May 8, 1972

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Electronics

The International Magazine of Electronics Technology

May 8, 1972

Highlights

U.S. tries to boost technology export, 65
Government agencies have ambitious plans to stimulate electronics exports. But they are being frustrated by the mixed reactions of industry and outright opposition of labor.

Special report: tangled path to wired city, 91
That return link necessary to achieve two-way operation for the wired city creates a snarl of troubles, but solutions are being found in suburban experiments.

Special Report: n-channel races to market, 106
Development of practical fabrication processes has started makers off on a race to produce high-speed, high-density, low-cost n-channel RAMs for a market that may reach $200 million by 1975. Also:

- Intel begins production of two dynamic shift registers and a static RAM—all TTL-compatible, 107.
- Coplamos process by Standard Microsystems controls parasitic currents through oxide-isolated MOS, 111.

SJCC to highlight peripherals, 141
Computer show exhibitors will also demonstrate how to get the most out of data processing systems, especially through use of communications techniques.

And in the next issue . . .
Prospects for trade with Eastern Europe . . . putting EEs back to work . . . packaging LSIs in plastic . . . computer-aided design of C/MOS logic.

The cover
Tangle of wires symbolizes the obstacles that lie between the promise and the payoff for the many services that two-way CATV could bring to the wired city.

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Publisher's letter

The wired city—the not-so-fanciful description of a community transacting its business, organizing its entertainment, even alerting its security personnel to disasters via two-way cable links—is now being tested in several communities. Our special report on page 91 details the advances—and pitfalls—on the road to the wired city.

"There are some who say that two-way CATV systems will revolutionize the use of television," says Jerry Walker, our consumer electronics editor. "But not many people talk about what could be one of its most lasting effects: the ability to find out instantly what all subscribers are watching and for how long. That information could bring about a whole new era in programming experimentation, especially where an economically significant audience segment, even though not a majority, could be identified."

Although it will not be until the 1980's that this all-encompassing preference research will be available, the implications for program producers and sponsors is clear. As Jerry, who prepared the report, observes: "While watching a demonstration of a polling technique, I realized that I couldn't wait for the day when I'd know that turning off my set registers one vote against a show I dislike, even though this is a kind of passive complaining. Unfortunately, when the set is on, the broadcaster will not be able to know if anyone is actually paying attention to it. Falling asleep will still be the big undocumented passive protest for many viewers."

The sudden blooming of n-channel metal-oxide semiconductor processes—and products, such as random access memories—at half a dozen companies in the same year (see special report starting on p.106) is more than a coincidence. It's more like proof that n-channel has come of age, after being on the scene, albeit on the sidelines, since the inception of MOS a decade ago.

Indeed, the activity in n-channel R&D is making this the year of the RAM, the big product area that will be impacted by all the current n-channel advances.

"That's because n-channel techniques add a whole new dimension to MOS memory technology, opening up a sizeable market—large computer mainframes—that was largely closed to p-channel products," says Larry Altman, our solid state editor, who handled the report. Industry experts estimate that semiconductor RAMs will have sales measured in the hundreds of millions of dollars by 1975.

Larry observes that "some companies that were pioneers in n-channel five years ago still have not announced any memory products." And, he points out, other companies, not yet active in the field, will be jumping in soon. One semiconductor manager interviewed by Larry describes his management strategy this way: "I'll just buy it—the people, the equipment—and convert as n-channel technology matures. It'll be cheaper than trying to start n-channel R&D from scratch now."

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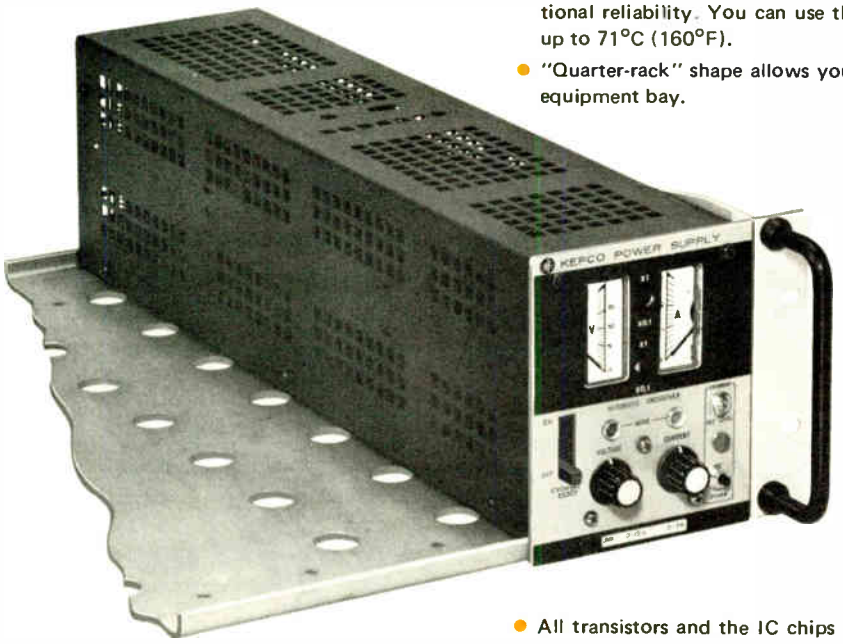

