are also becoming feasible. One such wrist-watch now on the market features an on-demand LED readout to flash the hour, minute, and second and adjusts to ambient light intensity. Another, perhaps more remote possibility at present, is the use of liquid crystal displays. The limiting factor is the small amount of power available in a watch. However, this type of display may be used more easily in a digital clock which is not limited by small power cells.

*Since preparing this material, Mr. Marshall has moved to another company.



Oscillator circuit. Using a single npn transistor in a Pierce oscillator configuration and a temperature-compensating capacitor, the oscillator circuit has a three-terminal configuration that reduces the required value of the external capacitors and allows a closer temperature compensation of the quartz.

NEW EL-MENCO Transmitting Dipped Micas take only 1/6 the space, yet cost less than conventional types.



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47		C	0.50	0.10	0.07	0.03	2.010	.850	.220
1200	1500	F	4.90	3.80	1.20	0.42	2.010	.850	.230
2700		F	5.90	5.80	2.20	0.90	2.010	.850	.230
3300		F	6.10	6.20	2.60	1.10	2.010	.850	.230
5600	1000	F	6.50	7.30	4.10	1.80	2.010	.850	.240
9100		F	6.80	8.10	5.50	2.40	2.020	.860	.260
10,000		F	6.90	8.40	6.40	2.70	2.020	.860	.260
15,000	750	F	7.00	8.90	7.80	3.30	2.030	.870	.280
20,000		F	7.10	9.20	8.30	3.50	2.040	.880	.310
22,000		F	7.20	9.40	8.80	3.70	2.030	.870	.300
30,000	500	F	7.20	9.60	9.30	3.90	2.040	.880	.320
36,000		F	7.30	9.80	9.70	4.10	2.040	.890	.340
39,000		F	7.30	9.90	10.0	4.20	2.050	.890	.350
68,000	250	F	7.40	10.3	10.9	4.50	2.050	.900	.370
100,000		F	7.40	10.5	11.5	4.70	2.070	.910	.440

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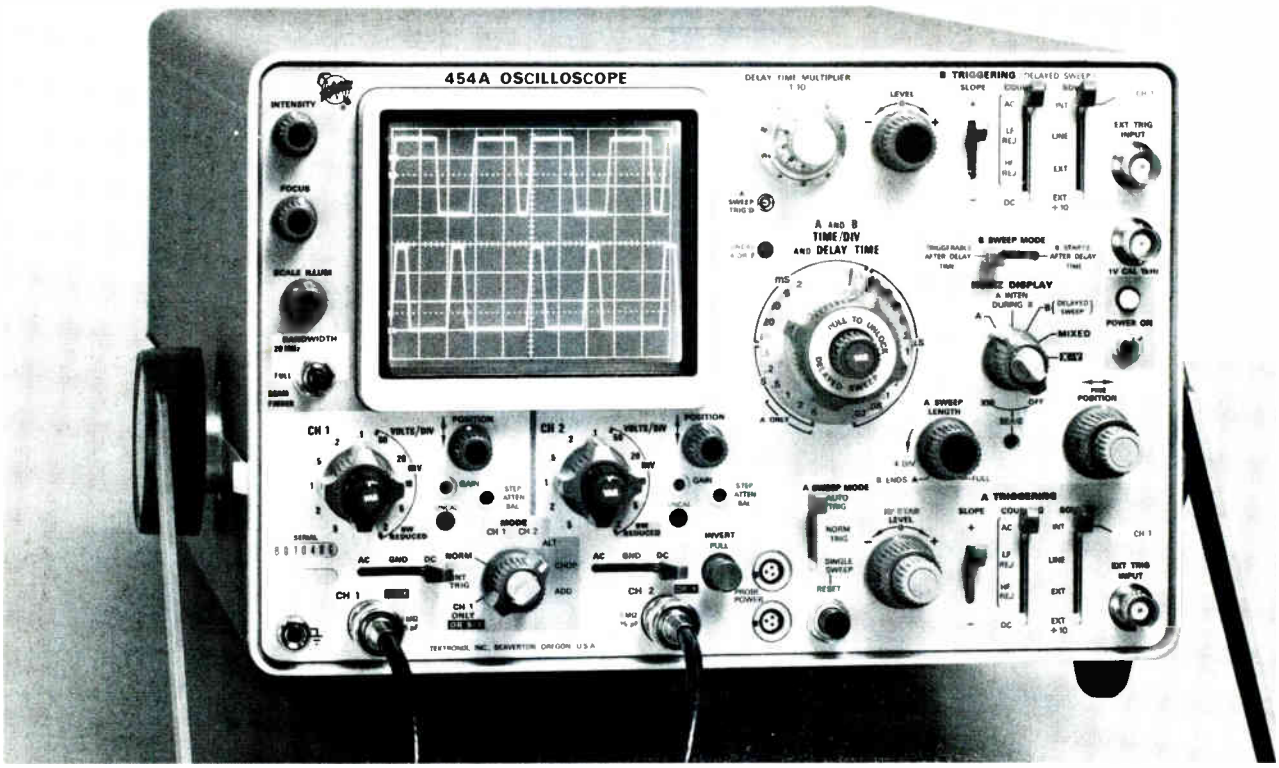

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There's an upturn in the wind

Semiconductor, components, peripherals firms report early-1971 orders outpacing fourth-quarter 1970 levels, but some wonder if turnaround is a real trend

Reactions vary widely—from a grateful "its definitely over" to a wary "we're optimistic, but it's too early to tell"—but a canvass of electronics companies across the nation reveals that many feel business is picking up at last. Most agree that the worst of the current slump is over, but not all are convinced that the upturn will continue.

Contributing to the upturn, say industry spokesmen, are general, though small, improvements in the economy, increased capital expenditures, the release of some military funds, and, for components suppliers, a refilling of depleted inventories. And some are confident that by the time inventories are again exhausted, business conditions will have improved sufficiently to allow modest ongoing growth.

Among the markets fueling order-booking increases are home entertainment and automotive gear, numerical control equipment in industrial plants, and computers and peripherals.

Riding the crest of the upturn during the first quarter are semiconductor, instrument, and components houses; they're generally reporting jumps in orders of 5% to 15% from end-of-1970 figures. A typically cheerful reaction to the upturn comes from Kenneth Stone, manager of market forecasting for TRW Inc.'s electronics components divisions, Los Angeles, who says, "If this year continues like the first three months, it will be a good year for us—probably greater than 10% above forecasts." Bookings in the divisions are running more than 10% ahead of the fourth-quarter 1970 levels. Crediting the automotive and home entertainment markets in particular, Stone notes that the color TV sector represents "about half the action. EIA figures show this industry is up about 15% in bookings, and our business reflects that," he adds.

At Signetics Corp., Sunnyvale, Calif., "TTL and linear products [order bookings] are up. MOS, which is a new business for us, is being well accepted and military products are holding their own," reports Edward Winn, manager of product marketing.

Concurring is Gene Selven, director of discrete linear and digital bipolar marketing at Fairchild Semiconductor, Mountain View, Calif. He feels that "the second half of the year will see a bullish market," and attributes it to "the release of military dollars and the replenishing of companies' low supplies." January-February order bookings in his area were "up dramatically" from the fourth quarter, and the market is now on a par with last year's first quarter, he reports.

At Hughes Aircraft Co's Microelectronic Products division, Newport Beach, Calif., January and February bookings ran 60% below those of the same months last year, but "by the end of March, we had practically all our 1971 sales in the backlog," reports William S. Eckess, marketing manager; "92% of our planned business had been booked or shipped." Nevertheless, he views the March showing as an isolated upturn. "It looks like some things are picking up, but business won't be as good as it was two years ago. The hottest market is hybrids, and the orders are coming primarily for missile and airborne applications. The commercial hybrid market hasn't developed as well yet because hybrid prices can't compete with those of printed circuit boards," he says. But Eckess also reports that the company's CATV equipment business is doing well.

Another cheerful view comes from Floyd Kvamme, director of marketing at National Semiconductor Corp., Santa Clara, Calif. He reports that business has picked up considerably since "we fell off the cliff" last April. He believes the second quarter will be as strong or stronger than the first and reports that peripherals, such as printers, have been doing signifi-

The view from Washington

Government statisticians believe they see signs of an upturn in electronics, as in other industries, although it's not coming as quickly as the Administration would like. Defense procurement in February rose 4.5% from the January level of $17.7 billion, and, according to a Commerce Department analyst, it's a good indication of a general upturn in February. "That's just about how we see electronics as a whole," he says. "Some segments of the business, such as industrial communications, bottomed out sooner and began improving a month or so earlier. And areas like consumer products are lagging a bit behind defense, but there are signs of improvement there, too." But this data is relative, and officials emphasize that almost anything looks good after a year in which 107,000 electronics workers lost their jobs, and the value of shipments declined more than 7%, according to the latest Commerce statistics.

cantly better, minicomputer manufacturing is "mixed, although there seem to be some bright signs," and video terminal manufacturing is moving upward slowly.

And at the Motorola Semiconductor division, Phoenix, a spokesman reports that "we are backordered in every line from discretes to ICs." However, he adds that he is not certain if it's a real upturn or just an inventory adjustment.

The upturn hasn't been confined to Western semiconductor houses, either. William A. Glaser, manager of OEM sales for RCA's Solid State division, Somerville, N.J., says March was the best month in a year, capping a three-month upward trend. The division's semiconductors have been selling particularly well to manufacturers of consumer and automotive products, power supplies, and communications gear, he notes. However, Glaser is not entirely convinced that business has finally turned around; rather he views his improved bookings only as an "indication" that an upswing is near.

The overproduction that was a factor in last year's decline at semiconductor houses also has affected companies that supply IC manufacturing equipment. One such company is Teledyne TAC in Woburn, Mass. "There are still signs of capital conservation," cautions sales manager James L. Yosten. "This is a slow recovery, and in some sectors of the electronics industries, there could be false starts."

Automatic sputtering and thermal evaporation equipment for IC production is doing particularly well at Bendix Corp.'s Scientific Instruments & Equipment division, Rochester, N.Y. Equipment is being ordered not just by "the IBMs, RCAs, and Sylvanias" but also by the "small four- or five-people R&D labs doing specialty work in ICs," says Lee B. Buraks, a district sales manager.

Instrument houses are also reporting higher order bookings. Frank Elardo, Western field marketing manager at Tektronix Inc., Beaverton, Ore., attributes increased orders in January and February to "the economy, which is generally starting to loosen up, and some capital equipment buying."

A mixed report comes from E-H Research Laboratories Inc., Oakland, Calif. William Boggs, systems marketing manager, notes that systems orders are up very significantly over last year because "people have to buy production equipment every few years." On the other hand, bookings for bench instruments are off "because with tight money, people are putting off the purchase of lab equipment."

Digital instruments and aircraft displays have been pushing up orders at Weston Instruments Inc., Newark, N. J., according to William Weir, vice president for marketing. "Our sales and shipments are going to be up between 5% and 10%" for the first quarter of 1971 compared with last year's first quarter, he reports. Weir sees "a slight trend—but only slight—upward for the instrument industry," though he feels "the signs aren't sure enough."

In the components sector, Allen-Bradley Co.'s Electronics division, Milwaukee, reports its sales for the first two months of 1971 were from 5% to 15% ahead of the 1970 average. Much of the increases were due to the division's expansion of its line of components, notes Clayton Ryder, director of marketing.

In Euless, Texas, a spokesman for ECC Corp. reports, "We're having a very good month. Sales of lamp dimmers are up considerably as a consequence of increased home construction, and components sales are 25% greater than a few months ago."

Helping the upturn in bookings at Analog Devices Inc., Cambridge, Mass., are analog-to-digital and digital-to-analog converters, a particularly fast-growing area. Order bookings for the first two months of 1971 ran ahead of the year-end quarter by 10% to 15%. March bookings did even better. "We expect to increase sales in 1971 on the order of 20%," asserts Lawrence T. Sullivan, vice president of marketing. "We have a large number of customers, none representing large sales, and few for inventory products."

The components companies also are being helped by customers starting up postponed projects. One such order—updating a city's fire alarm system—is helping business at Kepco Inc., a power supply maker in Flushing, N.Y. Max Kupferberg, sales manager, reports that a turnaround in orders started at the end of January and has continued.

And Sprague Electric Co., North Adams, Mass., also sees things picking up. "The market for commercial and industrial items is very competitive, but it started looking better as the computer business seemed to improve," says a company spokesman.

On the computer end, a spokesman for Burroughs Corp., Detroit, reports that orders during the first two months of 1971 were up substantially over the same period last year; the company's growth rate, he adds, is beginning to come back to the 20% level that prevailed before 1970. Citing medium-scale computers as big sellers, he reports that the Navy has just ordered 43 of the B3500 machines. At Control Data Corp., Minneapolis, Curtis W. Fritze, vice president for corporate planning, notes a flattening out of the downward curve, with improvements in 1971 pointing to a slow recovery.

One particularly bullish area, at least for the Computer Products division of Ampex Corp., Culver City, Calif., is core memories. For end users, "our business in fast extended core memory systems for the IBM 360/50 and 360/65 is really beginning to explode," reports marketing manager William Slover. He looks for 1971 first-quarter figures to top the comparable 1970 period by at least 30%. Tape drives also will be up by 5% to 10%.

The division also "has seen signs of some turnaround" in the OEM side of the market. "Some major orders are being let—particularly for core stacks," Slover reports. But on an industrywide basis, he feels many unfilled OEM orders will be cancelled. □

Reporting for this story was done by *Electronics'* six domestic bureaus and by its New York department editors.

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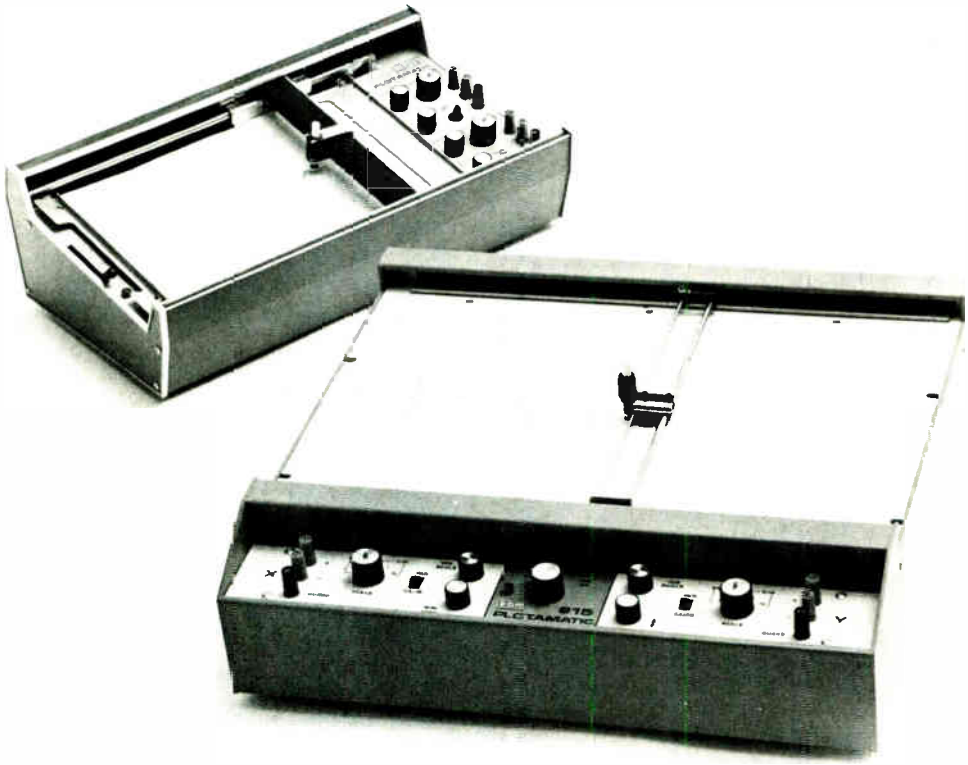

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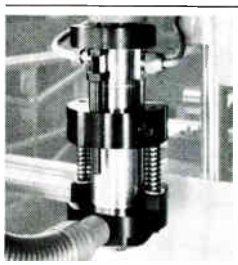

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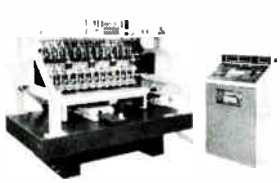

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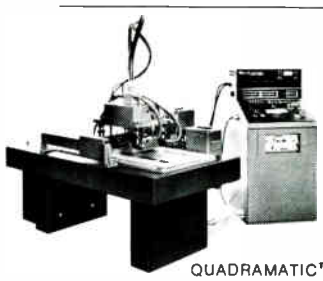

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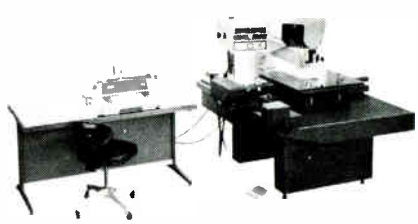

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Computers

Shipboard EDP gets favorable breeze

Computerized navigation, as well as engine room, bridge, and loading control, can increase safety and efficiency, say advocates; Norwegians lead the field

by Robert Skole, McGraw-Hill World News

Embarrassed about having to radio the Danish coast guard for help after his 16,000-ton freighter went aground, a Norwegian skipper was even more chagrined to discover he was actually in Sweden, some 75 miles from where he thought he should have been. One in a series of ship groundings this winter in the Baltic due to navigational errors, this incident fits right into the sales claims of shipboard computer systems makers. They've been getting up steam for the past few years and now appear to be making some headway.

Shipboard systems firms, both in Europe and in Japan, are quick to cite collision avoidance and improved navigation as major selling points for computer control of ship functions. But they're also offering setups that control engine room and bridge operations, loading and unloading, and maintenance. And, in some cases, computers even check barnacle growth or provide medical diagnoses.

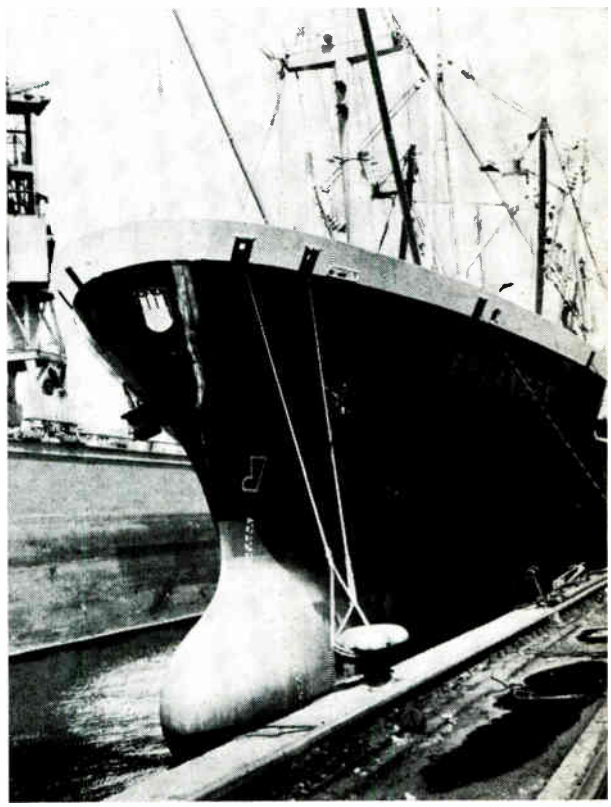
Undisputed leader in the shipboard computer control business is Norcontrol, a division of A/S Noratom-Norcontrol of Horten, Norway. But Swedish and Japanese firms also are making systems, and West German companies are experimenting with computer control for ships.

In their approaches to designing shipboard systems, makers split into two camps. One group advocates the use of a large general-purpose computer to control a variety of ship functions. The other, and predominant, group is pushing for deployment of several minicomputers aboard ship, each handling specialized tasks. For either alternative, makers admit that hefty initial investments are required to convert to computer control. However, they maintain that the systems can so increase ship efficiency and cut sailing time that they pay for themselves quickly.

One spur to Norcontrol's shipboard computer business has been the successful operation since 1969 of a prototype system that controls both bridge and engine room functions on the M/S Taimyr, a 12,000-ton freighter. The company has received orders for 15 shipboard computer systems, eight of which will be delivered this year. And its first commercial system debuted this winter on the maiden voyage of the T/T Thorshavet, a Norwegian supertanker.

"Next year you should find about 50 computer-controlled systems on order or installed," predicts Aake Madesacter, sales manager of process control systems for ASEA, the large Swedish electrical equipment maker, which has installed one computer aboard a tanker built by Kockums Shipyard, Malmo, Sweden. "I expect a market growth of about 30% per year after that," he adds. Kockums has orders for computer installations for six 255,000-ton tankers ordered by Sweden's largest shipping line, the Salen Co. of Stockholm.

One sailor who's already convinced of the value of shipboard computers is Arne Soerensen, captain of the Thorshavet. He reports that he is "greatly impressed" with the computer system's data radar portion, which can display and plot 12 targets simultaneously. He said this capability is especially valuable in the crowded English Channel.



Automated. Electronics control engine functions on German freighter.

No computer failures have occurred in the year and a half that the Taimyr has been sailing, according to Norcontrol and A/S Norsk Data-Elektronik, the Norwegian firm that makes the Nord computer used in the system. Norcontrol sells two systems, each costing $80,000 and up. One controls a wide range of engine room and machine functions; the other handles navigation and controls subsystems.

Competing with Norcontrol are several European electronics companies. One, the Philips ship auto-

mation group, with headquarters in Oslo, is installing a prototype computer-control system on a 162,000-ton tanker being built in Norway. This system uses a Nord 1 computer with a Philips-made Ferroxcube core whose capacity is 256,000 words of 18 bits. "We wanted plenty of spare memory to enable us to update," reports Erik Boger, head of the group. One of the system's features is a built-in Omega receiver.

Others, like Sweden's ASEA and Kockums, are using minicomputers for specialized functions instead of large general-purpose machines. ASEA's Madesaeter feels that makers of radar systems will be offering computer controlled anticollision systems and that his company might better concentrate on engine room, refrigeration, loading, and other functions, leaving radar and navigation to others. The company has installed a computer-controlled system on a 210,000-ton tanker.

Also going the minicomputer route—but with a variation—is A/S Norsk Elektrisk & Brown Boveri of Oslo, which is 51% owned by the Swiss firm Brown Boveri & Cie AG. The company is installing a system aboard an 80,000-ton liquefied petroleum gas tanker. In this setup, two computers are linked together in case one fails.

In Great Britain, the showpiece for shipboard computers is the Queen Elizabeth 2 [*Electronics*, Feb. 2, 1970, p. 104]. There, a Ferranti Argus 400 is designed for navigation assistance using meteorological data inputs and for on-line, real-time optimization of steam condenser efficiency. However, the computer's real virtues would be most apparent on long runs, and the QE2 has had only one such run; it's been largely confined to West Indian cruises. The QE2's computer also performs engine room logging "and it does this very well," says Tom Kameen, engineering director of Cunard International Technical Services Ltd.

One of the most successful ventures in shipboard computers has been made by England's GEC-Elliott Process Automation Ltd.

Out in the cold. Polar-Ecuador-class ship uses programable Telefunken data processors to control engines and refrigeration equipment.

The company's process control system, using its March 2112 computer, has been installed or will be installed on 35 Brazilian-operated vessels, bringing the firm about $6 million.

Elimination of personnel and use of less-skilled sailors is one of the motivations in Japanese shipboard computer work. Six Japanese ships with computer-controlled systems are either in operation or are scheduled for production, but sources say few more are likely to be built during the next five years because shipyards are pretty well booked up till then, and computers aren't included in plans.

Japan's most highly automated ship, the Seiko Maru, a 138,000-ton tanker, was completed last September by Ishikawajima-Harima Heavy Industries Co. Ltd.; it uses a Toshiba Tosbac 3000S computer. And the country's first turbine-powered ship with computer control of its engine plant is scheduled for completion later this year. Mitsubishi Heavy Industries Ltd. designed the system using a Mitsubishi Electric Corp. Melcom 350-5.

West German electronic firms, however, feel manpower savings are secondary compared with other advantages, such as better engine operation and improved fuel economy. As yet, however, shipboard computers are still in the experimental stage there. Siemens AG is working on computerized loading, with computers installed either onboard or at the dock. But the Germans have a thriving industry for noncomputerized shipboard electronics.

However, shipboard computers seem to have run aground in the United States. "To our knowledge, there are no commercial U.S. ships in operation . . . using a general-purpose digital computer to run everything," says William Bringier, chief staff engineer at Technical Associates of New Orleans. "The only ones with true computer control are highly experimental," he adds. "Complete computer control is possible, but there's little incentive to implement it. You're looking at something to provide a fixed function, with a life of 20 to 25 years, so computers seem to offer little advantage," he says.

Supporting this view are Esso Europe and Shell International Marine Ltd., both large tanker fleet operators. Gordon Pringle, Esso Europe's technical advisor, says that "if the engine room is suitably designed, ordinary hard-wired logic controllers will give us what we want more cheaply than using a computer." However, Esso does use some small special-purpose computers for loading control.

At Shell International, Georges Thebaud, manager of application and development, says the company is developing electronic control modules for some engine room functions, "but the time is not yet ripe to use them operationally." However, Shell is planning to experiment with at least three computer-controlled collision-avoidance systems. □

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Consumer electronics

Consumerism tide crests in Washington

With self-regulation a dead letter in the face of hectic consumer lobbying, electronics firms are helping to write legislation—to avert even tougher laws

by Larry Armstrong, Washington bureau

Consumer electronics manufacturers—feeling the increased pressure of consumer lobbying—are reluctantly giving up their self-regulation stance to stave off unpalatable legislation. The switch is a timely one. Consumer groups, unable to deal effectively with manufacturers on questions of reliability, service, and warranties, have banded together and have found plenty of powerful allies in both parties and in the Administration.

Consumer legislation activity has been hectic on Capitol Hill, and out of the myriad bills introduced, Congressional committees are preparing to hammer out three —perhaps four—that would cast long shadows on the consumer electronics industry. New laws on consumer advocacy, product safety, and warranties almost surely will be passed this year, and class-action proposals, allowing consumers to sue in Federal courts as a group, are given a 50% chance of success.

Most industry leaders would like to see self-regulation given a chance to work. "But if Government intervention becomes necessary, then we will have to have it," admits Garth Heisig, Motorola's director of consumer affairs. "Safety, quality, and reliability have to be built in at the initial design stage—you can't legislate them into a product."

"Nevertheless," says a less optimistic company spokesman, "since Government control is inevitable, in the four areas, we're working to clarify the legislation." That "clarification"—more candidly characterized as "watering down" by another industry insider—involves testimony at Congressional hearings, stepped-up public relations work, and plain old lobbying.

Spearheading the drive by the consumer activists is Rep. Benjamin Rosenthal (D., N.Y.). Rosenthal's consumer protection agency bill, largely molded from Ralph Nader's testimony on an earlier consumer affairs department measure, has been watered down since it died in the House Rules Committee last year (it had passed the Senate). Most notably, the new agency, acting as the consumer advocate, would not have the power to subpoena defendant companies. Hearings are slated for April 27.

The Administration approach, as articulated in the President's consumer message, probably will lodge that advocacy function in the Federal Trade Commission.

In the Senate, the most effective consumer crusader has been Senate Commerce Committee chairman Warren Magnuson (D., Wash.). He has revived from the last session the model bill written by the National Commission on Product Safety that would create an independent agency for determining which consumer goods are unsafe. The President would give that function to the Department of Health, Education, and Welfare, and would allow manufacturers to test their own products—the approach considered the most workable by industry. Since the 91st Congress held only token hearings on product safety, this year's hearing will be extensive; they're expected to begin in May.

Warranty legislation passed the Senate and was killed in a House committee last session. But Magnuson has reintroduced his bill, which strictly defines warranties and separates them into "full" and "partial" guarantees on items costing more than $5. A full guarantee would specify service and re-

Bridge-builders

Electronics companies are starting to make efforts to improve their consumer relations. For example Motorola's director of consumer affairs, Garth Heisig, last year made more than 40 house calls—and some 50 other top Motorola executives dropped into customers' homes to chat about performance and satisfaction, as well as to gather feedback for design and styling ideas.

Another example is General Electric Co.'s "guaranteed-or-your-money-back" program, under which unsatisfied customers can return TV sets within 30 days for a full refund, no questions asked. However, many retailers, including some GE-franchised dealers, admitted they were unaware of the practice.

Macy's in New York pretests some of its electronic merchandise, and its bureau of standards has absolute authority: "It can order merchandise off the shelf at any time," says bureau vice president Daniel Chaucer. The company proscribes television sets with soldered-in, interior-mounted fuses and equipment such as speakers and turntables that do not have plug connections to other components. Macy's also reads labeling, warranties, and instructions—and requires that they be clear and unequivocal.

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SINGLE OUTPUT	LXS-B-5-OV	5±5%	5.8	5.0	4.0	3.0	$125
DUAL OUTPUT	[1] LXD-B-152	±15 to	1.6	1.4	1.2	0.7	150
		±12	1.4	1.3	1.1	0.6	

single output
$150
5 volts
at 9.0 amps
with overvoltage
protection built-in

dual output
$160
±12 to ±15 volts
at 2.5 amps each

TYPICAL C PACKAGE MODELS	Model	Voltage VDC	Max. Amps. at Ambient of: 40°C	50°C	60°C	71°C	Price[2]
3 3/16" x 4 15/16" x 9 3/8"							
SINGLE OUTPUT	LXS-C-5-OV	5±5%	9.0	8.0	6.8	5.3	$150
DUAL OUTPUT	[1] LXD-C-152	±15 to	2.5	2.3	1.9	1.5	160
		±12	2.0	1.8	1.5	1.2	

Other models available in:
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0-7, 0-18, 0-32, 0-60, 0-120 volts—up to 4.5 amps
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NOTES: (1) Only one overvoltage protector accessory is required for both outputs on LXD series power supplies.
(2) Prices are USA list prices only. FOB Melville, N.Y.; North Hollywood, Calif.; Montreal, Canada. All prices and specifications are subject to change without notice.

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Caveat vendor. Rep. Rosenthal wants Cabinet-level consumer agency.

pair for a given length of time at no additional cost to the consumer; all others would be partial, and would have to say so.

The most controversial part of that bill is Title 2, which gives broad new legal powers to the Federal Trade Commission. The Electronic Industries Association opposed Title 2 at March hearings; the Senate Commerce Committee is expected to rush to have its report out sometime in April. Again, the Administration measure is less strict and therefore more palatable to industry.

Although provisions in the Magnuson warranty proposal would obviate the need for specific class-action legislation, several bills along these lines have been proposed—and are being hotly contested. Opponents claim that allowing any one consumer to sue in Federal court on behalf of all others could clog the already overloaded calendars, and that the legal complexities could drag out class action suits for years—without interim compensation for the consumer.

But the real battle is over the "trigger" feature of bills following the Administration's line: they require the FTC or Justice Department to find deception before consumers could sue manufacturers for damages of less than $10,000. Consumer activist proposals, such as that of Rep. Bob Eckhardt (D., Tex.), have no trigger provision.

Class-action proponents claim that the Administration is trying to stave off class-action legislation by creating the National Institute for Consumer Justice. The 15-man institute, a nonprofit corporation, is studying incentives for better grievance-handling systems, and is expected to come up with a small claims quasi-court procedure in 12 to 18 months.

Congress is not the only sounding board for consumer attitudes within the Government. The Bureau of Radiological Health, for example, first showed industry its teeth by limiting X-ray emissions from color television receivers. Under the authority of the 1968 Radiation Control For Health and Safety Act the final phase for the TV standard goes into effect June 1—sets can emit no more than 0.5 milliroentgen per hour when measured 5 centimeters from any point on the outside of the set under worst-case conditions.

The bureau's watchdog standards for microwave cooking ovens will become effective on Oct. 6. Ovens manufactured after that date can emit no more than 1 milliwatt per square centimeter prior to sale, and no more than 5 mW/cm² during the useful lifetime of the oven.

The President's Office of Consumer Affairs, recently granted full advisory status, is the most visible liaison for industry, government, and the consumer. Headed by Mrs. Virginia Knauer, described by one of her staffers as "a gadfly running around urging industry to pay attention to the consumers," the office's primary responsibility is to develop interagency positions on consumer legislation. But it probably functions more effectively as a clearinghouse for some 4,000 consumer complaints monthly.

And how do manufacturers face up to all this activity? "Attitudes of business have undergone some changes from outright anger," says Frank McLaughlin, director of industry relations for Mrs. Knauer's office. "They now can sit down with Government without a meteoric rise in blood pressure." □

Communications

The terminal profits of satellites

The firm that wins the FCC's approval of its domestic satellite system will determine how fast the lucrative ground station market will grow

by Jim Hardcastle, Aerospace editor

As eight industry teams race to see which will become the nation's first domestic satellite communications carrier, a vast new market for ground station gear, terrestrial interconnect facilities and spaceborne electronics is in the offing. And of these by far the biggest ticket item will be ground station equipment.

"Between now and 1977, we see a $100-million market for ground stations," says J. W. McNabb, director of engineering at Philco-Ford's Communications and Technical Services division, a leading ground station manufacturer. McNabb, who's also chairman of the Electronics Industries Association's satellite subdivision, points out that this estimate includes very little for receive-only stations, which at first "will account for only $10 million to $15 million of the market." However, by 1980 when the prices of stations have decreased and the number of users has increased, such nontracking stations may constitute the largest single market for ground equipment, serving users like TV stations who need only one-way links. "The electronics share really takes over in receive-only stations," McNabb says. He estimates that with these stations, electronics will account for 70% of their $100,000 to $200,000 cost, while antennas will account for another 20%.

These are the least expensive of the three kinds of terminals described in the filings with the Federal Communications Commission. Most expensive are the "two, three or four large gateway stations. They're a $2-million to $3-million kind of job," he says. But since they play such a key role in each system, McNabb predicts they will probably be built by the applicants. In the $1½-million range are the stations that will provide regional two-way service. According to McNabb, about 30% of their cost will be in antennas, while another 35% will go into multiplex units, low noise receivers, microwave links and related ground electronics. But it's in the receive-only terminal market that McNabb predicts the competition will be the toughest. "By definition, anybody who has some orders can compete," he says. "The technology is here—it's just a question of when they will be needed."

Whomever the FCC selects finally as the first domestic satellite communications carrier will have a great impact on how the market for ground station equipment develops. "If a company like Comsat wins, they'll tend to spread the contracts around like they always have," says one industry source. "If General Telephone and Electronics and Hughes win, it'll be a different story," since both Hughes and Sylvania have strong ground station capabilities.

So, who will win? Because of AT&T's need for a satellite system to wire together its Picturephone network and provide flexible circuit capacity, most industry sources agree that the AT&T/Comsat proposal [*Electronics*, Nov. 9, 1970, p. 112] will gain early approval. This alone would create a $30-million market for ground stations, which AT&T Long Lines officials emphasize will not be built by Western Electric.

For a second satellite system, which will almost certainly be approved to provide for the other common carriers, the systems proposed by RCA Global Communications, Hughes/GT&E and Western Union must be viewed as serious contenders. Comsat also has proposed a second system, but it's unlikely to win approval, thanks to the FCC's avowed interest in creating competition in communications. If the TV networks, whose traffic is needed to make five of the proposals financially viable, have their way, either RCA, Comsat, or Western Union will be selected. Their views are expected to carry great weight with the FCC, which could also force the consolidation of the RCA, Hughes/GT&E, and Western Union filings into one system.

Will there be a third system? If there is, it will probably be because Fairchild-Hiller, MCI-Lockheed or Tele-Communications Inc. is successful in taking the network distribution business away from Comsat, Western Union and RCA.

Once approval is given, however, it will still take at least six months before station contracts are awarded, according to one ground station manufacturer's timetable. Another 12 to 18 months will then pass before hardware deliveries begin.

As for how soon the FCC will select the winners, officials predict the end of the year, but most industry sources consider that optimistic. "If the first system is approved before the end of spring in 1972, the commission will be doing very well," says one. "All it takes is for one applicant to file a petition to deny, and the whole process falls apart. It could take years."

The FCC's Common Carrier Bu-

Probing the news

reau and its three technical advisers –NASA's Goddard Research Center, General Electric, and the Mitre Corp.–are then expected to work until early fall before submitting their recommendations to the commission. FCC sources say that the eight proposals will be gauged by three standards: the economics of the proposed system, the novel services that it will make available, and the efficiency with which it utilizes the orbital slots and frequency spectrum.

How much separation should be maintained between the satellites' orbital slots to limit cross-channel interference and how many orbital slots would be available must then be resolved, FCC sources say. General Electric Co., which for some time has been under contract with the White House Office of Telecommunications Policy to study this question, will provide the answers.

According to the telecommunications policy aide who has worked most closely with GE, however, these questions may be moot. "There's no real problem of orbital or spectrum space," says Walter Hinchman, noting that the FCC recommendation of 5° separation originated in last year's White House position paper on domestic satellites. "And we came up with that number as a for-instance. It can be reduced significantly with a little technical innovation," leaving orbital space for all the applicants, he says.

Hinchman adds that another problem posed by the applications –the fact that all applicants ask for orbital slots in the narrow 40° of arc from which spacecraft can see all 50 states–may also be moot. "You can make a very strong argument that one or two satellites could serve both Alaska and Hawaii," he says.

Consequently, once the FCC has decided what systems can best serve Alaska and Hawaii, the remaining winners may be selected on the basis of how many satellite circuits are needed in the other 48 states and who can best fill that need. □

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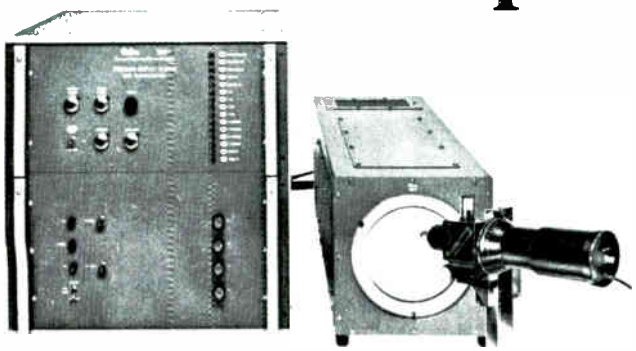
Circle 153 on reader service card

How do you measure-up?