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JMK 36–1.5M	0–36	0–1.5	395.00
JMK 36–3M	0–36	0–3	465.00
JMK 55–1M	0–55	0–1	395.00
JMK 55–2M	0–55	0–2	465.00
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Readers comment

Straightening the record

To the Editor: Your report [*Electronics*, Feb. 28, Electronics International] of Ferranti's experience with the liquid crystal test technique is not correct. I know of no particular reason why the liquid crystal compound material should be suspected of causing cancer, and I have never at any time advised that the compound in question might cause cancer. Neither I nor any other Ferranti chemist has at any time recommended stricter precautions than those maintained by John Keen of the Royal Radar Establishment. In fact, Ferranti Ltd. uses VL-1047N liquid crystal supplied by RRE and operates identical precautionary measures to those used at RRE. These are the precautions we normally take when handling a new and unknown material. Further, since we adopted the technique some months ago we have continued to use it without a break.

T.L. Houghton
Chief Chemist, Ferranti Ltd.
Hollinwood, England.

■ *We are happy to set the record straight in this matter. Electronics erred in attributing to the chief chemist the statements about possible danger from using the liquid crystal. However, the notes made by our London editor during telephone interviews with two Ferranti semiconductor engineers concerned with using the technique include references to the dangers mentioned.*

On d-a converters

To the Editor: Your article "Digital-to-analog converters: trading off bits and bucks" [Mar. 13, p.84] is outstanding for presenting and clarifying the many DAC performance characteristics that must now be considered by the electronics engineers. Too often the engineer is misled by headlines of low price. It is most misleading to the industry to advertise a DAC as a 10-bit model when its linearity drops off to 7 or 8 bits at 70°C.

Robert R. Jay
Micro Networks Corp.
Worcester, Mass.

To the Editor: We welcome your ar-

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Readers comment

ticle "Digital-to-analog converters: trading off bits for bucks." It should assist in improving the understanding of a complex product, offered in an unbelievable variety.

However, we must take issue with the paragraph that talks about the possibility of building a 16-bit converter with 10-bit "accuracy" to attempt cost savings. It is, of course, possible to build a 16-bit converter with 16-bit linearity but with scale factor, or gain, accuracy of only 0.1%, as would be considered appropriate for an 8- or 10-bit converter. All that is saved is the cost of a good zener reference. The real cost of building the 16-bit converter lies in giving it 16-bit linearity. We doubt that there is a practical use, in instrumentation or control, for any DAC with linearity errors not at least commensurate with the LSB value. On the other hand, we are frequently asked to provide converters with linearity errors appreciably smaller than the LSB value.

Your caption for the oscillograms of Fig. 6, "photos, courtesy Analog Devices, have been retouched," implies that the pictured characteristics may have been altered before they were given to Electronics. In fact, our original oscillograms were retouched by Electronics to improve printing quality.

Your graphic description of a non-monotonic DAC (shown in Fig. 9) qualitatively depicts the reversal of direction in the transfer function. The actual non-monotonic transfer function shown could not occur in a real device.

Cyril H. Brown
Analog Devices Inc.
Norwood, Mass.

■ *Differences of opinion exist between makers on the first point raised by Mr. Brown. A 16-bit DAC with a 10-bit accuracy to save cost was a concept suggested by one maker interviewed for the article. Sixteen bits implies a wide dynamic range and often the user is more interested in the shape and trends of the variable being plotted than absolute accuracy. In the figure referred to, retouching was necessary to show the glitch or very fast transient, which was very faint on the original.*

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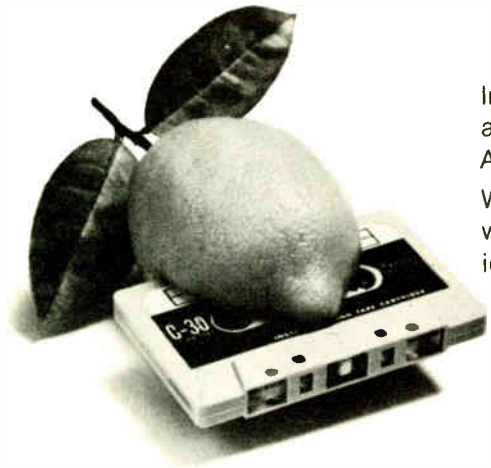
Two Years Ago, Almost

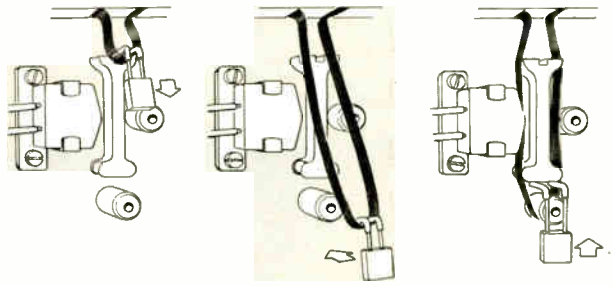


Including us. A digital cassette recorder. Seemed like a great idea at the time. But there was too much garbled info. And lousy reliability. A bumper crop of real lemons.

Well, we licked our wounds along with everyone else. But we also went back to the drawing board because we still thought the basic idea was sound. And we came up with a unit that really works.

A Whole New Concept

To get super reliability, we reasoned, you have to control that tape. So, we started from scratch. Got rid of the traditional pinch rollers, belts, solenoids, levers and mechanical linkages from the transport. Took out the head guide forks.

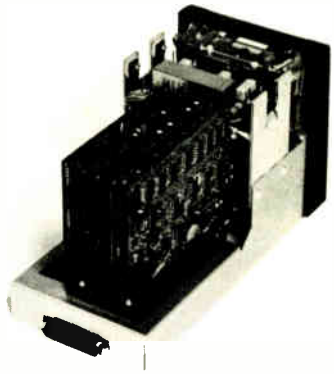


Eliminated the need for pressure pads. Those were the main cause of head and tape wear, oxide shed and dropout.

Then, instead of just pushing the head up to the tape as it rolls by, we decided to get the tape out of the cassette. (That way the cassette is just a tape holder.) So we designed two little fingers that pull the tape down past the head, over a precision guide and around a capstan. That maintains optimum head wrap angle—critical for read-after-write operation. And it's all done automatically as you load. (We've got a patent pending, in case you're interested.)

The Insides

Next, we put in three DC motors. One for the capstan and one for each reel. Servos positively control tape tension on both sides of the capstan. And tension sensors confirm proper loading to BOT—no writing on tape leader. There's no drag on the tape. Ever.



So now we have high bi-directional tape speed, fast start/stop times, precise start/stop distances.

Reel motor torque is automatically reduced when EOT or BOT is sensed to prevent pulling tape from cassette reel hubs or other possible tape damage.

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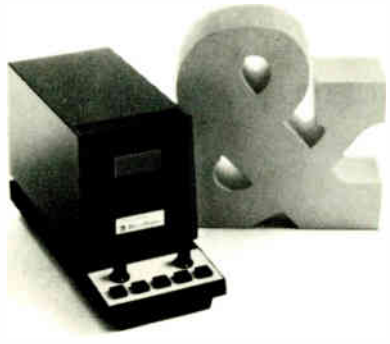

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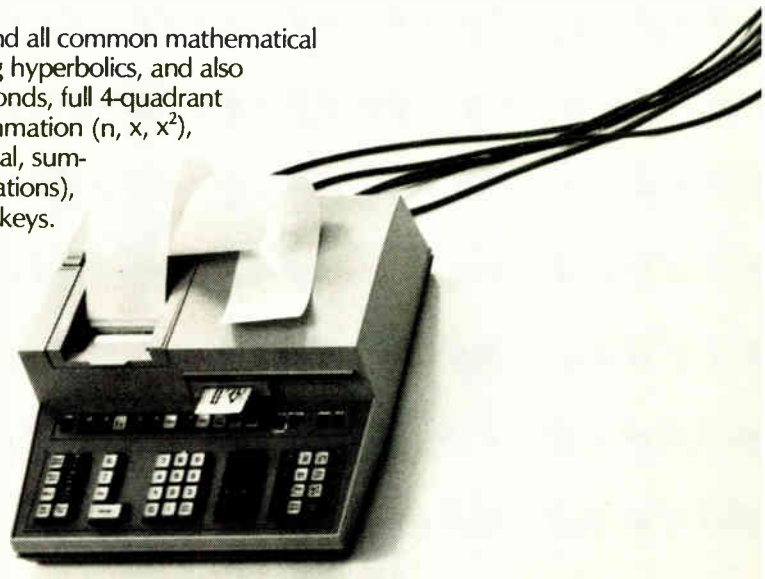