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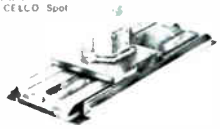

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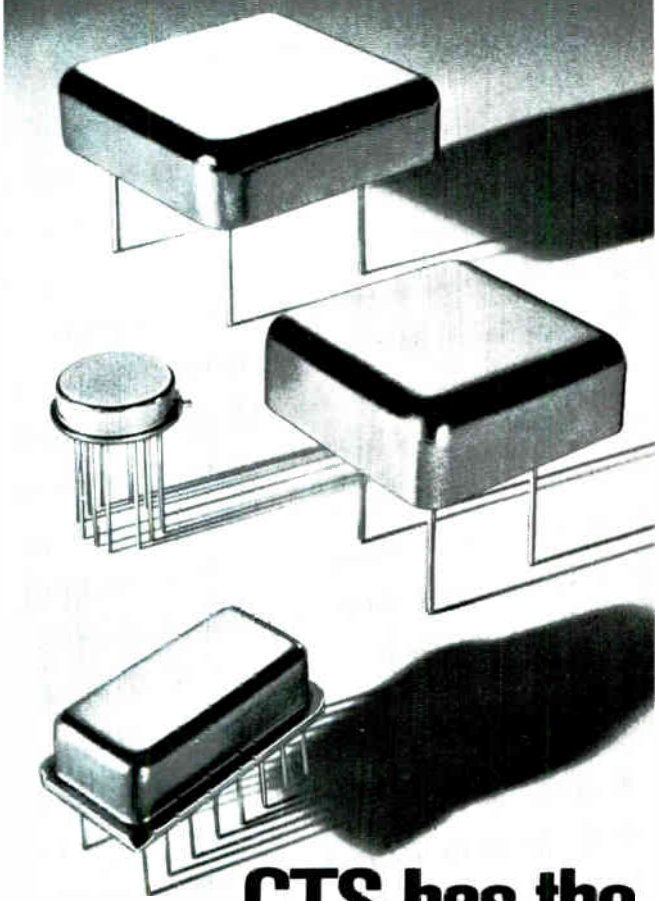
Circle 154 on reader service card

counting/timing application?



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Circle 115 on reader service card

Generator offers synthesizer stability, six-digit display

Digital technique locks signal at 100-Hz intervals to provide high accuracy from 50 kHz to 80 MHz

How many times has the engineer wished his signal generator were a frequency synthesizer? LogiMetrics, in an updated version of its rf signal generators, seems to have turned this wishful thinking into reality—and at a reasonable price. Called the Signalock 925, the new model offers the stability of a synthesizer while retaining both the versatility and the low cost of conventional signal generators. In addition, the 925's output frequency is monitored and displayed on a six-bit digital counter, which, if desired, can be used independently of the signal generator.

The key to the instrument's stability is a closed-loop digital locking technique developed by LogiMetrics. It allows locking at 100-Hz intervals throughout the 50 kHz-80 MHz range. When the Signalock circuit is switched in, the frequency of the digital readout is first stored in a memory. Then it's continuously compared with the generator's output frequency. If the difference between the measured frequency and the memory frequency is more than 10 Hz, an error signal develops that returns the oscillator to the original frequency stored in the memory. The error signal is processed so as to minimize residual fm while maintaining a 10-Hz stability.

The degree to which the oscillator's frequency has drifted determines the rate at which the error-correcting signal is fed back to the oscillator circuit. If, for example, a large frequency drift has occurred, the oscillator frequency will be corrected quickly, but as it approaches the desired frequency, the rate of correction will be much slower. This assures both low residual fm and an adequate acquisition time.

Key components in Signalock loop operation are the two six-bit binary counters: an up-counter/memory and a down-counter. With the loop unlocked, the up-counter is updated and reset every counting cycle (0.1 second). When the loop is locked, the main counting gate circuit closes and a locking strobe inhibits the up-counter, making it in effect a memory that stores the last number counted. This number stays in the memory until the loop is unlocked.

The down-counter is reset before each counting cycle begins. During the cycle, it is set to the up-counter's stored number. If the rf oscillator hasn't drifted, the

Easy reader. Built-in six-digit electronic counter can be used independently of the rf generator if desired.

down-counter's output will be zero at the end of each counting interval since the same frequency will have been counted up and down in equal time period. However, if the oscillator frequency has drifted, then the down-counter output at the end of the count cycle will differ from zero by some binary number that's proportional to the amount of frequency drift. Thus, an appropriate feedback signal can be generated by sensing the output of the down counter.

Frequency lock is indicated by a red panel light. When the generator frequency is locked, the light remains on; when the unit is unlocked, the light is off. And if the end of locking range is being approached, the light will blink as a warning to the operator.

Accuracy in the locked mode is 10 Hz plus the accuracy of the reference frequency source. The internal reference comes from a 5-MHz temperature-controlled crystal oscillator that has an aging rate of less than 1 part in 10^6 per year and a temperature stability of about 2 parts in 10^8 per degree centigrade from 0°C to 55°C. Also, a jack provided at the rear of the unit allows the use of an external 1-MHz frequency standard or, if desired, provides a 1-MHz signal from the internal reference.

The Signalock generator produces a signal with harmonics that are at least 30 decibels below the carrier. Noise and a-m hum are 70 dB below the carrier, while residual fm is less than ±1 ppm plus 10 Hz. The rf output is continuously adjustable from 0.1 microvolt (—127 dBm) to 3 volts rms (+23 dBm) into a 50-ohm load. A step attenuator provides 13 10-dB positions and a calibrated vernier provides an additional 18 dB of amplitude adjustment. Accuracy is within ±1 dB at any frequency. Output is leveled to within ±0.5 dB throughout the frequency range.

The carrier can be amplitude-modulated internally up to 95% at either 400 Hz or 1 kHz, and externally from dc to 20 kHz, depending on the carrier frequency. The percentage amplitude modulation is read on a front panel meter to an accuracy of ±5% of full scale. Distortion on the 1-volt output range and below is less than 3% for 70% modulation and less than 1% for 30% modulation.

The counter allows the user to select any of three resolutions: 100 Hz, 1 kHz or 10 kHz. Nominal input impedance is 50 ohms; with an input signal level of 50 mV rms, count accuracy is ± 1 count ± the reference frequency.

A BCD-coded output from the counter is available as an option. Model 925, which can be rack mounted, operates from either 115 or 230 V ac from 50 to 400 Hz and draws less than 50 watts. It measures 7 by 16¾ by 18⅜ inches and weighs about 25 pounds. Unit price is $2,975, and availability is 90 days after receipt of order.

LogiMetrics Inc., 100 Forest Drive, Greenvale, N.Y. 11548 **[338]**

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RADIATION MICROELECTRONICS HAS CHANGED ITS NAME TO HARRIS SEMICONDUCTOR

Circle 119 on reader service card

Instruments

Prober focuses on big chips

by James Brinton, Boston bureau manager

Wafer test station for LSI handles 72,000 chips an hour; modular design includes replaceable ac probe tips

While the spotlight has been shining on high-speed LSI test systems [*Electronics*, Dec. 7, 1970, p. 107], Teledyne TAC has been busy developing a high-speed probe station—the kind that's necessary to get the most out of the new test machines.

Electronically, testing already is fast. Mechanically, "there's always been a see-saw speed battle between test systems and handling equipment," says James L. Yosten, sales manager. But Yosten feels TAC is ahead of the game with its new PR-100 probe test station.

It's fast: assuming zero test time and 80-mil chips, the PR-100 probes about 72,000 chips per hour. TAC says this compares with a maximum of 40,000 per hour for the fastest competing unit under the same circumstances. It's also comparatively inexpensive. Starting prices are about $8,900, against $10,900 for TAC's former top-of-the-line—and slower—model 1200.

The unit can make ac tests; in fact, says Yosten, it may be the first wafer prober especially designed to do so. It can handle the biggest wafers around, and some that aren't around yet: TAC is offering an optional stage with five inches of X-Y travel. What's more, upcoming fine geometries should not outdate the machine—the stage is offered with minimum steps of 0.25 or 0.5 mil as well as 10- or 20-micron minimum increments.

The PR-100 can hold, under its broad, flat baseplate, all the electronic circuitry needed to exercise MSI and LSI devices. This has been a limitation on earlier probe testers, where small tables made smaller performance boards necessary and so made some tests difficult or impossible.

Speed is largely a result of TAC's development of a high-speed Z-stage, which gives the PR-100 the ability to raise or lower the wafer and make contact. Using a proprietary, electronically driven, servo-damped Z-stage, the PR-100 makes the up-down trip in only ten milliseconds, against 90 to 100 milliseconds for most probes and 50 milliseconds for other TAC models, the company says. Speed along the X-Y axes is a customer selectable 0.8 or 2.0 inches per second.

Moreover, the PR-100 is modular: everything from its probes to its X-, Y-, and Z-axis stepping logic is in modular form and is either quickly replaceable or repairable. If a probe tip is damaged, a new one can be purchased for $2.50 and installed by the user. Also—and most important from the production standpoint—the user can set up his own multiprobe heads and align them quickly without tying up the PR-100. To do this, TAC offers an assembly fixture for $2,000 and a so-called "planarizer" box, a sidelighting attachment that can be used to level the points of the probe tips; it costs $600 and works with up to 60 probes.

Assembly and planarization once had to be done on the machine, causing hours of downtime; with some probe stations, the assembly job had to be done by the manufacturer and weeks could pass

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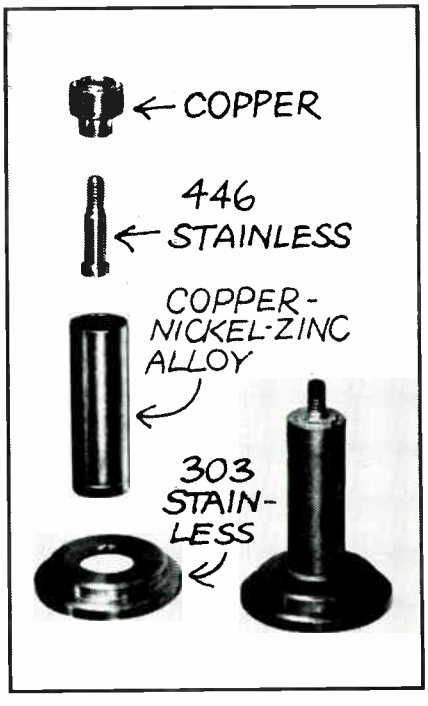
And we will be happy to help you look. Please write if you want to know more about the limitations—and the advantages—of brazing. Just ask us.



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Circle 121 on reader service card

New products

before the new probe head would arrive and be put to work. Yosten notes that a quick change of probe head and performance board can get the PR-100 ready to work new chip types in minutes. And a probe can be repaired and realigned in only a little longer period.

Says Yosten: "A 40- to 60-probe head used to be nearly impossible for a user to put together and adjust in-house, and with increasing chip sizes and more pinout pads, the problem was fast compounding itself. With the PR-100 we hope to put a lot of the ability to make fast fixes and changes in the hands of the production engineer; the cut in downtime is icing on the cake."

The ac capability required a tightly controlled approach to mounting the probes. With ever faster logic, the probes had to be built and mounted like some radio frequency components—with the wavelength of the signal in mind. This amounted to creating a probe head with which it was possible to bridge the distance between the electronics of the performance board and the bonding pad in only 0.75 in. This probably is short enough to make the grade with high-speed ECL and still have some clock frequency range to spare.

Although it is basically aimed at high-speed testing of large chips, the PR-100 comes in four models, two for large chips, and two optimized for discrete components. The PR-100/85 and 81 have 0.8-in.-per-second X- and Y-axis movement speeds and the 81 offers the 10-millisecond, high-speed Z-axis stage. These machines are aimed at discretes.

The PR-100/25 and 21 have the 2-in.-per-second X- and Y-stage movement speeds; the 21 uses the high-speed Z-stage. The combination of high speed in both vertical and horizontal planes makes these two machines, especially the 21, suited to large chips.

Base price also varies; the PR-100/85 is $8,975 while the top-of-the-line model PR-100/21 costs $10,975.

Teledyne TAC, 10 Forbes Rd., Woburn, Mass. 01801 [339]

Components

Scanner gives pulsed output

Electrooptical unit for use in facsimile, OCR applications reads at 100-kHz rate

Most optical scanners, including electron-beam tube and mechanical types, convert an optical input to an analog voltage output. When they are reading data for input to a digital computer, sample-and-hold circuitry must first process the signals. A new approach offers the resolution of vacuum-tube scanners, but at a lower cost and without the need for sampling circuits.

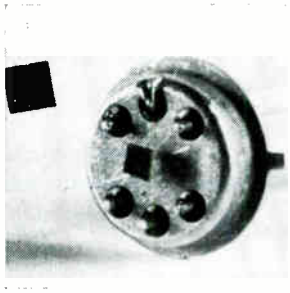
Called Solidscan by its developer, Optonetics Inc., the scanner converts an optical signal directly into a train of amplitude-modulated pulses that are similar to a sampled analog signal. Each pulse identifies a particular scanning location, and the amplitude variation provides gray-scale definition.

The Solidscan module can scan at 100 kilohertz, about one-tenth the rate of vidicons but adequate for optical character recognition, facsimile, and similar applications. Through the use of appropriate logic the scanning mode can be point by point, in groups of points, or in entire lines. The electronics for digitally programing the module's output and processing it into a particular code are available with the module as an option.

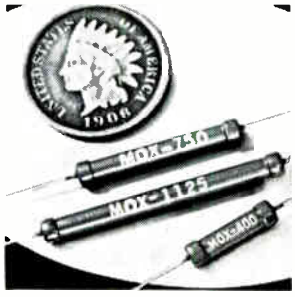
In essence, the module is a multilayer sandwich, made up of a layer of light-emitting phosphor within a crossgrid of thin electrical conductors, which is laminated to a continuous layer of photosensitive semiconductor material. The optical target image is focused on the photosensitive layer, and the cross-

Three p-i-n diode spst switches are offered, each operating over the frequency range from 200 MHz to 18 GHz. Model M862 is rated at 40 dB isolation; model M863, at 60 dB; and model M864, at 80 dB. Low VSWR and insertion loss are featured. Switching speed is less than 20 ns; power handling, 5 W. General Microwave Corp., Marine St., Farmingdale, N.Y. [341]

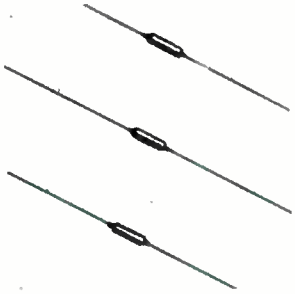
Broadband fixed attenuators operate over the range of dc to 18 GHz. They come in type N connectors (model 219), precision 7 mm connectors (model 220), and SMA connectors (model 222). Typical VSWR values are less than 1.15 at 12.4 GHz and less than 1.25 at 18 GHz. Standard dB values range from 3 to 20 dB. Midwest Microwave Inc., Packard Rd., Ann Arbor, Mich. [342]



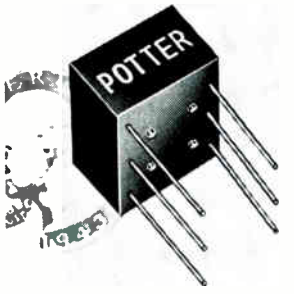
Flake thermistors are low-cost, low-noise devices, require no support by substrate backings, and are designed for lead mounting or mounting by customer to substrates or sensing surfaces. They are available on a variety of standard mounts. Thermal time constants range from less than 38 ms to 75 ms. Price is $7.60 to $19.10. Thermometrics, 15 Jean Place, Edison, N.J. [343]



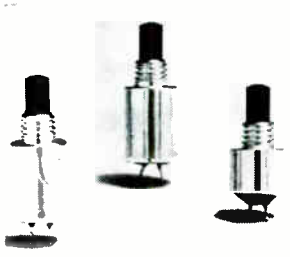
Metal-oxide-glaze Mini-Mox resistor has a temperature coefficient of 100 ppm to 500 megohms, with stability of better than ±2% for 2,000 hours at full load current. Units range in value from 1 to 10,000 megohms in power ratings from ¼ to 1 watt. They come in tolerances of 1 to 10%. Victoreen Instrument division of VLN Corp., Cleveland, Ohio [344]



Three sizes of durez-dipped axial lead capacitors feature ruggedized termination capable of withstanding +525° F for 60 seconds. Dimensions range from 0.200 x 0.065 x 0.065 in.; solder-coated copper leads, 0.016 x 1.25 in. They are available in values from 10 pF through 100,000 pF in NP0 and general purpose dielectrics. Vitramon Inc., P.O. Box 544, Bridgeport, Conn. [345]



SCR/Triac trigger transformers 7310/7320 have turns ratios that vary from 1:1 to 5:1 and primary inductance of 4 mH. They perform these functions: supply adequate current, at a specified voltage level to turn on an SCR; provide adequate isolation between circuits; and provide 180° phase reversal in full wave circuits. The Potter Co., W. Florence Ave., Inglewood, Calif. [346]



Microminiature, butt contact spst switches are designated models 8631, 8632, and 8633. Coin silver contacts are standard features on all three models, with contact ratings for a ½ ampere resistance load at 115 V ac or 28 V dc. Minimum insulation resistance is 10,000 megohms. Dielectric strength is 500 V at sea level. C&K Components Inc., 103 Morse St., Watertown, Mass. [347]

Miniature knobs in the KB series are designed to fill the requirements for rotary switches having a ⅛-in.-diameter shaft. Shaft hole depth is 0.630 in. The 0.550-in. straight knurl bodies are machined aluminum and available with plain 0.997-in. skirts or types having engraved numerals 0-9, with 36° spacing. Alco Electronic Products Inc., Box 1348, Lawrence, Mass. 01842 [348]

grids are electrically energized in a programed digital sequence, causing the light from the phosphor to interact point by point with the photosensitive layer and resulting in a real-time pulsed output. Resolution can be as high as 600 elements per linear inch, or 360,000 scanning points over a square-inch surface.

The module operates in the visible and near-infrared regions with a sensitivity of about 10^{-10} watt per element. It also offers a linearity of 10% over three orders of magnitude for gray-scale definition. The field of view of the optics required to focus the image is 10° by 10°. Power consumption of the system—including electronics—is about 15 watts, due mainly to the 5-volt logic, since the individual scanned points consume less than a microwatt each.

The Solidscan module is available in numerous configurations, from linear arrays of 1,000 points at about $100 in OEM quantities, to arrays with densities ranging from 90,000 to 360,000 points per square inch. The prices of these arrays are considerably less than those of comparable silicon-diode arrays, Optonetics says. The system is packaged in a 4-by-4-by-6-in. package and weighs 8 pounds.

Optonetics Inc., 32 Henry Street, Teterboro, N.J. 07608 **[349]**

Gas planar displays, liquid crystal units challenge LEDs

The battle for the instrument display market is primarily between light-emitting diodes and gas-discharge tubes like Burroughs Corp.'s Nixie—although there are also some skirmishes involving the first liquid crystal readouts.