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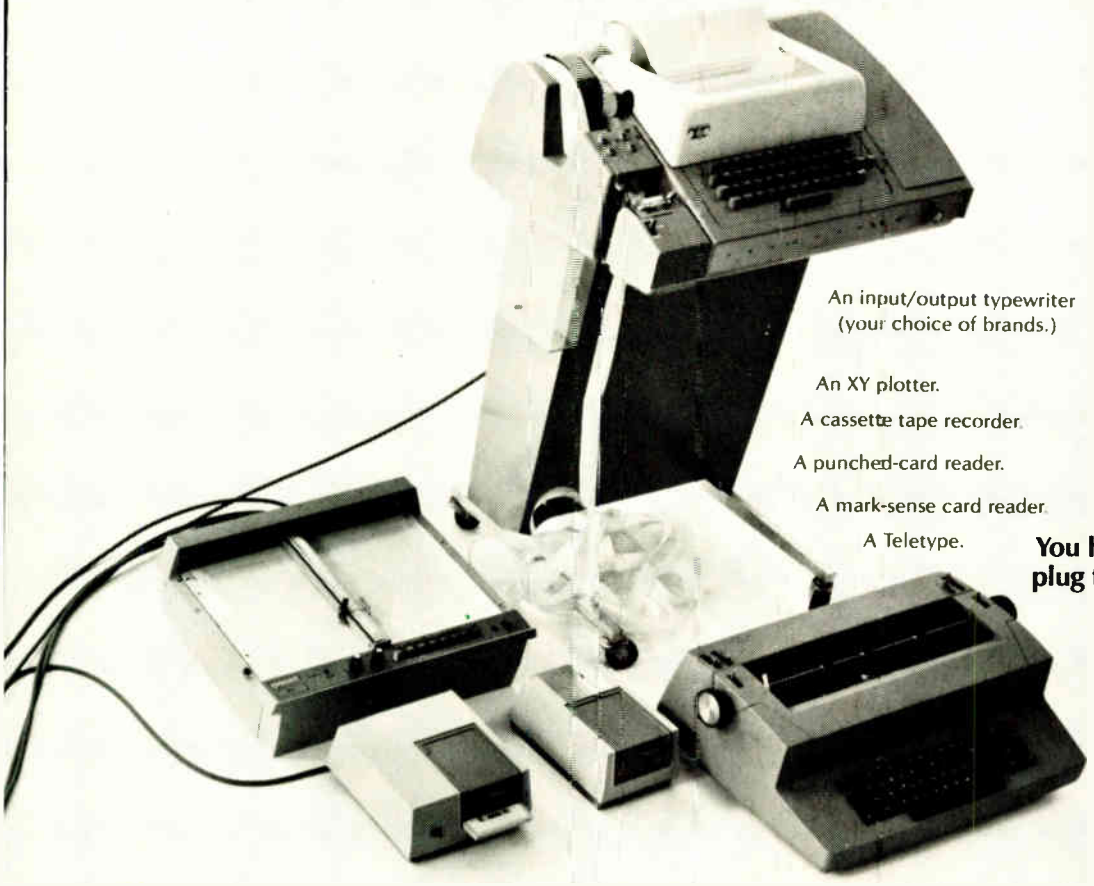

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People

Katzmann's formula for success: continuity

What is the secret of success in instrumentation? After 20 years in the business, Fred L. Katzmann believes he has the answer. In one word it's "continuity"—continuity of management and continuity of goals.

The former vice president of

Katzmann: Putting his money on continuity.

Singer's Instrumentation division and ex-director of Monsanto's Electronic Instruments division is certainly in a position to know. He has seen, first-hand, how changes in the thinking of management can have disastrous consequences—often because of the short-term goal of a healthy appearing profit-and-loss statement. He has also observed the success of such companies as Hewlett-Packard and Tektronix and feels that it's no coincidence that these companies are still under the direct control of their founders.

Plan to stay. Last August, Fred Katzmann put his money where his mouth is and, with two partners, bought Ballantine Laboratories in Boonton, N.J., from Singer. The three partners— Katzmann, Milton J. Lichtenstein, and Louis V. Foundos—have decided to conduct their business as if they're going to be around for a long time, because they intend to be. They have developed a long-term business plan, and they intend to stick by it.

One part of their plan is simply the realization that instrumentation is a mature industry. "We're no longer selling technology," Katzmann says. "The problems of mass production are behind us. Now we must sell solutions to measurement problems. Whatever makes money for the customer, that's what we want to make—at a profit." Lichtenstein agrees. "Benefits, not features, are what sell instruments today," he points out.

Katzmann and company don't deny that innovation is still needed. But they're against innovation for its own sake. "The pioneer," says Katzmann, "is the guy with all the arrows in his backside."

A concerned citizen, Katzmann believes that engineering has made a real economic contribution to society. But he feels it could do a lot better. Part of the problem, as he sees it, is the Government. Too large a fraction of the electronics industries has adapted its entire method of operation to the Government and its nonprofit-oriented goals. "IBM and the Japanese have done things differently," he observes, "and with notable success."

Witmer says the key is cutting labor cost

"At our yield rate and high unit value, we could afford to hire the president of General Motors to turn out chips, provided, of course, he had the right technical background," says Warner H. Witmer, president of Mosfet Micro Labs, a high-technology-sounding mouthful in Quakertown, Pa. MML was formed in 1969 and is in the business of fabricating MOS chips and wafers. And it plans to do so with the best-trained people it can find, coupled with a minimum of investment.

"Labor costs are no longer a major consideration in the manufacture of these devices," asserts Witmer. One wafer, he points out, will yield a multiplicity of products. "It pays to make the wafer as carefully as possible and use the best people because they have the best chance of making good devices."

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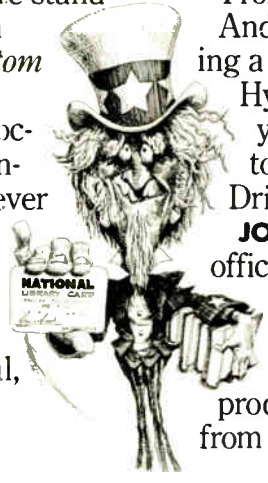

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People

With this philosophy, Witmer eschews the usual approach of partitioned production with specially trained but relatively low-skilled people responsible for different parts of the process. If the technology should change, such technicians are difficult to retrain, he says. And with responsibility shared, it's difficult to pin down the source of a problem, should one crop up, Witmer says, basing this opinion on his 15 years of experience in the development of electronic components and solid state devices at RCA, Western Electric, and United Aircraft.

Teamwork. Instead, Witmer is setting up two-man teams of a highly trained engineer and a technician to be responsible for the entire wafer production process, including diffusion, photolithography, and metalization. And MML will have such teams for each of the MOS processes it is perfecting. "It gives flexibility for our customers, and no excuse for not delivering," declares Witmer. The processes include standard, complementary silicon gate MOS, as well as the newer oxide-nitride processes. MML also has developed a power FET of the overlay type that's compatible with MOS processing. And in addition, Witmer asserts he has a pinhole-free process. This increases yields markedly, and is a key to making his production team profitable.

Coupled with this approach to fabrication, Witmer has also taken a close look at the production line itself. "We've thrown out all the witchcraft," he asserts, and with it has gone the expensive vertical laminar-flow rooms—"We use hoods instead"—and careful control of humidity—"We don't need it." The result, Witmer claims, is that he can set up a production line for under $50,000. He obtains substrates and masks from outside suppliers and produces custom-designed chips and wafers in as little as two weeks time. Assembly is done by local jobbers. And because the initial equipment investment is low, MML can handle custom work in exceptionally small quantities—as few as 10 wafers looks reasonable, says Witmer.