A new contender that looks like an LED is actually a member of the gas-discharge tube family. It's the first product out of Sperry Rand Corp.'s recently formed Information Displays division; it's called the SP-730 and comes in three versions. One model—the SP-731—has two digits and a ± sign; the two-digit version is the SP-732, and the

three-digit unit is the SP-733. Each one has decimal points for all digits.

Unlike other gas-discharge tubes, the 730 has a segmented display. Instead of 10 digits mounted one behind another, the tubes are built with a planar display area consisting of seven segments. Like other gas-discharge displays, the 730s require a high-voltage supply—170 volts in this case. Dissipation is 200 milliwatts per digit. Though the color of the lighted segments is the usual dull orange, with a red filter in front, an 730 looks like a LED readout. And character height equals that of large LED displays—0.33 inch. Segment width and height also correspond, as does total package size—0.825 in. high, 0.235 in. deep, and 0.75 in. wide (two digits). The only noticeable difference is that the 730 shows no visible gaps between lit segments.

According to divisional sales manager L. L. Pond, Sperry expects to attract customers who like the appearance and size of LED displays, but are put off by their high price—typically $10 per digit. For orders of 5,000 packages, the 730 will go for $2.30 per digit.

Fast delivery is something else Pond is planning to offer.

Meanwhile, liquid crystal displays are starting to appear as commercial products. Optel Corp., whose three-digit 1003 was the first off-the-shelf liquid crystal readout, has added two more products, and expects still another to be ready before summer.

New units are the 3½-digit 1043 for voltmeters, and the four-digit 1053 for clocks. Specifications are similar to those of the 1003. Numbers are formed from a seven-segment font and character height is 0.45 in. Operating voltage ranges from 15 to 60 V; dissipation is 40 microwatts per segment at 20 V; lifetime is 10,000 hours; and operating range is 0° to 50°C.

The product next due is for counter makers—an eight-digit readout.

Sperry Information Displays Division, P.O. Box 3579, Scottsdale, Ariz. **[350]**

Optel Corp., Box 2215, Princeton, N.J. **[351]**

Instruments

Tester geared to memory user

Aimed at incoming inspection of IC units, tester can work with wafer probe stations

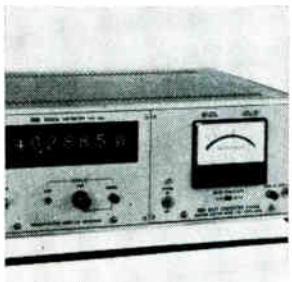
The president of Macrodata Co., William C.W. Mow, has been saying for some time that expensive test equipment, such as his firm's MD-200 system, shouldn't be wasted on semiconductor memory testing [*Electronics*, March 1, p. p. 65]. Instead, Mow promised a tester that would sell for $50,000. He still intends to deliver on that promise, but in the interim, Macrodata has unveiled a simpler unit that sells for just $13,750.

Called the MD-100, it's a functional tester aimed primarily at incoming inspection needs. "I don't think the memory user should have to spend $75,000 for a machine to do his incoming inspection," Mow comments.

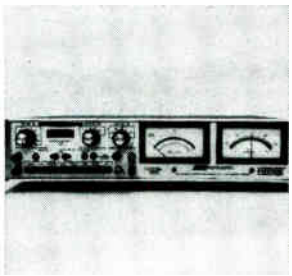
Besides being a stand-alone functional tester, the MD-100 can be made to work with primarily dc testers, such as the Teradyne J-259, the Datatron 4400, and the Fairchild 5000. And while it's expected to be used to test standard, packaged read-only memories, random access memories, and shift registers, Macrodata will provide an optional ($250) adapter that permits the MD-100 to interface with wafer probers for functional production probing done by semiconductor manufacturers.

The unit handles memory components ranging in capacity from one word by one bit to 65,536 words by 16 bits at data rates up to 5 megahertz, or a 200-nanosecond cycle time. Incorporated in the machine is a special-purpose dual

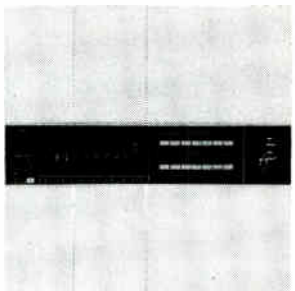
Digital multimeter has 21 switch-selectable ranges—eight each for ac and dc voltage and current, and five for ohms. The unit features high sensitivity: it measures in 10 mV and 10 μA steps on the lowest voltage and current ranges. Weight is 2½ lb. Price is $195.50. Esterline Angus, division of Esterline Corp., P.O. Box 24000, Indianapolis, Ind. [361]



Direct-reading digital wattmeter provides accuracy from 10 kHz without correction, regardless of power factor. Accuracy is ±0.1% from 4 Hz to 1 kHz, ±0.2% from 30 Hz to 2 kHz, and ±0.5% from 20 Hz to 10 kHz. Type 2885 DWM is self-contained and utilizes a proprietary time-division multiplier circuit. Yewtec Corp., 1995 Palmer Ave., Larchmont, N.Y. [362]



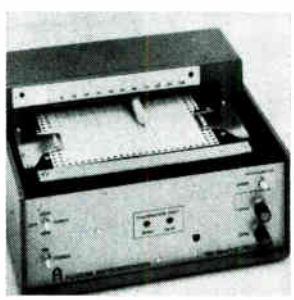
Frequency response analyzer model 310 covering frequency range 0.02 Hz to 20 kHz simultaneously measures phase and amplitude with over 40 dB of noise and harmonic rejection. A sinusoidal signal drives the mechanism under test. Output is fed back and is used to provide phase and amplitude information. Price is $3,950. Weston Instruments, Hatboro, Pa. 19040 [363]



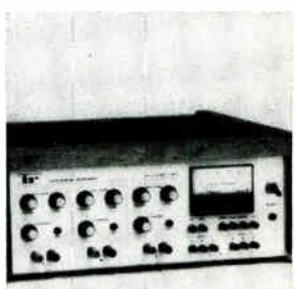
Digital voltmeter, model 8400A, offers accuracies of 0.004% for 90 days and 0.01% for one year without calibration. Other features are systems compatibility and ease of interface. It provides five ranges of dc from 0 to 1,100 volts, plus a "1" for 20% overrange, and 33 readings per second. Price is $2,450. John Fluke Mfg. Co. Inc., Box 7428, Seattle, Wash. [364]

Programable frequency synthesizer model 201-S covers frequency range 0.1 hertz to 2 MHz. Digital readout provides 0.1-Hz. of resolution (eight digits). Operation is manual or through remotely programed BCD inputs. Spectral purity is 70 dB for nonharmonic signals and 50 dB for harmonics. Price is $2,700. Lorch-Adret Corp., 105 Cedar Lane, Englewood, N.J. [365]

Ratio computer calculates and displays the ratio of two dc voltages that change in real time. Changing voltage is taken from a single transducer, rather than two separate sources, making resetting or recalibration unnecessary. Ratio is accurate to 0.5% from 0.100 to 9.999; cycle time is variable. Price is $995. MSI Electronics, 34-32 57th St., Woodside, N.Y. [366]



Five-inch servo potentiometric recorder for Keysort cards, model 192, shows output of low-level transducers and laboratory instruments. Readouts also are available on 100-foot continuous charts. Speeds range from 2 in. per minute to 1 in. per day. Input is full-floating with a maximum voltage of 100 V dc. Price is $495. Fluidyne Instrumentation, 27th St., Oakland, Calif. [367]



Lab power supply model 9B condenses four instruments into one: three power supplies and a voltage-current meter. Unit features two 0-25 V dc, 0-1 A supplies, and one 0-10 V dc, 0-5A supply. Stability and resolution are high. Supplies are isolated, with current limiting. Each has overvoltage protection. Price is $299. Integrand Research, Box 428, Santa Susana, Calif. [368]

New products

processor that's microprogramed "to solve the logical problems of testing semiconductor memories at high speeds," Mow says. The two parts of the processor are used for on-line generation of, respectively, addresses and data patterns by the million.

This is achieved by means of semiconductor programable ROMs —Mow stresses that no general-purpose computer is required in the system, obviating the overhead costs of software.

The MD-100 will come equipped with two "personality cards." Each of these holds the test socket plus any special timing generation and level translation needed to interface the memory being tested with the machine. One is essentially a general-purpose card from which the customer can build up any special timing and level generation he needs for a special device he tests regularly. The other will come from Macrodata's new family of personality cards tailored to the more popular standard semiconductor memory devices that are now on the market.

Additional personality cards are available from the company and they cost $500 to $750, depending on the complexity of the device they're designed to test.

The machine provides test sequences such as walking 1s and 0s and read and write forward and backward in standard firmware packages. Other test routines available include what Macrodata calls its galloping 1s and 0s pattern, which tests all bits in an array, the addressing, the interaction between bits and patterns, plus sequence dependency for transient performance.

Controls for these routines are microprogramed into the processor's ROMs for incoming inspection or production testing. For engineering testing, a random access read-write memory is provided to accommodate diagnostic routines.

The complete unit is housed in a rack-mountable 12¼-by-19-inch enclosure.

Macrodata Co., 20440 Corisco St., Chatsworth, Calif. 91311 **[369]**

Tektronix adds 500-MHz scope to its 7000 series

Ever since Hewlett-Packard Co. unveiled its 250-megahertz model 183A, then the fastest laboratory oscilloscope, observers have been waiting for Tektronix Inc. to make its move in the fast growing high-frequency measurement field [*Electronics*, Aug. 17, 1970, p. 121].

The move was made at the 1971 IEEE Show when Tektronix introduced a 500-MHz unit with sweep speed of 500 picoseconds per centimeter and vertical sensitivity of 10 millivolts/cm. It's the fastest laboratory scope on the market.

The instrument—consisting of the 7904 mainframe, the 7B92 dual time base, and the 7A19 single-channel amplifier—is a new member of Tek's 7000 series [*Electronics*, Aug. 3, 1970, p. 101]. The 7904 mainframe sells for $2,900, the dual time base for $1,400, and the amplifier for $500.

The dual time base has three display modes: intensified delaying sweep, delayed sweep, and alternate.

Tektronix achieved the high-frequency response by developing a new cathode ray tube and high-speed hybrid circuits for the vertical amplifier. As in H-P's 183A, the CRT in the Tektronix scope has helical delay lines as its vertical deflection plates. This construction —in place of parallel plates—effectively increases the tube's deflection factor. Direct access to the CRT provides 1-gigahertz bandwidth at a deflection factor of 5 V/cm.

The 7904 is compatible with all 7000-series plug-ins, including the counter and multimeter units. Its CRT has an 8-by-10-cm viewing area. Writing speed goes up to 10 cm/nanosecond, and to 20 cm/ns with fogging enhancement.

With Tektronix now in front in the scope speed race, the ball is back with H-P. Company spokesmen acknowledge that a new unit is in the works, but won't say when it will be ready for the market.

Tektronix Inc., P.O. Box 500, Beaverton, Ore. 97005 **[370]**

Low-priced synthesizer aimed at automatic test jobs

High resolution and high spectral purity usually are not needed in frequency synthesizers that are intended for automatic test systems. Most engineers are willing to trade off some capabilities in these areas in return for a price reduction.

That's the idea behind a synthesizer built by RF Communications Inc. Designated the RF-828, it sells for $2,600; today's high-performance units cost over $3,000.

Resolution is 1 kilohertz, although a $300 option extends this to 1 hertz. In addition, the RF-828 "doesn't have super-good spectral purity," says Robert Hesselberth, sales manager. The figure is 60 decibels, compared with 100 dB for higher-priced units.

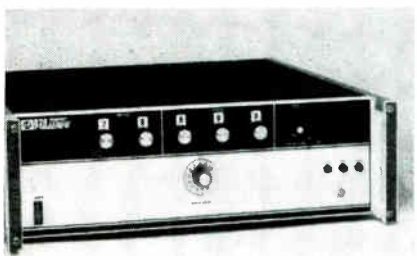
Another reason for the low price is that the RF-828 uses an indirect synthesis scheme. Instead of generating frequencies with decade dividers attached to the output of a crystal-controlled oscillator, the RF synthesizer uses a phase-locked loop.

With the exceptions of resolution and spectral purity, the RF-828 matches the specs of most other synthesizers, states Hesselberth. For one, range is 1 kHz to 80 megahertz. Output is adjustable between 0.01 to 1 volt, and harmonic outputs are down 40 dB.

Another feature is programability. Binary-coded decimal signals can set both frequency and output amplitude.

RF Communications Inc., 1680 University Ave., Rochester, N.Y. 14610 [371]

Wide range. Frequency synthesizer has outputs from 1 kHz to 80 MHz.



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Circle 193 on reader service card

Data handling

RAM combines bipolar, MOS

14-chip, 2,048-bit memory with beam leads offers 125-ns access time

"The multichip approach is the future of semiconductor memories," says Robert R. Kressler, marketing manager for logic and memory functions at Texas Instruments Inc. Why does he say so? "This design provides low interconnection and packaging costs, and permits us to choose the optimum chip size for best yield."

TI used the multichip approach in developing a 2,048-bit random access memory with static MOS storage and TTL inputs and outputs. It is aimed at applications requiring relatively small memory capacities, such as peripheral equipment.

Compared to monolithic memories, Kressler says, the hybrid types offer high speed (125-nanosecond access time in this case) at low dissipation (9.65 milliwatts per bit, 1.3 watts total). The largest monolithic RAMs available, says Kressler, are 1,024-bit devices with access times of 300 ns and above.

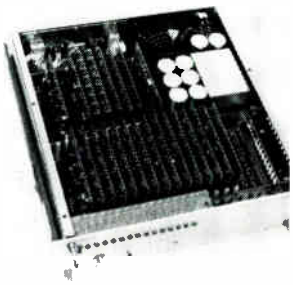
The TI memory's storage elements are eight low-threshold, 256-bit MOS chips; six bipolars are used for decoding, sending, writing, and control. Power can be removed from the decoders during standby for 30% less dissipation. All of the chips are beam-leaded, as are all of TI's hybrid memory products; the ceramic substrate has two layers of metal interconnections.

Two organizations are available: 2k by one bit (SMA 2001), and 1k by two bits (SMA 2002). Four chip-select inputs permit easy expansion

Modular solid state keyboard FS 300 eliminates encoding electronics and electrical contacts, and reduces component count. A ferrite key switch with one moving part develops the code. Power consumption is as low as 50 mA at 5 V for a full 88-key board. Logic level outputs are DTL- and TTL-compatible. Port Electronics Products, 133 Brimbal Ave., Beverly, Mass. 01915. [401]

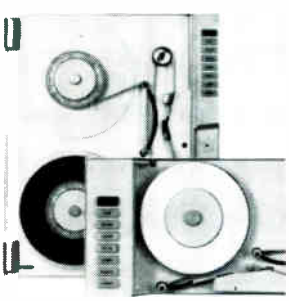
Code generator produces all 128 characters of the 7-bit ASCII code without a full-size keyboard. It is wired for positive logic, with a bounce-free, TTL-compatible output, and requires a 5-Vdc power supply. Light-emitting diodes display bit levels. Generator requires no special skill to operate. Price is $98. Mechanical Enterprises Inc., 5249 Duke St., Alexandria, Va. 22304 [402]

Acoustic coupler model DD 103 AC converts EIA or TTY signals to standard frequency shift keyed signals for transmission over phones. Bit serial data is transmitted in a form compatible with 103A data set. Features include half/full duplex circuitry, coherent switching, accurate carrier detect. Digi-Data Corp., 4315 Baltimore Ave., Bladensburg, Md. 20710 [403]



Analog-to-digital conversion system offers three ranges of speed up to 10 MHz, narrow aperture sample and hold devices, 15-bit resolution, and single end or differential input multiplexing capabilities. Features include buffered output data register, multimegohm input impedance. Preston Scientific Inc., 805 E. Cerritos Ave., Anaheim, Calif. 92805 [404]

Computer/cassette system, designed for use with peripherals and with programable digital controllers, consists of an Interdata cassette tape unit and the company's Model One computer. System is applicable wherever medium speed input-output and large storage capacity are important. System uses standard cassettes. Interdata Inc., 2 Crescent Pl., Oceanport, N.J. 07757 [405]



Magnetic tape transports, Mod 310 and 311 series, designed for use with minicomputers, peripherals, and data communications systems, eliminate take-up reel, enabling unskilled operators to handle tape at high speeds. The two series are provided in both 9- and 7-track configurations. Tape format is IBM compatible. UniComp Inc., 18219 Parthemia St., Northridge, Calif. 91324 [406]

Modem with a symbolic status display is insensitive to virtually all bit patterns. The 4,800-b/s modem, designated the model 248A, is macromodular in construction, and the multicolored display instantly indicates the condition of the modem. Packaging is stand-alone or for cabinets. Information Exchange Systems Inc., 3312 Gorham Ave., Minneapolis, Minn. [407]

Automated data input system reads documents of any size or format, printed in any font. The OCR system, called Grafix I, reads from filmed document images rather than directly from paper, using film in the same way that tapes and disks are input media. Keystroking of source data is eliminated. Information International, 12435 W. Olympic Blvd., Los Angeles, Calif. 90064 [408]

New products

of the memory for larger systems. Power required is ± 5 volts. Both types come in 1.6-inch dual in-line packages with 28 pins on 100-mil centers. Rows are on 1.2 in. centers.

The memory is easy to use, Kressler says. "Even people who haven't been using memories in their equipment can handle the simple static memory," he asserts. Kressler feels it will find use in such applications as printer buffers, buffer memories and communications buffers.

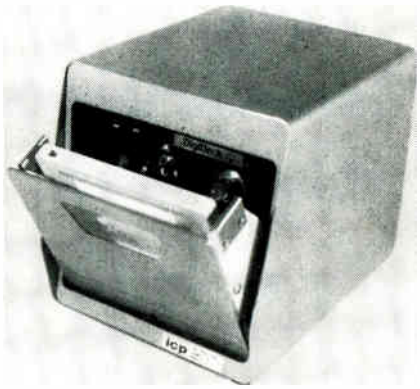
Price of the SMA2001 in quantities of 100 to 999 is about 7 cents per bit. In larger quantities, it drops to about 5 cents, and Kressler sees the 1973 price approaching 2 cents. However, he does not expect this memory to compete with large dynamic MOS memories, which are heading toward prices near 1/10 cent. Those devices are made for different uses, such as mainframes, but TI hopes to share in that market with a 16k dynamic memory to be introduced in June.

TI is also selling a high-threshold, 2,048-bit RAM storage array, the SMA 1001. It, too, uses eight 256-bit beam-lead MOS chips, but contains no decoding or drivers.

Texas Instruments Inc., Inquiry Answering Service, P.O. Box 5012, M/S 308, Dallas, Texas 75222 **[409]**

Incremental cassette unit reads, writes up to 40 cps

Because of their low cost, simplicity, and convenient operation, tape cassettes have been widely hailed as the successors to noisy and hard-to-handle punched paper tape now used for data entry in simple terminal and minicomputer installations. But though cassette recorders haven't really offered the type of incremental operation needed for these applications, International Computer Products Inc. of Dallas thinks it has changed that with its new PI-70 parallel input/output incremental cassette unit. This character-by-character recorder offers random data entry, easy error correction with step-by-step backspacing, and reading and writing on one instrument—all for $769, which is lower than the price of comparable paper-tape punch and reader, says ICP vice president Robert N. Miller.