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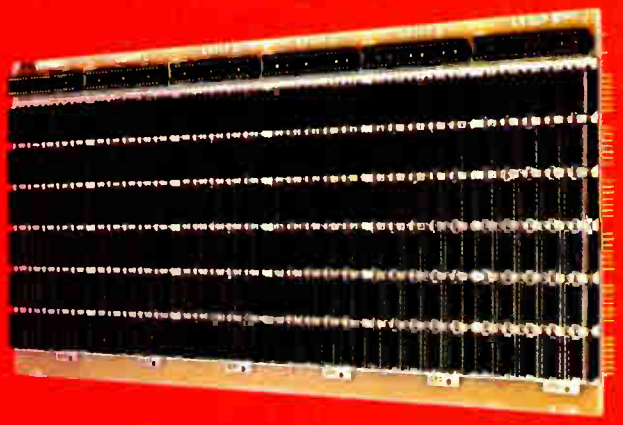

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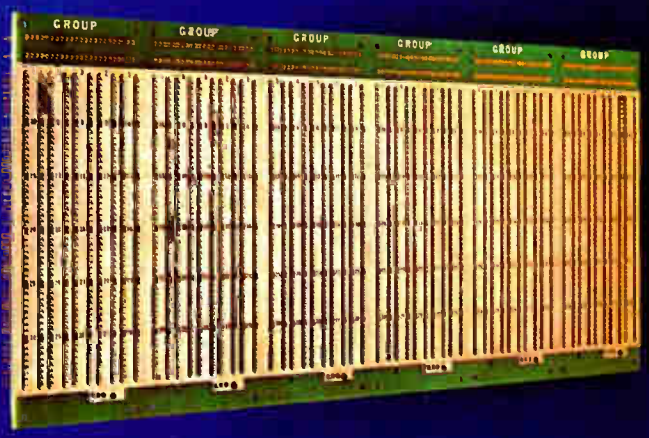

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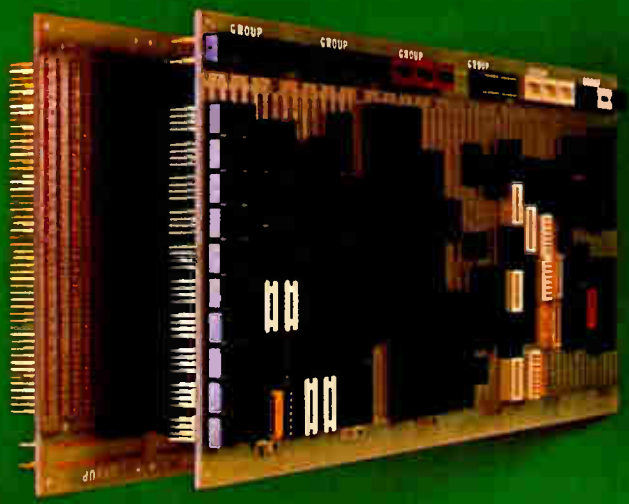

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From the company with the industry's broadest line of IC sockets comes one of the widest selections of standard off-the-shelf panels. Pick and choose from pin-in-board panels, socket-on-board panels, Select-A-Wrap® prototype panels, and multi-purpose panels.

Every socket panel we make is available with TI's exclusive gold stripe contacts. We metallurgically bond gold at the contact point, where it does the most good. No wasted gold. Reduced cost. More reliable contacts.

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TI pin-in-board systems are high in reliability, low in profile. Contacts have low contact resistance and high retention. That means they stand up to vibration and rough use. And, thanks to a multi-purpose pin grid, you can easily mount almost any component – including capacitors, resistors and other discrete components.

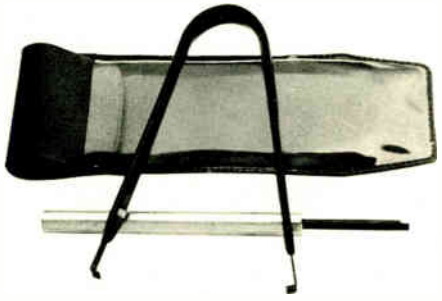
Socket-on-board panels offer a choice of literally hundreds of low-cost standard designs. Take your pick of copper/nickel alloy with gold clad contacts or phosphor bronze with gold or tin plating. From 30 to 180 functions per panel. A variety of I/O designs. Black or white sockets.

Select-A-Wrap prototype panels feature the unique opposed ground and power system. They can handle any combination of 14 or 16 pin sockets. Yet all you pay for is the number of functions you need. Three basic panel sizes of 40, 70, or 100 functions, maximum. All prototype panels mate with standard-size edgeboard connectors.

See what we mean by a broad line? Add TI's sockets, custom design capability, and wire wrapping to the mix, and you've got the most complete off-the-shelf line of interconnection systems and components available in the industry.

Send for free TI Pick-a-Panel Pak

Each Pick-a-Panel Pak includes all the detailed information you need to choose from TI's broad line of standard panel products. Plus a handy pocket tool kit, as shown, with both an IC extractor and a unique Change-a-Wrap tool for manually wrapping or unwrapping connections. And for a limited time we'll also send along a special discount certificate good on your first order of TI panels.



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Please send me free Pick-a-Panel Pak. Don't forget my bonus tool kit and discount certificate. I am most interested in:

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Spring Joint Computer Conf.: IEEE, Convention Center, Atlantic City, N.J., May 15-18.

Aerospace Electronics Conf.: IEEE, Sheraton Dayton Hotel, Dayton, Ohio, May 15-17.

Electronic Components Conference: Electronic Industries Assn., IEEE, Statler-Hilton Hotel, Washington, D.C., May 15-17.

International Microwave Symposium: IEEE, Arlington Park Towers Hotel, Chicago, May 22-25.

Power Sources Symposium: Army Electronics Command, Shelburne, Atlantic City, N.J., May 23-25.

Microwave Power Symposium: IMPI, Govt. Conf. Centre, Ottawa, Canada, May 23-26.

Photo-Optical Applications in Security, Surveillance, and Law Enforcement: SPIE, Conrad Hilton, Chicago, May 24-26.

International Transportation Exposition/Congress of Transportation Conferences: FAA, SAE, IEEE, etc., Dulles Airport/Sheraton Park, Washington, May 27-June 4.

International Switching Symposium: IEEE, MIT, Cambridge, Mass., June 6-9.

Spring Conference on Broadcast & Television Receivers: IEEE, Marriott Motor Hotel, Chicago, June 12-13.

Air Pollution Control Assn. 65th Annual Meeting: APCA, Fontainebleau, Miami Beach, June 18-22.

International Conference on Communications: IEEE, Marriott Motor Hotel, Philadelphia, June 19-21.

Joint Measurement Conf.: ASQC, IEEE, ISA, NBS, et. al., U. of Colorado, Boulder, June 21-23.

Conf. on Precision Electromagnetic Measurements: IEEE, NBS, U. of Colorado, Boulder, June 21-23.

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Circle 21 on reader service card

Think Twice:

Extra contribution is one way to the top. Specifying HP scopes will help you, too.

Here's why.

You're an engineer on the way up. Your ideas, your designs, your work all reflect the extra contribution you're making. (You might even slip back to "the shop" after dinner and on weekends.) Rewards won't be long in coming.

There's one more thing you can do for yourself and your management. Show them a way to cut operating expenses and boost profits. How? By being critical and downright hardnosed in making your cost/performance comparisons on instrument purchases.

Scopes Have Changed.

Take laboratory oscilloscopes for instance. In the past several years, scope design and performance have changed—for the better. Many companies, maybe yours, are in the process of replacing older scopes, to take advantage of the extra capability these new models offer. To get the best buy now, you're going to have to do more than look at the name tag and spec sheet. Plug-ins are not compatible. Calibration is completely different. Controls and operations have changed radically. It's a whole new ball game. *Little* that you learned or used on older scopes —*whether theirs or ours*—can be transferred to the new models. You need new techniques, new training materials, new parts. Here are three specific reasons why you should investigate the HP 180 Series...why you should think twice.

HP Scopes Cost Less To Buy

Analyze your total measurement needs, then ask both manufacturers to submit prices. On latest model plug-in lab scopes, you'll find that HP can consistently save you money — lots of it. For example on a 75 MHz non-delayed sweep, plug-in system, ours is 24% less (with delayed sweep, 18% less); at 100 MHz, ours is 16% less; for 1 GHz sampling, you'll pay 54% less if you buy ours.

HP Scopes Cost Significantly Less To Operate

Because scopes have changed, training, operation, calibration, and repair are expenses that you'll have to contend with—no matter which make you buy. HP's new scopes are supported by simplified operation and live or videotaped training and repair sessions that can substantially cut your start-up and overall operating costs.

Calibration? We've cut the number of adjustments by 50%—and eliminated interactive adjustments. Therefore, when you're comparing oscilloscopes be sure to include in that comparison the cost of calibrating each manufacturer's unit.

Our users are reporting shorter training periods, faster, surer measurements, and savings up to 50% on calibration time and costs. Some companies buying Hewlett-Packard, cite this as the main reason.

HP Technological Leadership. More Performance. Fewer Problems.

HP innovations in general purpose lab scopes include: the first scope with a real time bandwidth of >250 MHz; the first 18 GHz sampling scope; the first 100 MHz variable persistence and storage scope; and the first and only 100 MHz scope with a "big-picture" CRT (8x10 div, 1.3 cm/div). These are meaningful, functional innovations that boost your performance, not your costs.