Direct drive. Reels are driven directly so there is a constant bit density per degree of rotation.

In incremental operation, the PI-70 can read and write up to 40 characters per second, storing 50,000 nine-bit bytes on a standard 300-foot cassette. It can also be used in conventional block fashion, storing up to 120,000 bytes at a rate of up to 1,000 per second. One 2-ounce cassette can store the same data as 2½ to 3 pounds of paper tape, says Miller.

The PI-70, unlike most cassette recorders, does not use a capstan drive. The spindles (or reels) are driven directly, resulting in a constant bit density per degree of rotation, like a phonograph record or magnetic disk, rather than constant linear density. Though this approach (also used in other ICP recorders) is not traditional, it offers a number of advantages for digital cassette operation. One, for example, is elimination of the pinch rollers that clamp the tape to the capstan. These cause significant wear in conventional recorders, according to Miller, and limit the life of a cassette to about 100 passes in normal operation. In addition, the starting and stopping of the tape in incremental operation wear out the mechanical parts.

The disadvantage of the spindle drive is that the variable density of the tape limits total storage to about 60% of what it would be on

a constant linear density tape. However, Miller says that one of ICP's tapes can hold about 40 typed pages.

Most users take up only about the first 10 to 50 feet of a 300-foot cassette anyway, he says.

The PI-70, which includes the basic deck and electronics, features fast bidirectional access as well as rewind. All functions are controlled by digital levels or contact closures.

Output signals tell the operation or status of the machine.

The recorder stores bytes of up to nine parallel bits; the ASCII standard is eight, but the additional bit offers increased control versatility. The byte is applied to the nine input lines, then a tape strobe signal increments the tape one character. The machine can be read incrementally or it can be read in blocks.

Rewind speed is 45 seconds maximum for a standard 300-foot cassette. Error rate is less than one error per million characters with an approved cassette. The recorder has a detector which signals the beginning or the end of the tape.

The PI-70 uses bit-mark-sequence encoding developed by ICP for cassette use. It is somewhat similar to complemented NRZI, but uses four separate flux changes (two on each channel) per bit for data storage and timing information, and convenient error detection. This BMS system has been proposed by ICP as a standard for incremental cassette recording as required in many office, industrial, and terminal uses.

Another standard has been proposed by the European Computer Manufacturers Association for block recording with cassettes, but Miller feels that it is more useful for peripheral applications in carefully controlled computer environments because of its high recording density.

Size is 6¾ by 8 by 6½ inches; weight, 4 lb. The unit requires ±15-volt and +5-V supplies.

International Computer Products Inc., P.O. Box 34484, Dallas, Texas 75234 **[410]**

Packaging and Production

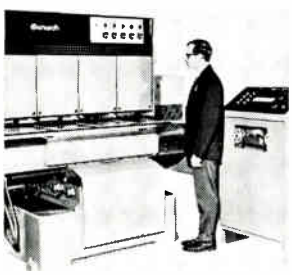
Pc boards cool down

Solder reflow at low 380°F reduces multilayer board warpage and device damage

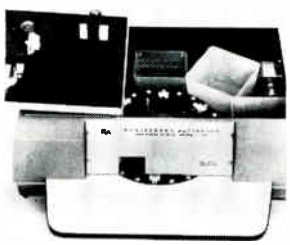
Most printed circuit board specifications allow the solder plating to contain anywhere between 50% and 70% tin. However, this wide range compels the user to boost his reflow temperature as high as 460° to 50°F to assure that the plating melts, whereas if its composition were kept closer to the eutectic point—62% tin and 38% lead—the reflow temperature could be dropped to about 380°F. This lower temperature would mean less danger of delamination and warping of boards as well as less degradation of components. Now Defiance Circuits Corp. is guaranteeing just such a temperature specification on multilayer boards up to seven layers thick.

Defiance president William Lehrer says studies of the composition of boards made over the past few years led to a narrowing of the limits on solution composition. Previously, he says, the solder bath contained 1.5 to 2.75 ounces of tin for every gallon of solution, nearly a 100% variation. Now, he says, the concentration is held at 2 to 2.75 ounces per gallon, or a 37% variation. Similarly, lead concentration used to be 1 to 1.5 ounces per gallon, while now it's 1.25 to 1.75, and fluoboric acid (HBF_4), which was 47 to 65 ounces per gallon, is held to 45 to 55.

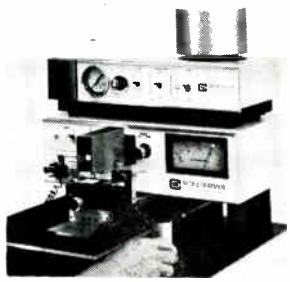
However, this closer control on solution composition is only one of the steps he had to take to assure continuous plating of the eutectic composition, Lehrer claims. A sec-



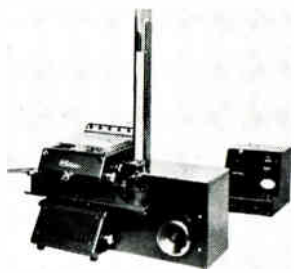
Cycle rates exceeding 100 drilling operations per minute are possible with the solid state N/C NPB-100 pc board drilling machine. It features positioning accuracies of ±0.0005 in. and spindle combinations to handle production at rates up to 150,000 holes per 2-shift day. Spindle speed is selected by direct-reading dials. Monarch Machine Tool Co., Cortland, N.Y. [421]



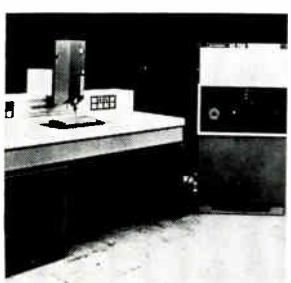
Semiautomatic Auto-Bin model 005 probes and tests leaded components, such as transistors, resistors and capacitors, and sorts them into separate bins according to test results. Unit features heads that separate, isolate and contact long or short leads with positive pressure. It measures 34 x 23 x 11 in. high and weighs 120 lb. Engineered Automation, Elm St., High Bridge, N.J. [422]



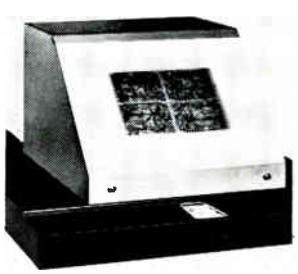
Abrasive machine for trimming thick films, model MT-100, is a modular system consisting of the Micro Trimmer used in tandem with the model MB-101 Micro Blaster, which stores and feeds the abrasive powder. The work platform will accommodate any size and shape substrate up to 2 in. x 2 in. and ¼ in. thick. Comco Supply Inc., W. Olive Ave., Burbank, Calif. [423]



Screen printer model 1200-LTV features a magazine fed linear transfer feed mechanism. The feed system incorporates a "walking beam" feeder that is adjustable for substrates ranging from ¼ in. x ¼ in. to 3 in. x 3 in. Model 1200-LTV prints up to 1,500 impressions per hour. Price is $16,960. Wells Electronics Inc., 1701 S. Main St., South Bend, Ind. [424]

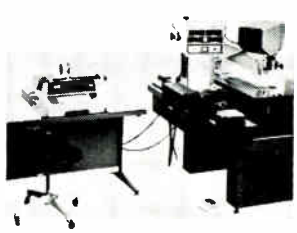


Wirecenter semiautomatic wire terminating system utilizes a numerically-controlled X-Y positioning table in conjunction with a fixed terminating head and can accommodate panel sizes up to 10 x 10 in., 10 x 20 in. and 20 x 20 in. Production rates of 250 wires per hour may be achieved. Prices start at $17,000. Hughes Industrial Products Div., Box 92904, Los Angeles. [425]

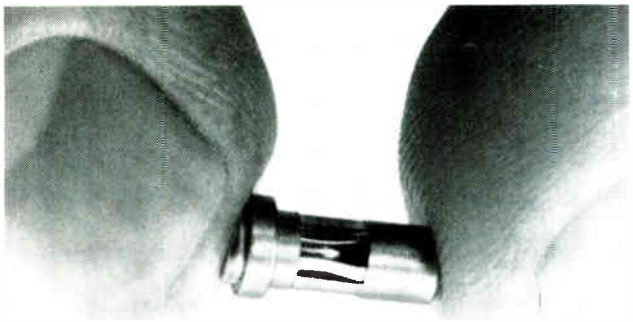


Insertomat model 805 helps to insure error-free insertion of parts into pc boards with the use of brightly radiating light guides. It handles pc boards up to 12 in. x 18 in. A rotating tray with 30 part bins is synchronized with the light guides to illuminate the locations on the board where that particular component is to be inserted. Electrovert Inc., Mt. Vernon, N.Y. [426]

Speed in selecting and removing E-Z-Code wire markers from their rolls, plus elimination of wasted markers, is featured in portable tape dispenser WT-610. Unit holds ten WMT series marking tapes in a compact form that can save production time losses due to searching for marker. It can be fastened to work benches. Thomas & Betts Co., Butler St., Elizabeth, N.J. [427]



Punched tape programs for any standard N/C format drilling system can be prepared direct from circuit art, negatives or pc boards with ±0.0001 in. resolution by the Opic II optical programing and inspection center. System permits direct programing of boards up to 25 x 25 in., and can encode in desired format. Excellon Industries Inc., Garnier St., Torrance, Calif. [428]



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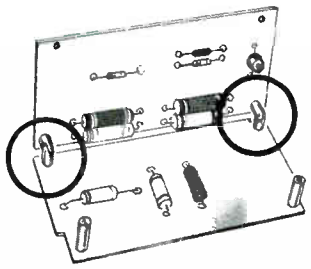

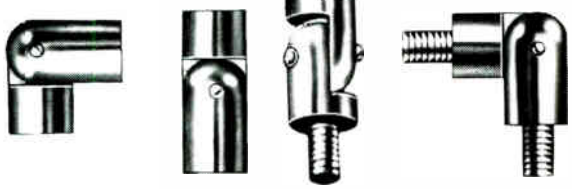

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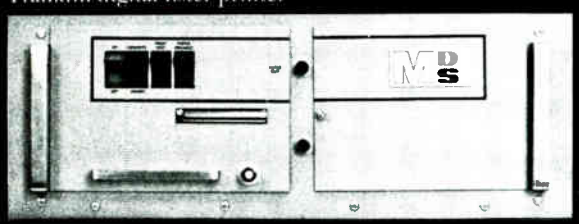

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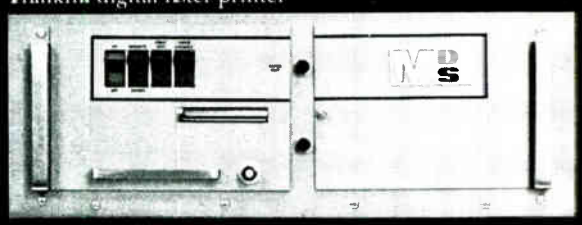


Mohawk Data Sciences Corp.
King of Prussia, Pa.

Circle 135 on reader service card

ond step involves accurately calculating the area of the board to be plated, since that area determines the time that the board should be immersed in the tank. Defiance uses an automatic plating area calculator made by Kahn & Co., Hartford, Conn. This area determines the current density, which in turn determines the voltage on the plating buses. Defiance's chief chemist now continually checks the tanks for composition and bus voltage to maintain them within acceptable limits. He also finds that he has to add extra material more often now to maintain the right concentration.

The area calculation is used only for the high-throw baths for multilayer boards with plated through-holes. Being completely covered with copper, such boards can be immersed in these baths, which have a high fluoride content that tends to attack unprotected epoxy-glass base material. It therefore can't be used either on boards without plated through-holes or on one-sided boards.

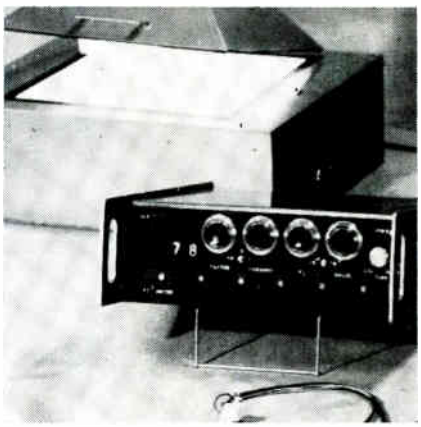
Defiance Circuits Corp., 12 Shepard St., Lawrence, Mass. 01843 **[429]**

Plating-area calculator saves time and material

Plating of printed circuit boards is probably the last bastion of the alchemist in electronics technology. Such factors as time in the tank, the composition of the solution, and the arrangement of the electrodes in the tank have usually been empirically determined, even though electroplating is one of the oldest areas of electrical technology. Now some of the art is giving way to science. A new plating-area calculator from Catoptrics Inc. measures the circuit-pattern area of the pc board and calculates the proper time the board should stay in the tank. The result is less waste of plating time and materials.

The instrument is told the desired plating thickness, the plating current density, and the plating solution, and then, working with pc

New products



Close calculation. Instrument computes area and time from amount of light passing through mask in holder, rear.

negatives measuring up to 12 by 12 inches, measures the area to be plated to an accuracy of 1% and computes the plating time to an accuracy of 2%.

In use, the negative is laid in the holder and evenly illuminated from underneath. Above it is placed a hood that's funnel-shaped to concentrate the light coming through the negative onto the photosensor. The amount of light transmitted is proportional to the clear area of the negative and thus to the area to be plated. This "clear" area, however, is in fact gray, and an advantage of the instrument, according to Catoptrics president George P. Klein, is that it automatically zeroes out the grayness of a negative so that no new adjustments are necessary.

The unit then converts the photosensor output to a digital number for display of plating area, and also uses it to compute the plating time. It handles plating thicknesses from 5 to 10,000 microinches.

The savings offered by the instrument are illustrated by Klein with an example: if 50,000 square feet of boards are plated every year, then a 10% error in estimating area results in 5,000 square feet of extra plating.

The complete unit is available for $2,395; a version without the calculator (it gives the plating area only) is available for $1,195.

Catoptrics Inc., 159 Robby Lane, New Hyde Park, N.Y. 11040 **[430]**

personal business®

APRIL 1971

Travel
Washington's live beat: Lower Georgetown

Dollars
Land deals demanding cash—plus caution
The tax man cometh

Health
Ulcers: A hazard to the man moving up

Housing
On the move: Viewing a new bedroom town

Consumerism
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Puerto Rico: Springtime Junket From San Juan to Mayaguez

Anybody who missed the Caribbean last winter should take note: Springtime in Puerto Rico—Apr. 1 to June 15—is lovely. It's sunny, in the low 80s with a breeze. And there is a pocketbook lure. After May 1, winter hotel rates—$50 to $60 a day double, European plan— drop by 30% to 40%. What's more, bookings are down. You have some leeway.

A workable travel plan is to spend three days in San Juan for some neon culture along the Condado-Isla Verde hotel strip, with a look at Viejo, or Old San Juan. Then rent a car to tour the island for three or four more days before flying home. It makes a good one-week package.

Start with the big strip hotels where swimming pools are atop swimming pools and the gaming rooms are open from 8 p.m. to 4 a.m., with craps, roulette, and "21". Along Condado, the Caribe Hilton, Puerto Rico Sheraton, and Condado Beach (get into the new wing)—are top names in a long list. Fifteen minutes east by cab along the second strip, the big names this season are Americana and El San Juan where night club action goes on late. And there's the more conservative Racquet Club.

Restaurants in the strip area have changed. Current recommendations include Scotch & Sirloin (steak and lobster), Benihana (Japanese steak house), and El Cid and El Cabildo (Spanish). The famed Swiss Chalet has become too jammed, too touristy.

Viejo. In Old San Juan, you can pick up a touch of 16th century Spain (or a touch of stomach distress in the wrong restaurant). Among top attractions: the new Institute of Puerto Rican Culture, a museum of classical and modern native arts; Casa Blanca, the home of the Ponce de Leon family (being restored); and El Morro castle, the 350-year-old fortress that became a national park last year.

Leading private galleries include Casa Del Arte and Galeria Botello, for native arts; Jose Alegria for antiques, and Casa Cavanaugh, now showing wicker, straw and iron furniture. Tip: For bargains in watches or jewelry, go by small airliner to St. Thomas, a 25-minute flight.

San Juan dining spots are as unpredictable as those in Manhattan—especially the Spanish places in Viejo. For such dishes as black bean soup and paella, La Zaragozana ranks first, and El Mediterraneo and La Gallega are runners-up. The well-known Barra China has slipped.

For Old San Juan night life, don't miss El Convento, the Spanish hotel where the night club has striking ballet Español, and the small bar-club provides Puerto Rico's version of the satirical review. Other night spots: Ocho Puertas and Las Cuevas de Altimira.

Piña Colada. A rental car can be obtained in San Juan and driven eastward through the Rain Forest, a botanical garden spot at the east end of the island and particularly lovely in springtime. This is on the way to El Conquistador, overlooking the sea. This flashy resort with its bars, pools,

Personal Business is an exclusive McGraw-Hill feature that you will see periodically in this magazine.

Personal Business takes a few moments to discuss the personal interests you share with other successful people. Investments, health, housing, taxes, travel, books and fashion are a few of the subjects.

Like the rest of this magazine, Personal Business' purpose is to be helpful and we hope you enjoy it and look to it for valuable information.

The hard way to find out you're underinsured.

Inflation has increased the value of the average home by 43% over the past ten years. Unless you've recently increased the value of your Homeowners insurance, your home is probably one of the two out of three homes that are underinsured.

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casino (big enough to house a 747), and psychedelic nightlife is a must on anybody's tour of Puerto Rico.

To unwind, a driver might lunch on fresh fish at the Crossroad restaurant in nearby Fajardo (seafood is generally your best bet in Puerto Rico)—then go south and west along the shore to Ponce (150,000). At this town, the Intercontinental hotel is strictly U. S. style and El Coche is strictly native. Nain's restaurant, in the interesting Rambla section of Ponce, has good steak, and close by, Ladi's seafood is good.

Ponce's art museum with its display of 17th- and 18th-century religious pieces is well worth an hour's stop, before driving westward and north to Mayaguez. Puerto Rico's third city. There the local Hilton is small, pleasant, and has nine-hole golf and deep-sea fishing charters. At night, Bolo's is the place for fresh lobster. And by day, there's a relaxing two-hour sidetrip on narrow back roads to El Monte park where, in springtime, the flowers are worth some color photo shots.

On the road from Mayaguez back to San Juan, the town of Aguadilla has a good lunch stop at the Montemar hotel; and close in near San Juan the Dorado Beach hotel, the VIP stop, is in full sway. A night here is suggested, before tackling San Juan again. Or at least take time to make a trek to the Dorado's bar for a Piña Colada made with Coco-Lopez, pineapple juice and white rum.

Two Piña Coladas will prepare anybody for the jammed San Juan airport, and the flight home.

Sand and sun, and miles of gold and white beaches

Buying in an old world atmosphere: Casa Cavanagh is a restored San Juan mansion dealing in local and the traditional from around the globe

TRAVEL

Washington's live beat: Lower Georgetown

A man who's in Washington this spring for business—or politics— might enliven a night away from the hotel with a visit to "lower" Georgetown, from M Street south. This twisty-street and alley section near the old Chesapeake & Ohio canal is the newest, liveliest "in" locale in the town.

At Canal Square, a bunching of stores and offices around a crooked courtyard, the Port O'Georgetown is humming. This big, pleasant restaurant serves up prime steak and has a bar that is congenial for a late drink. Also in the Square, a gift for one's wife can be found at Teri's Parfumerie, or at a shop called Undercover Things, Ltd.

Down along the same alley is Blues Alley, the best spot in Washington for old fashioned (pre-rock) jazz, where the likes of Wild Bill Davison, the trumpet man, hold the stage. And nearby, a warm-hearted bar called The Guards is the kind of place where students mix with young GOP lawyers. Next door, Number One Son is currently serving some of the best Oriental cookery in Washington. Another new spot nearby: the Potomack, with a menu of 18th century American items such as clam fritters and veal pie with sage.

On the north fringe of Georgetown on Wisconsin Avenue, a smart new spot has become popular with the Administration crowd. It's La Nicoise, with quite good French food and a generous measure served by the bartender.

Around town. Outside Georgetown, the Washington restaurant scene has been spiced with numerous new kitchens. Best is Childe Harold, an eight-table Continental address where the cookery and service are skilled—at $15-and-up per person. Reservations are a must: Connecticut Ave. off 20th. The Golden Table is proving to be a welcome oasis near the State Dept., and Adam's Rib, near the World Bank, is adequate.

Georgetown's tow path, once used by donkeys hauling barges, is now a fashionable walk-way fronting quaint homes. Civil War buffs will enjoy the quiet, historic atmosphere

"I sell nostalgia" says Bill Cannon, owner of Blues Alley

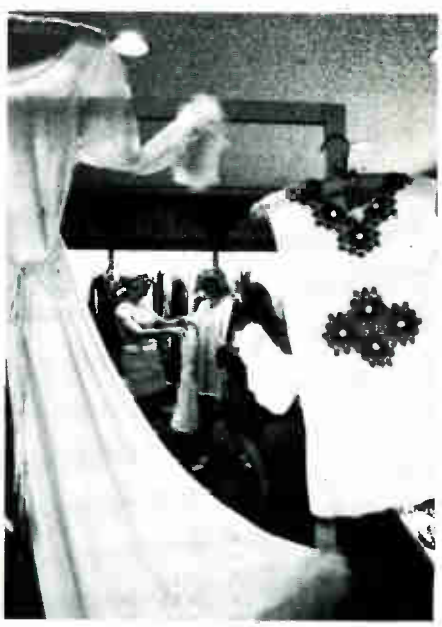
Guitarist Steve Jordon packs in an overflow crowd with music from his days with the big bands of Hirt, Goodman and Kenton

Le Consulat, a regal sort of place located in the Embassy Row hotel on Massachusetts Ave., has a good-quality traditional menu and excellent service. Old-timers' hotel Harvey's the 100-year-plus restaurant, is making quite a comeback at its new 13th and K location.

For anyone who likes the offbeat, The Gangplank—a refurbished barge anchored on the southwest waterfront—has a great view, good drinks, and a seafood kitchen.

Word to the wise: The M street restaurant row just west of Connecticut Ave. has generally disappointed many visitors in recent months. But there's a discovery spot around the corner: Cantina D'Italia. Its entrance on Connecticut is unpretentious—but the food is fine.

The elegant and traditional are both served at Port O'Georgetown. Mr. and Mrs. W. D. Pierson (he's a former White House aide, now a prospering attorney) chose Tournedos of Beef St. George



Under-Cover Things, Ltd. is one of the smart fashion boutiques located along Canal Square

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Land deals demanding cash —plus caution

Land development companies have lately been making a strong move, bidding for the attention and the confidence of investors. These developers, selling lots on the installment plan, are a far cry from the quick-dollar artists who used to palm off the kind of land you locate with a rowboat. From Florida to California, many are working on a sounder basis than in the past. They are under closer federal and state control, have firmer financial backing, and steadier management.

So, today, a buyer can weigh the pros and cons with somewhat more assurance. He can sort out the propositions—and come out ahead.

The plus side. An investor can, of course, do two things: He can buy parcels of bare land, in a price range from as low as about $3,000 to as high as $30,000. Or he can buy shares of stock in the land companies themselves, some of which are listed on the major exchanges.

It is quite possible, for instance, to find some attractive land deals with reputable companies such as Deltona (Miami-based) which, in its Marco Island development in south Florida, is selling residential lots in a $7,000 to $30,000 range. A buyer gets backyard boat-dock facilities, golf courses, and other extras. General Development (Miami) and Amrep (New York) are among other firms with similar properties scattered across the country. "You can do right well by them," says a top Chicago CPA specializing in the field.

The down side. But there are still good reasons to be wary. Impartial advisers report that a number of companies in the land-development business have had little experience. "This is a gentle way to put it," says a New York analyst. Land buyers, for instance, are often lured into deals by blue-sky profit promises. "They get fooled on a promise of 10% appreciation—and find out when they try to sell later on."

Another expert adds this note: "If it's back land without roads, the risks are very great. And whatever you do, don't rely on an airplane tour of a strip of land. This bird's eye view means nothing."

As for buying the stocks of either listed or unlisted companies, you can sum it up this way: The prospects for many companies are generally better than in the past. But there are pitfalls. For example, the method the companies use to report earnings has been questioned.

Rule of thumb: Stick with good, solid names in the industry, and remember that you need more than average brokerage advice in any deal.

The tax man cometh

If your April 15 tax filing gives you that sinking feeling when you think of it being dropped in the mailbox—you're far from alone. The real trouble: Far far too many people in higher income brackets need professional tax help, and stubbornly refuse to get it and pay for it.

A partner in a top Washington law firm and a tax specialist, puts it this way: "At least 75% of executives in the $20,000 to $40,000 income range get absolutely *no* high quality tax advice. Some hire a $25 service—but that doesn't do the job."

Today, especially, with the form 1040 and the revised law itself more complex than ever, a man who's in this class needs a pro's help. But get to the present situation: What if you're one of the 75%?

Try resting easy. A man shouldn't get too flustered if the local IRS office calls him in for a visit. This can happen to a taxpayer even if his 1040 return is as innocent as a spring flower.

Obviously, items such as unusually high charitable or medical deductions—or offbeat things such as the use of income-averaging—can flag a 1040 for closer inspection. High income alone (and this surprises many people) can also flag a return. Today, throughout the whole U.S., there is automatic machine screening of virtually all returns, with the chances for full audit—or partial audit—rising sharply as a man's income goes from $15,000 or $20,000 on up the line.

What happens is, the IRS machine automatically picks out certain returns for what the boys in the trade call an eyeball scan. This means that an IRS examiner makes a quick personal check of the 1040. But only if he sees something amiss does he toss it on the "possible audit" pile.

A simple notice by mail usually means that the taxpayer is in for something less than a full, no-holds-barred audit. Odds are that only one or two specified items on the 1040 will get a going-over. Your best bet is to relax. It's probably just routine.

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Getting tax help. But there's a telltale call that can spell danger. If an IRS agent phones and then appears in person, this may signal a full, detailed audit, with some serious questions coming up. If a man is one of the 75%, it's now a case of getting busy fast and nailing down the personal services of a CPA or tax lawyer. It's a must.

In any case—except for minor matters—a tax man should be used when it comes to going to the IRS office. He will go with the taxpayer, or by himself, and he should decide this. If the amount of money at stake is sizable, and the tax man can't go personally—or at least send a qualified assistant—then maybe the client needs a new tax man.

Facing IRS. But suppose that, after all, a man ends up alone at the local IRS office—what's the risk? A first blunder—and it happens frequently—is to take to IRS all the tax paperwork related to the 1040 filing. Only what is specifically requested should be taken—no more. The danger: opening up a totally unnecessary line of inquiry.

Next, the taxpayer should keep in mind that the IRS examiner—even though he may work in humble civil-service surroundings—is a professional when it comes to putting a 1040 through the mill. "He'll have seen countless returns like yours—remember that," says a New York CPA whose clients include members of top corporate management.

The IRS man won't push anybody around rudely. But he won't miss any tax dollars, either. And note: He has wide discretion in many cases, and the power to exercise his own judgment over a taxpayer's affairs. Good rapport can count. A favorite complaint among agents is that the businessman sometimes "talks down" to them. It hardly pays. An IRS agent can say "no" too often—and cost you money.

If a taxpayer thinks that the agent is wrong, he can appeal within the IRS. But by this stage, any man—who hasn't already done so—should have a reliable pro working the case. Here it's a matter of arbitration, bargaining, and settlement.

Tranquilizer: Over 60% of such appeals are "settled"—and for less than the IRS had originally demanded. Even a full audit needn't be a disaster. About 7% actually pay off with tax refunds, and 40% produce no change in the tax at all. So don't panic when the IRS calls.

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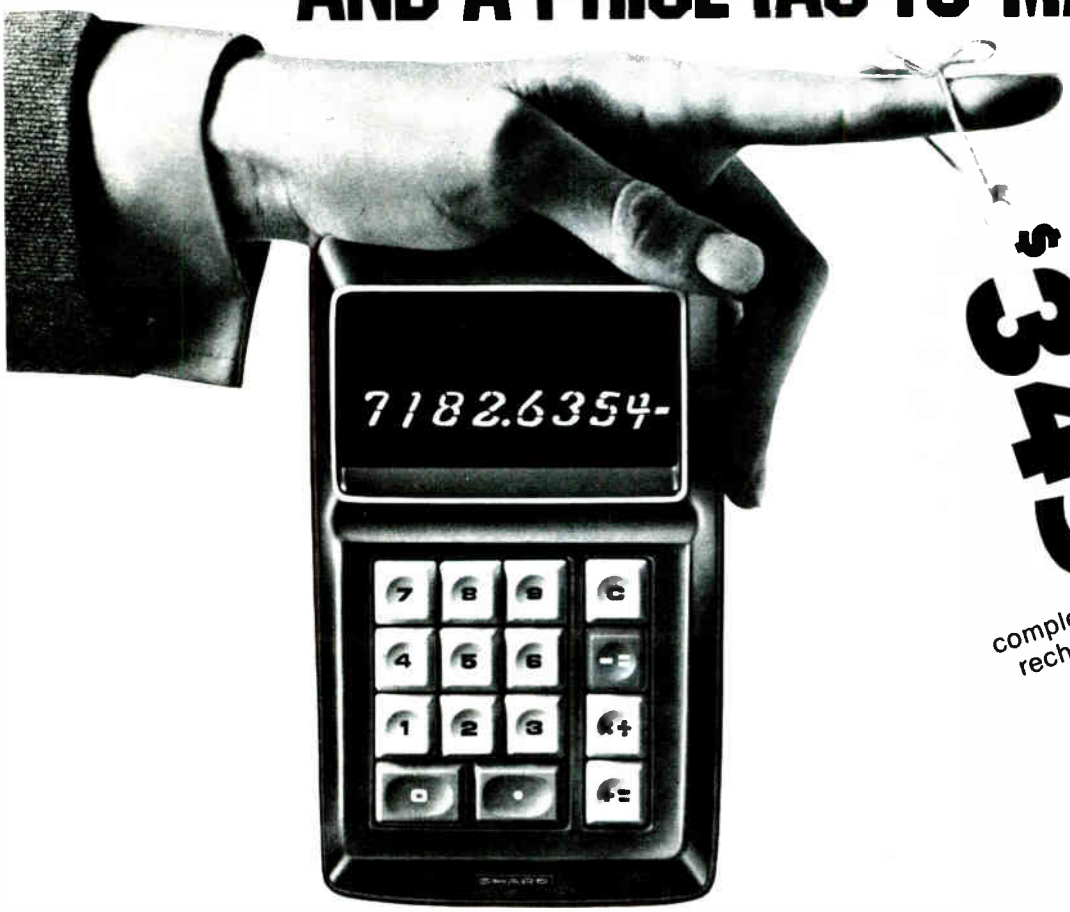

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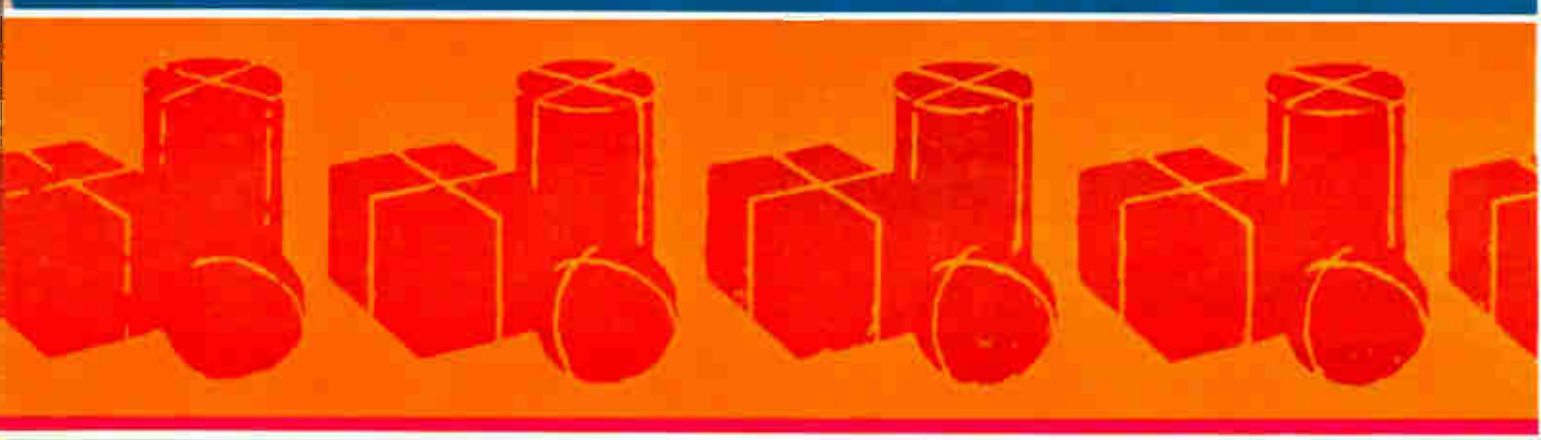

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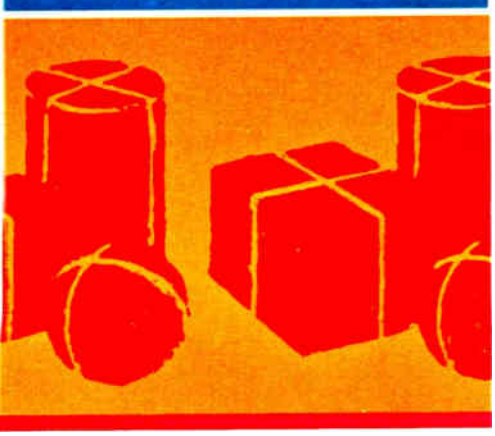

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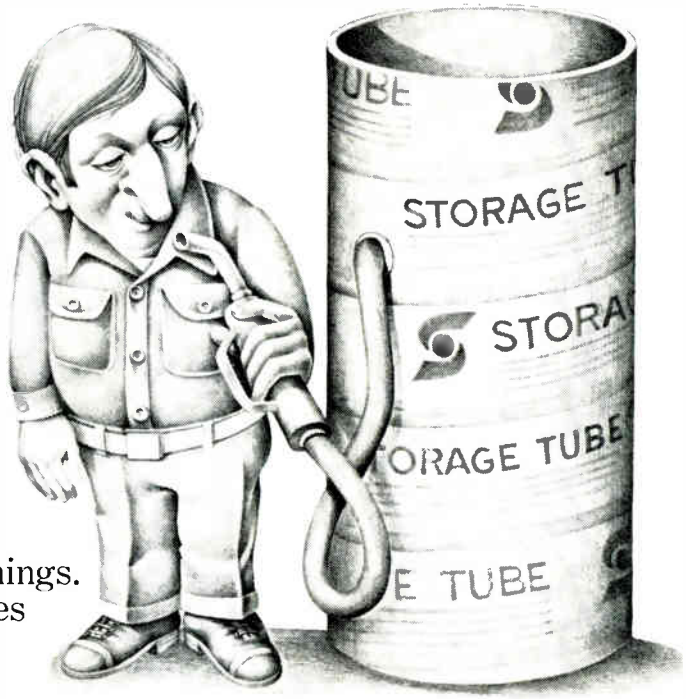

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Ulcers: A hazard to the man moving up

A man over 40—if he's the hard-driving, intense type at the office, and hasn't yet made it to the top—can be a prime candidate for a peptic ulcer. "It's an executive suite ailment that seems to hit hardest at vice-presidents pushing for top slot," says Dr. Richard Winter, director of New York's Executive Health Examiners.

"Presidents give ulcers—and an ulcer giver isn't so apt to get one himself," Winter adds.

In any case, high-pressure jobs can pave the way for an ulcer. This is especially so if the victim is overly conscientious, a perfectionist, and the kind who willingly shoulders all available responsibility. A man with such characteristics—an "ulcer profile"— has an estimated 20% chance of getting one. There's still a 10% chance without that profile. The message: To prevent an ulcer, learn to relax.

The slow burn. Stress lays the groundwork, but physical susceptibility may be a factor, too. For example, the victim's system may produce a heavy amount of digestive acid. "You're a candidate if you get a sour stomach whenever you eat spicy foods," says a top internist.

People with type-O blood may be ulcer-prone, too. Also, some drugs—aspirin, cortisone, and others—can increase acid and lead to ulcers. As to age, highest odds are for a man 40 to 60. Under 60, it's usually duodenal; after 60, it's more apt to be a stomach ulcer, and possibly more serious.

A slow-burning stomach pain just beneath the breastbone is the crucial sign. A clue: It starts an hour after eating—and food dulls the pain, almost without fail.

Eating like a bird. Diet, medication and more relaxation usually provide the answer. But traditional ideas on diet have changed. Spicy foods, alcohol (even beer), coffee, tea—and smoking— are out, as always. But, says a leading specialist, "A dreadfully bland diet isn't really necessary—you can survive comfortably at dinner."

Antacids are still part of the treatment. And tranquilizers, or in some cases minute doses of phenobarbital, are important aids. In stubborn cases, some newer types of drugs are used to block the vagus nerve which stimulates the flow of stomach acid.

But often it isn't the treatment that is the problem—it's the patient. The MDs frequently find it hard to keep people on the diet-medication routine after early

relief is obtained. This is one reason why 30% of all ulcers return within five years. Another is that the underlying emotional problems too frequently go neglected.

In a minority of serious cases, surgery can be the answer. But ulcer surgery is now well within the "highly successful" category, and new methods have eased the burden on the patient. Many surgeons remove somewhat less of the stomach and also sever the vagus nerve (formerly not done). The result: shorter in-hospital time, fewer complications.

Pills. A pill-prone man with an ulcer can get into dire trouble if he goes in heavily for self-medication. He may relieve the usual symptoms. But self-dosing can cover up serious complications, even cancer.

About 90% of all ulcers are the nonmalignant duodenal type. The rest are stomach ulcers. The danger is that an estimated 15% to 20% of all stomach ulcers are cancerous—so it's foolish to avoid a checkup. The smart rule: If symptoms last a week, see a doctor.

HOUSING

On the move: Viewing a new bedroom town

The painful business of changing home communities means more than juggling tax problems and salving the shaken feelings of the kids. Any family man who seeks a comfortable new berth for his wife and children in a strange urban area must pick his suburban bedroom town with great care.

This puts it mildly. It can be a hard job. Men who've lived through lots of moves—and the professionals who advise them—make these prime suggestions:

· First, visit three or four towns in the new area. Then narrow the choice down to one town before you start the tedious job of househunting. Reversing this—a common blunder—can lead to troubles.

· Take patience along with your bankroll. Says New York relocation consultant Michael Schell: "Figure on a month just to pick the town before you even look at a house. And figure on making a few compromises, too—but let them be in the house you buy, not in the town you pick."

The town. The pros stress the idea that smart selection of the suburban town can get a man more for his money in terms of services, surroundings, and convenience. This can be vital, they say, even at a time when real estate prices in

higher-income suburbs are softening and mortgage money is easier to come by.

Often, for example, a "name" town will cost a third more, house for house, than a neighboring area where surroundings are similar and services are likely to be just as good, if not better. Some well-heeled towns have weaker local school systems than less affluent towns because a high percentage of residents send their children to private school. It becomes a case of carefully weighing the pros and cons.

Generally, of course, the best bet is a town or neighborhood—new or old—that will maintain its fundamental character. And this becomes a must if resale is planned in three to five years.

Says a Washington, D.C., relocation adviser: "A village with good resale features can quickly become a dead duck if the woods bordering it suddenly turn into a 1,000-house development." Another old hand points to the danger of buying in neighborhoods bordering golf courses—the club may sell out to a developer. It happens, and frequently.

Agents: Generally, the local bank in town is the best bet for leads to real estate agents. But note: Use a different agent for each town.

Tax side. In top-rank suburban towns, annual tax bills generally range from about $20 to $40 per $1,000 of market value. Caution: Ask the real estate agent the dollar amount of taxes last paid on a house, and find out if there has been a tax boost since.

Check, of course, on planned projects such as new schools—and make sure that the houses you have looked at aren't unreasonably taxed within the area. In any case, warns New York relocation consultant Robert Stahl: "Don't rely on tax 'rates' published by the town—they can be awfully misleading."

Another tip: An inside look at the town hall can be revealing, and usually straightforward answers can be gained from town officials. Spend an hour in the municipal building, an hour at the high school, 30 minutes at the library, and have lunch in the town restaurant—and you can get a surprisingly clear picture of a typical bedroom community.

Fire protection?—this can be gauged by comparing insurance rates.

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Golf gear and garb

If you need new golf clubs—order now. A golfer should figure on two or three weeks to have his order filled for a quality set, assuming he isn't lucky enough to find the particular set he wants in stock.

This year, say the golf pros, lightweight steel alloy shafts are the order of the day, with aluminum falling far into second place among country club buyers. The theory: With any lightweight shaft, more of the weight goes into the club head—and this means a little more distance on the fairway. Note, too, that some reports show that stainless steel shafts cause problems for the advanced golfer.

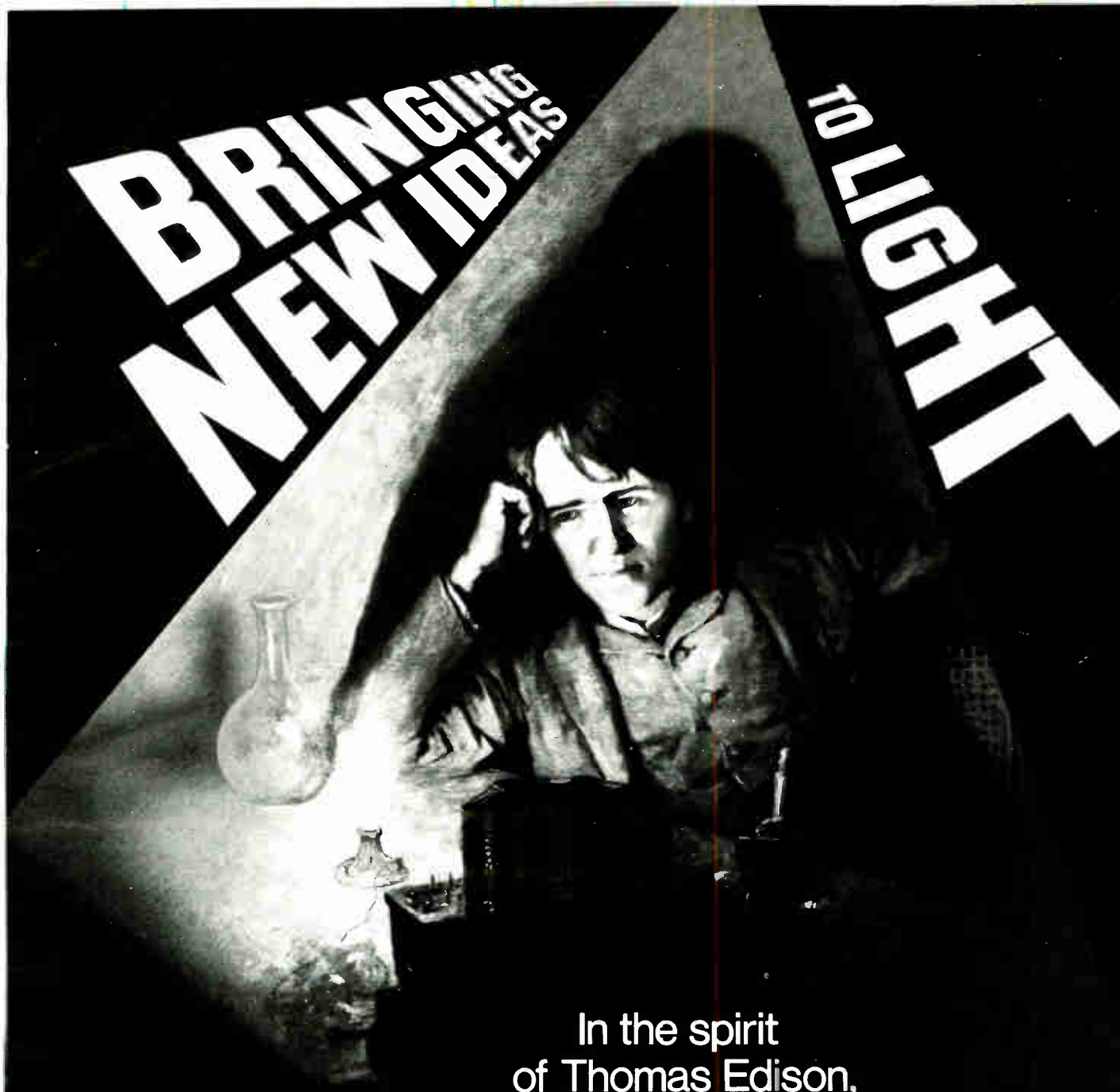
Prices high. A set of quality "proline" golf clubs—4 woods, 8 irons, putter, wedge—runs about $350 to $400 (MacGregor, Spalding, Wilson, Ben Hogan, etc.). A "store line" set of 14 clubs in the same brands will fall in the $250 to $300 range. It's a question of going to "pro" shops and stores—and shopping with care.

Good quality vinyl golf bags range $50 to $100, with leather $150 and up, and corfam about $200. Top-quality golf shoes of corfam or leather are $35 to $40, with Foot Joy's Aztran shoes at the high end.

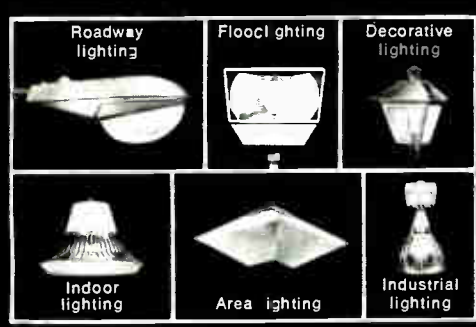
New lightweight pull carts for toting a bag run $25 to $35, and carts with colorful fabric bags built-in, $50.

Garb. To spruce up a sports wardrobe, even a conservative golfer needn't hold back on buying vivid colors. For instance, at higher-bracket shops, wash-and-wear pants are appearing this season in burgundy, paprika, as well as bottle green. Washable, permanent-press stretch pants of double-knit Dacron are popular. Alpaca sweaters are back again—and in bright colors, at $40 and up. Floppy brimmed golf hats of poplin cotton are in style, too; they're comfortable, practical, at $7.

BRINGING NEW IDEAS TO LIGHT



In the spirit of Thomas Edison, General Electric brings you a brilliant array of new lighting ideas



General Electric traces much of its lighting inspiration to the spirit of Thomas Edison. It's in this tradition that innovation, efficiency, quality and good looks are designed into General Electric luminaires for high-intensity discharge lighting systems — indoors and out.

You can now provide safety, beauty, economy, and convenience for places people work, walk, park, play, drive or fly. Find out more about GE's idea-inspired lighting systems by writing "Lighting Ideas," General Electric Company, Hendersonville, N. C. 28739.

With a General Electric lighting system, you too can bring new ideas to light!

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GENERAL ELECTRIC

Sports beat: Boats, country clubs

This season the boat dealers are showing more and sleeker new hulls and topsides than could possibly be floated in a square mile off the shores of Newport. But insiders say this: Inspect the sleek new stuff—but remember that this may be an excellent year to buy a second-hand craft. For instance, the top-rated New York yacht brokers, Sparkman & Stephens, have reported that boat-for-boat this year's prices of used boats are down roughly 10% to 20% from last season. One recent example: a 36 ft. wooden craft ("best buys are in wood"), priced last year at $22,000, sold this year at $15,000. . . . In Chicago, dealers report good-quality second-hand boat buys, and occasional "sacrifice" sales. It all depends on your area—so shop around. . . . And note: Despite all drawbacks, new boat prices are up roughly 10% over 1970.

Some golf and country clubs are in trouble financially—maybe yours included. A survey by Harris, Kerr, & Forster, club experts, explains that though club revenues were up an average 4.4% in the last year, costs increased a good 6%. Most clubs, says H-K-F, are being murdered by zooming real estate taxes and other woes. Many if not most will lay on substantially higher dues in 1971. So you're not alone. . . . H-K-F points this out, in case you want to nudge a member of the club board: Many golf clubs are suffering from weak management. A top-grade professional manager ($20,000 to $40,000), says H-K-F, can save a club several times his pay each year.

The dollar parade —how to make it and keep it

Tax notes: Anybody who hasn't passed the $20,000 mark in income, and who takes the standard deduction, can have Internal Revenue fill out his tax return. IRS figures the tax, and either sends you a bill or a refund. If billed, there's a 30-day period in which to pay (no interest charged). It's a way to save some sweat, if no cash. . . . On the domestic side: If you hire fulltime or part-time domestics (ranging from nursemaids to cooks) and wages amount to $50 or more in a quarter, you owe Social Security tax on 5.2%, so does your employee (up from 4.8% each last year). Thus, the total is now 10.4%. The penalty to you for not paying is rough: all back taxes due (both shares), plus 6%, plus up to 25% of the back tax. Check with your local IRS—or maybe your tax adviser, if this has been a long-neglected obligation. Next due date is Apr. 30.

Smart money dept.: *How to Invest in Gold Coins*, by Donald J. Hoppe, is a good book about coin history and the practicalities of developing a collection. But this is more than fun, says Hoppe. If you want a safe place to put your money—you can't beat it (Arlington, $8.95). . . . *Careers:* Top advisers in the field of careers and compensation suggest that at least two books are outstanding for the man who is at a career-crossroad—or, frankly, out of work: *Realizing Your Executive Potential*, by Allan Rood (McGraw-Hill), reviews all the basic elements of corporate career planning. And Carl Boll's *Executive Jobs Unlimited* (Macmillan) deals successfully with the psychological side of making career adjustments in midstream.

From Margaritas to Rob Roys

Acapulco is a pleasant spot in April and May. Here's a current report: Best hotels remain the Pierre Marques (out of town, beautiful beach, great golf), Las Brisas (unique hillside spot), Ville Vera (in the hills, too, with fine tennis courts), and Malibu (a la Hollywood). But the big Acapulco news is the private club, Tres Vidas En la Playa. It's ultra ultra, has everything from championship golf to the best Margaritas made anywhere. A *must* is to use your top VIP contacts in Mexico. . . . Best restaurants in Acapulco: Normandie, Portofino, Chateau Vic's (international), and Paradise (seafood). Suggested night spots: Le Club, Le Dome, Tequila á Go-Go. Things to avoid: spicy foods, street vendors, coats at dinner. Note: Acapulco has a number of fine new high-rise condominium apartments in the $30,000 to $90,000 range . . . In London: Stop by the Dorchester in Park Lane and ask for the bar, and order a "perfect Rob Roy": Shake with ice ¼ oz. dry French vermouth, ¼ oz. Italian vermouth, and 1 oz. of good scotch.

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International Newsletter

April 12, 1971

ESRO proceeds with its own Aerosat

After effectively being shut out of participation in the first U.S. aeronautical services satellites over the Atlantic and Pacific [*Electronics*, Feb. 1, p. 69], the European Space Research Organization has decided to design a rival system. To speed design, ESRO has bypassed competitive bidding and has awarded three $600,000 contracts to European consortia for system studies aimed toward presenting a complete project at November's International Civil Aviation Organization meeting. Consortia leaders are France's Matra, the British Aircraft Corp., and Germany's Messerschmitt-Bolkow-Blohm. **Each group has an American partner—respectively TRW, Hughes Aircraft, and Boeing/General Electric.** ESRO officials emphasize the noncompetitive studies will not stick to France's "Dioscures" project, basis of much past ESRO work, but will examine U.S., as well as European, hardware.

Dieter Lennertz, project chief, says ESRO still hopes the White House will change its policy and collaborate with Europe—and he adds that signs point to such a shift. **But if not, ESRO hopes to launch preoperational Atlantic and Pacific satellites in 1974-75,** with other countries—possibly Canada and Japan—included.

Marconi-Elliott slates big push in small computers

The U.S. firms that dominate the small computer market in Britain for the first time can expect some real competition from a native firm—Marconi-Elliott Computer Systems Ltd. M-E is bringing out a new minicomputer line, **but more important, it can count on substantial market support from its parent, General Electric Co. Ltd.,** making it the first British minicomputer series to get the development, software, and backup effort that goes behind American machines. The system is competitively priced at the small end—$7,000—and goes to $120,000 at the top end.

The machines—real-time controllers for all process operation and communications applications—are abreast of U.S. state-of-the-art technology. **Store cycle time is 950 nanoseconds and maximum direct access data transfer rate is 800 kilobytes per second.**

Motorola signs second-source pact with Italy's SGS

Motorola and Italy's SGS have signed a second-sourcing deal that several European observers feel **could lead to a closer reapprochement.** The two will make each other's consumer linear ICs and high-level logic circuits. SGS later will likely produce Motorola's MECL 10,000 high-speed logic family. The companies will exchange IC masks and technical data but make no payments to each other.

One insider believes Motorola eventually could buy out SGS's bipolar IC business, leaving the Olivetti subsidiary, which once was one-third owned by Fairchild Camera & Instrument Corp. [*Electronics*, May 26, 1969, p. 181], its growing MOS line. SGS reportedly needs money to pay off a $32 million bank debt, more than half of it used for MOS development. Roberto Olivetti, president of the parent company, has said he **would like SGS to concentrate on MOS circuits for the company's office calculators.** Robert Heikes, European general manager of Motorola Semiconductor Products Inc., says a merger or partial takeover "would be very beautiful but it doesn't seem reasonable to us at this point." He admits, however, that the second-sourcing deal could be broadened.

International Newsletter

Gunn switches for fast memories?

Experiments with Gunn diodes could lead to computer memory devices with improved speed and simplicity, say researchers at West Germany's Institute for Solid State Physics. **The experiments are being carried out with special Gunn diodes that could be used as bistable switching elements operating at subnanosecond speeds.** Team chief H. W. Thim says the new diodes show current-voltage characteristics similar to those of Gunn oscillators or tunnel diodes, but with a significant difference—oscillations are suppressed in the new device.

Tunnel diodes have proven impractical as switching elements because they are difficult to stabilize—parasitic reactances in connecting leads tend to set up oscillations. And traveling domains in conventional Gunn devices make logic circuitry complicated. But in the new stabilized Gunn diodes, oscillations are suppressed by using high doping levels and keeping doping deviations below a critical value. Two stable states are achieved—a low-voltage, high current state and a high-voltage, low-current condition—**and switching occurs at less than 100 picoseconds.**

Siemens to handle Fujitsu control gear

Japan's Fujitsu Ltd. has signed a five-year agreement with Siemens AG for the West German firm to exclusively handle sales and servicing of Fujitsu numerical control systems throughout Europe. Initially Siemens will add five models of Fujitsu's Fanuc numerical control line to the six models of its own Sinumerik gear. **Fujitsu expects sales of its equipment in Europe will be 40% of Siemen's numerical control bookings.**

Fujitsu feels this an effective method of competing with gear made by GE in Italy, because it would be difficult for Fujitsu to sell directly to European machine tool manufacturers. **In the future, Fujitsu also expects to advance into the American market**—but probably by having an American company make the controls under license.

Japan slates major boost in value of computer installations

The Ministry of International Trade and Industry has set a goal of $9.72 billion for the value of Japanese computer installations by 1975, 5.7 times greater than the value at the end of 1969. The figure would represent about 2.5% of the expected gross national product in 1975, **equal to the computer installation/GNP ratio in the U.S. in 1969.**

The goal will be the basis for the government's computer policy, and will be influential in loans from government banks to the Japan Electronic Computer Co. Ltd.—the joint venture that buys computers from domestic manufacturers and rents them to users. MITI's goals also call for a 12-fold increase in sales of the EDP services industry by the end of fiscal 1975 **and a 6,200% boost in sales of software.**

Addenda

IBM plans to open its eighth overseas product research and development lab this year, in Japan. **One purpose of the lab is to develop input/output devices capable of processing Japanese written characters.** . . . The Swedish telecommunications administration is operating a computer-based system that presents three-month "profitability reports" on the agency's 7,800 vehicles. The reports give notice when a vehicle has reached its repair ceiling and should be sold or traded in. . . . **Matsushita will start producing solid state 25-inch color TVs at its subsidiary in Puerto Rico for sale in the U.S.** Capitalization of the plant will rise to $3 million from $100,000 and 100 new workers will be added.

Duplicator spins out 500 video tape cassettes

In drive to establish its VTR approach, Sony is marketing a complete dubbing package, will rent duplication time

There's been no lack of activity in the fast-moving video tape recording sector, but what has been lacking is a software production capability. By the end of the year, though, Sony will be supplying this missing link when it starts delivery of a complete equipment package for producing prerecorded video tapes. The company expects the availability of tapes to supply a strong sales push for its complete consumer VTR package [*Electronics*, Feb. 15, p. 11E], though the educational-industrial market is the current target.

To make its duplicator system work, Sony has developed a high-quality helical scan video tape recorder as the master program source. This recorder drives a bank of up to 500 printers that duplicate tape in real time. This master tape recorder provides broadcast-quality performance at far less cost than the four-head recorders commonly used in broadcast studios. Signal-to-noise ratio, for example, is at least 49 decibels on the first copy, and at least 43 dB to the fourth-generation copy, high enough to guarantee negligible losses in quality during editing or assembly. The master unit will sell for $25,000 in the U.S.

The key factor in the unit's high quality and low cost is the use of a "1.5-head" recorder with 2-inch wide chromium oxide (or equivalent) tape. The 1.5-head scheme, says Sony, is not prone to the color-banding noise and "venetian blind" effects that can degrade the performance of four-head systems.

In the usual helical scan recorder, the two heads record or play back alternate horizontal scanning lines, thus permitting possible periodic signal variations if there is any difference between the two heads. While Sony's recorder uses two heads, one records or plays back only the picture information portion of the signal, and the other the vertical blanking period sector. The portion of the signal handled by the "1" head is greater than that handled by the ".5" head, hence the 1.5 name. With this setup, picture information on each line is recorded or played back so that there's no switching during the line nor any change of heads between lines.

As in other high-quality color recorder, high-band, direct-color recording is used. Sony also employs a double heterodyne system for color subcarrier correction after playback. The signal format accommodates the stereo sound included in the video cassette system. All of these features are retained even after the master recorder's tape speed was reduced to 8.58 inches per second to allow 93 minutes of recording time on a standard 10.5-in. reel of video tape. And although video cassettes initially will offer only 63 minutes of recording time, it is expected to be extended to about 90 minutes by using thinner tape—and Sony wanted its duplicating system to have this time capability with standard tape.

The cassette printing system consists of a bank of up to 500 printers, four to a relay rack, and associated main control, monitor, and distribution systems. A master recorder signal is fed into the printing system as an input. Then all recorders in the system start simultaneously. Printing is in real time at 3.75 in./s on chromium oxide tape.

When the recording operation is completed, the printed cassette pops out and another blank unit is automatically readied for printing. Since printed cassettes can be collected and blank ones inserted at each position while the printing operation is going on, one person can service the entire system without idle time. Price of such a system, consisting of one controller rack and five printer racks with four printers each, will be $97,222 in Japan. Later this year Sony will produce cassettes from either film or tape masters through its worldwide service centers. A minimum order of 50 cassettes will cost $5 each.

Japan

Thin film RC filters are stable and versatile

Researchers at the Nippon Telegraph and Telephone Public Corp.'s Electrical Communications Laboratory have come up with a new series of thin film distributed RC filters that promise impressive performance, versatility, and ease

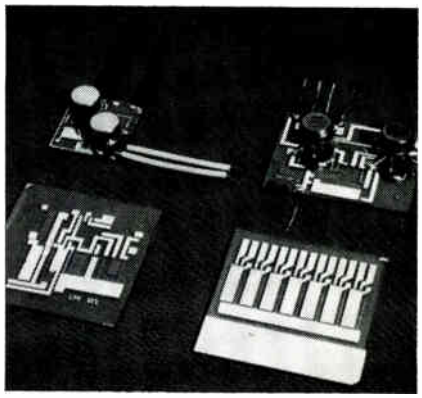
of fabrication. The basic design is a notch filter, but the new units can be combined with transistors to form oscillators, and active bandpass filters, too.

One of the most promising applications for the thin film devices is twin T filters for use with audio-frequency integrated circuits. Selectivity is usually achieved with discrete RC circuits fabricated with discrete components—three resistors and three capacitors. But the NTT researchers believe that very similar results can be obtained with a thin film distributed bridged T that would use only the equivalent of two components.

The devices feature improved operating characteristics—notably a better temperature coefficient. Conventional tantalum thin film filters have temperature coefficients ranging from —50 to —150 parts per million per degree C, with typical values of —80 ppm/°C. But measurements on the new devices show that temperature coefficient is less than —40 ppm/°C and researchers are hopeful that values as low as —10 ppm/°C can be obtained.

The thin film devices also exhibit impressive Q values, say the NTT researchers. A prototype 1-kilohertz filter shows a Q of 24, while a 10-kHz filter with a Q of 60 has been made. In this case Q is a measure of the frequency band passed by the active filter built around this thin film filter.

Another big feature is simplified fabrication. In the old manufacturing operation, beta tantalum is sputtered on a glass substrate, and is etched to the shape of the capacitor conductive electrode. The appropriate portion of this electrode then is anodized to form a dielectric. This is followed by sputtering of tantalum nitride and etching to form series and shunt resistors. The final steps are deposition of gold and etching to form contacts. In the new process, the resistance elements and the capacitor dielectric are fabricated from the same tantalum film, eliminating entirely a vacuum deposition step that was considered a major bottleneck in production.



Filtered. Thin films give 10-kHz and 1-kHz active filters (top left and right) and lowpass and seven-frequency notch filters (bottom).

Size of the new circuits has been kept small, and may go even smaller. The 1-kHz filter, with its two transistors, mounts on a 35-by-27-millimeter substrate. The 10-kHz prototype, designed for selecting the control signal from an earth station or for use in a communications satellite mockup, mounts with its two transistors on a 20-by-27-mm substrate. And the substrate could be reduced to 20 by 10 mm, say the researchers. Including their transistors, both filters have a thickness of 8 mm. Also fabricated were seven notch filters on one substrate, for use in the oscillator of a pushbutton phone, and both low-pass and high-pass filters.

East Germany

Communications equipment stars at Leipzig Fair

With their lineup of new communications gear at the Leipzig Fair, the East Germans once again demonstrated where a major part of their electronics effort goes. At the bustling industrial show, the East German stands glistened with everything from simple handsets and test transmitters to elaborate pulse code modulation systems and wide-band microwave gear.

As the fair closed its doors last week after a 10-day run, the communications sector had in sight another strong year, with output expected to increase by 15% and likely to surpass the $550-million mark.

As usual, much of the sector's vitality is coming from thriving export business, which accounts for roughly half of total communications production—business mainly with other Socialist countries. The stress now is clearly on high-frequency, multichannel communications systems, because in the East, as elsewhere, the scarcity of unused frequencies at the lower ranges is becoming a big problem. Besides, the increase in telephone traffic is creating a growing demand for upgrading existing links.

Examples of East German exports are large-scale deliveries of 4-gigahertz carrier systems designed for transmitting either 600 or 960 telephone channels. The state-owned VVB RFT communications combine is now installing similar gear for the Soviet railway system. In numerous other Eastern countries—among them Poland, Hungary, Bulgaria and Romania—RFT is also putting up new teletypewriter links or expanding existing ones. Other RFT projects abroad are outfitting the Czech telephone network with new automatic exchange systems and transmission gear, installing a communications link in Yemen, and the delivery of a second RFT radio transmitter to Cuba.

Now, apparently with an eye towards an even bigger slice of world markets, the East German communications industry is getting set for a massive demonstration of its engineering knowhow at a trade show in Western Europe. The event: Telecom 71, the big telecommunications exhibition to be held in Geneva from June 17 to 27.

Among the East German exhibits at Geneva, a likely attention getter will be a multi-channel, wide-band microwave system designed to operate in the 4- and 11-GHz frequency ranges. The system, termed BES, was developed at the Institute for Communications Technology at East Berlin by an engineering team headed by J.P. Rehahn.

Built around a modular concept, the BES equipment has a maximum transmission capacity of 300 telephone channels between 10.7 and 11.7 GHz and of 1,800 telephone channels between 3.4 and 3.8 GHz. Instead of telephony, the BES system can also be used for one video channel, including four sound channels, at either of the system's two frequency ranges. Except for the transmitter power stages, which use traveling wave tubes, the system is completely transistorized.

For unattended operation, the BES system is fitted with circuitry for remote monitoring and remote control. The signals required for these jobs are transmitted via a narrow-band service channel operating off the same antenna as is used for wide-band transmissions.

Another noteworthy piece of East German equipment is a system for receiving weather pictures from meteorological satellites. The system, designated WES 2, was designed at the Central Institute of Solar-Terrestrial Physics at East Berlin and manufactured at the workshops of the German Academy of Science there.

Unlike conventional receiving systems which use an elaborate, circularly polarized, helix antenna, the WES 2 employs two linearly polarized antennas in a crossed-dipole, or turnstile, configuration. With such antenna design, East German engineers say, there's no need for the receiver to track the satellite. It is this feature that makes the WES 2 especially suitable for mobile applications.

France

Towards satellite relay of TV programs

When France launches its fourth television network around 1980, thereby exhausting its available uhf channels, there is an excellent chance the French will turn to satellites for direct transmission of additional programs.

Such, at least, is the argument of a new cost study of alternative transmission systems, prepared by the French television authority and France's space agency. The study was presented at an international conference on space communications held in Paris earlier this month.

The study compares costs for a conventional ground microwave system against those of three satellite systems. One would beam programs direct from satellite to TV sets. Another would use a common ground antenna to send satellite transmissions to sets by cable. In the third, a mix these two systems, cables would relay satellite broadcasts in towns of more than 2,000 people, and individual sets would receive them directly in more sparsely settled areas.

Actually, the study finds the conventional ground microwave system the cheapest at the moment. It would cost $104 million in investment plus $18 million a year in operational expenses. All figures are based on present costs, not allowing for inflation between now and the 1985-90 launching date.

But the study recommends the "mixed" system as the most flexible and probably the cheapest by the 1980s, due to evolving technology. If built today, the satellite relay to both TV sets and cable-antennas would cost $113 million plus $20 million in annual operating costs.

The most expensive system, not surprisingly, would be to relay programs direct to TV sets. Each receiver would require a 3-foot-diameter fixed parabolic antenna, which would add some $215 to the cost of a set—though the study's authors figure a collective antenna for apartment-house dwellers would cost only $325, reducing individual outlays. All told, the study pegs costs of the individual-set system at $195 million plus $34 million a year in operating costs.

A satellite system requiring direct transmission to TV sets would need a 320-pound satellite containing two 500-watt repeaters, for two programs, operating in the 12-gigahertz waveband. Two satellites would be launched to have one as a spare.

A satellite transmitting only to a community antenna hooked by cable to TV sets could be much smaller. It would weigh around 180 lb and contain two 30-W repeaters. Either satellite could be launched by Europe's planned Europa-3 launcher or by an Atlas-Centaur rocket if the U.S. were willing to cooperate.

France's Thomson-CSF reported success in developing a high-gain antenna for satellite TV-relay ground stations in the 10.70- to 35-gigahertz range. The broad range of the 28-foot-diameter, cassegrain-type antenna was made possible by using a "pipe" as the primary source, illuminating the auxiliary reflector in its Rayleigh zone. The experimental antenna was developed under a contract from the French agency for telecommunications research.

Great Britain

A computer designed for character recognition

A conventional digital computer cannot learn from experience in the same way that human beings do. When faced with a new situation, a computer is not able to select automatically from its memory only the data that, if it were human, its experience would tell it was relevant. But, recognition of speech patterns and hand-written characters, for example, depend heavily on just such experience for quick execution.

For about five years, Igor Aleksander of Kent University has been looking for ways to do the job using a computer that is neither impractically large nor slow. About three years ago he worked out the configuration of a microcircuit module, which could be organized in networks that could learn from experience. A simple machine has been built to gain experience of how the modules work, and a much larger machine containing over 1,000 modules is likely to be working by summer.

Aleksander calls his basic mod-

ule SLAM, for stored logic adaptive microcircuit. In computer terms it is a bit-addressed binary store, eight bits in the early versions and 16 bits in the latest version. The latter has four inputs to a decoder followed by 16 flip-flop stores. Each store is pre-set with either a 0 or 1 through separate terminals. Four-bit words at the input are decoded to address the stores one at a time and the state of each store is transferred to the output terminal of the device for reading. Hence the device can store any one of 65,536 binary numbers. It is made for Aleksander by Integrated Photomatrix Ltd. as a 400-transistor MOS chip in a 14-lead dual in-line pack.

What interests Aleksander is the ways the individual devices can be made to behave in networks. When his machine is complete some of the most important experiments will be aimed at reliable recognition of handwritten characters. Characters will be exposed to a 16-by-16-matrix of light-activated switches, so that those in shadow switch off. The 256 parallel outputs from the matrix will feed the address inputs of 1,024 four-input SLAM modules, arranged in 16 layers of 64 modules.

In one layer of 64 modules, the distribution of connections between the matrix and the modules is essentially random. When a character is shown to the matrix, each SLAM module will receive a four-bit binary word corresponding to a random sample of the matrix. The stores so addressed can then be set up in some particular way (for instance, all in the 0 state) so that the 64-bit word on the output of the 64 SLAM modules corresponds to that character.

Whenever that character reappears at the matrix, the same stores will be addressed and the same 64-bit word will appear at the output. More important, if a subsequent character is similar to the original but not exactly the same, as with handwriting, the output word will be close enough to the original to be automatically classifiable with it, Aleksander claims.

In practice, 64 four-input SLAMs will not provide sufficient discrimination, so that similar but different letters would be classified as the same letter. Aleksander will use 16 layers of SLAMs with the matrix connected in parallel, but each set of connections will have a different random configuration.

The system's capability can be greatly extended by incorporating feedback. Aleksander feeds back the SLAM output, through decoding, to the address inputs. If the store content corresponds to the letter being shown to the matrix, feedback and input will coincide and the system will stabilize, establishing that recognition has been achieved. If the feedback store content and the input do not coincide, the randomly superimposed signals will produce an output that changes until the store content corresponds to the input. In character recognition jargon, this is an automatic "cleaning up" operation.

Feedback offers a simple way of recognizing sequences of letters. In handwriting analysis, it is often necessary to consider the word as a whole in order to recognize it. The stores can be set up for likely sequences, for instance T followed by H. The sequence would be fed back and the system will stabilize a recirculating TH if that is the input from the matrix.

Switzerland

Computerized system routes and handles telegrams

Swiss postal officials by May expect to log a milestone in communications when, after five years of preparation, they will have in operation Europe's first computer system for processing and routing telegrams.

Telegrams, Swiss postal officials recognized, lend themselves well to computer handling. The heading of each telegram contains the essential data required for processing—place of origin, identification, degree of priority, charging and accounting criteria, addressee, destination, etc. Such data can be handled easily by logic operations in data processing equipment, as can auxiliary operations such as filing, international accounting, calculation of payments, and compiling statistics.

The Univac division of Sperry Rand Corp. beat about half a dozen other contenders in the competition for the Swiss system. Called Ateco, (automatic telegram exchange with computer), the system will be put into operation in May. Its cost will run to around $7.5 million for all hardware and plant.

The heart of the Ateco system is a computer center in Zurich, Switzerland's terminal for international lines—about three-quarters of all Swiss telegram traffic passes through the city. To insure complete operational reliability all computers and peripherals are triplexed—three parallel chains of equipment work synchronously and process each telegram simultaneously.

The Zurich Ateco center houses three Univac 418 computers, whose ferrite core memories store more than a million bits each. The computers are interconnected by relays for synchronization. Each chain has a mass memory consisting of two magnetic drums, which can store 14 million characters. This memory, with a mean access time of 10 microseconds, is used as a store for telegrams pending processing by the computer or a free outgoing line. It also contains the lists of destinations, telegraphic addresses, opening hours of offices, and a complete library of control programs.

Two other magnetic drums in each chain serve as large-capacity memories, accommodating 132 million six-bit characters. Because of size, access time is long—around one-tenth of a second—but the contents are all telegrams routed during the prior 48 hours. These memories also are used for certain telephone services in the Zurich region, incorporating, for example, all the data from the records pertaining to fault-finding and clearance for the region's 350,000 telephone subscribers. Uniscope display terminals are used for this service.

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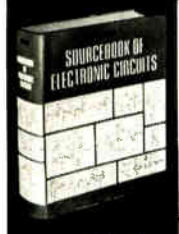

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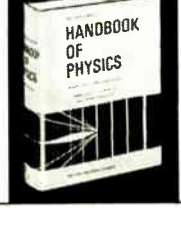

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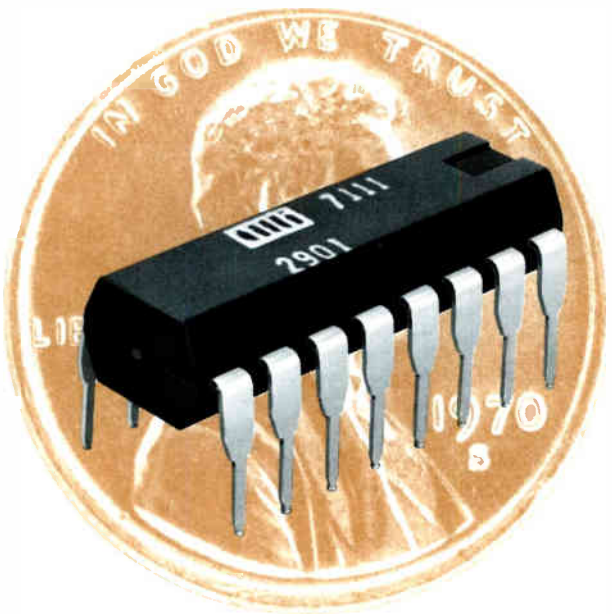

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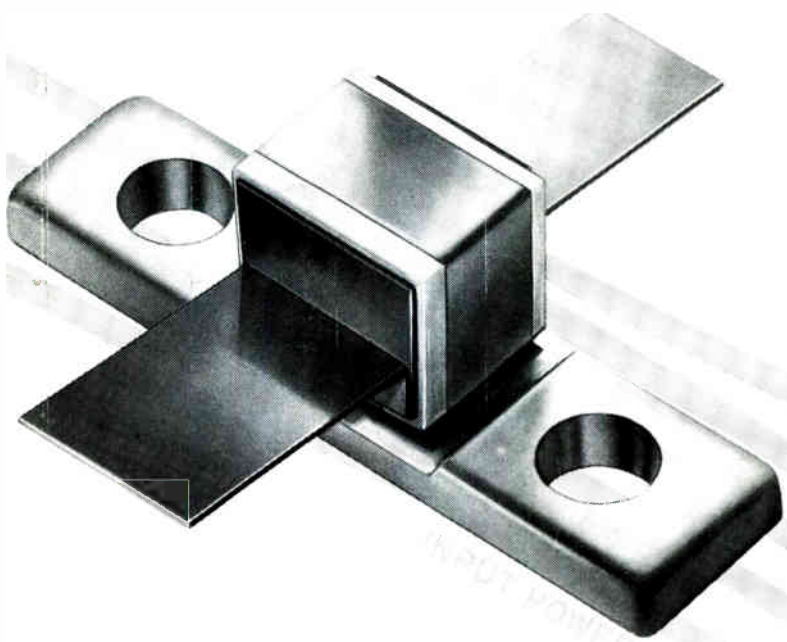

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