Think twice! Once you make the comparison, we're certain you'll choose HP. Many engineers like yourself—engineers on the way up —have already made the switch. For more information on how you can help your company boost profits and how you can help yourself make faster, more positive measurements, write for our free "No Nonsense Guide To Oscilloscope Selection."

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Scopes Are Changing; Think Twice!

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All your back panels can be tested with an Omnitester 900 Wiring Analyzer. This unit, pictured here in the center, has forward scan capabilities to determine, for example, whether a missing wire went to some other point. It then identifies that point.

The unit further tests for continuity resistance, insulation resistance, DC hipot, and features programmable dwell time.

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Delivery? Just 2 to 8 weeks, depending on the job and material availability. And we have two locations: Longmont, Colorado or Endicott, New York. For more details just call your nearest Amphenol sales office or write us direct. Amphenol Cadre Division, Bunker Ramo Corporation, 20 Valley St., Endicott, N.Y. 13760.

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Circle 24 on reader service card

Electronics newsletter

Laser system eliminates mask, clean room

Engineers at Bell Laboratories in Murray Hill, N.J., are using a computer-controlled laser beam to machine circuit patterns **directly onto ceramic substrates.** Conventionally, such patterns must be fabricated under clean-room conditions involving several process steps, including mask-making, photoresist applications, and chemical etching. With the new technique, **masks are eliminated because patterns are stored in the computer memory, and a "clean room" atmosphere is unnecessary.**

As many as 48 substrates, 1 by 3 inches each and coated with a thin film of conductive metal, are mounted on the outside of a drum. As the drum rotates, each substrate is successively exposed at a rate of 25 inches per second to a 35-micrometer-diameter beam from a neodymium-yttrium-aluminum-garnet laser. A movable lens keeps the beam in focus over the substrate's length. Metalization is either vaporized or left intact as the laser beam is pulsed at 960 watts for 250 nanoseconds. After a complete revolution of the drum, a reflecting mirror steps the beam to the next line to be machined.

Within the next six months, the still-experimental system **will be tried out at Western Electric's** manufacturing facility in Allentown, Pa.

Buried channels hold out hope of faster CCDs

Buried channels, a new technology stirring up excitement in some major laboratories, **could result in step-function increase in semiconductor device performance.** Buried channels are being used in charge-coupled devices to boost operating speed dramatically.

Normally, charge is transferred at the oxide-substrate interface of a CCD; consequently, some charge is trapped in "surface states" during each transfer—the condition worsens at higher transfer rates. This means that operating speeds around 20 megahertz appeared to be the limit for serial memories—until buried channels came along.

By implanting a lightly doped channel just under the surface of the silicon substrate—say, 1 micrometer—CCD designers can confine the charge to the bulk silicon, where it can't be trapped easily. The result: **laboratory shift registers operating at hundreds of megahertz, with the possibility of speed in the gigahertz.** What's more, in random-access-memory configuration, buried-channel CCD structures could mean access time of **less than a nanosecond for RAM chips containing tens of thousands of bits.**

Who's doing buried-channel work? Bell Labs published first, and Fairchild Semiconductor isn't far behind.

DuPont to offer thick-film switch

Thick-film compositions can do more than produce dielectrics, conductors, and resistors—**they also can produce active switching elements,** says a team of researchers at the duPont Co., Wilmington, Del. Their work could lead to a cheap control element for appliances and for power-control circuits.

On May 15, at the Electronic Components Conference in Washington, D.C., Stephen C. Thayer of duPont will report on new compositions that perform as threshold switches. They can be triggered by external heat or by electric current that induces self-heating. When triggered electrically, the switch provides a change in resistance of three orders of magnitude within 1 microsecond. Threshold voltages

range from 5 to 20,000 volts. The compositions, based on a reversible phase-transition phenomenon, **will be marketed soon under the trade name Tyox.**

Disk drive bids to change limits on mini systems

The development of a new disk drive at Omron Systems Inc., Mountain View, Calif., **is expected to change disk-based minicomputer systems drastically.** The new disk drive will offer 7.5 megabits of storage on a 6-inch-diameter disk with a worst-case access time of only 10 milliseconds. Data transfer rate is 7.5 megabits per second, and the cost will be about 0.05 cent per bit in OEM quantities. This compares with access time of 30 to 75 milliseconds and data rates of 1.2 megabits to 5 megabits per second for large, IBM-type disk drives.

In many disk-based minicomputer systems, the disk, which is typically slower than the IBM type, is the limiting factor in total system performance. **But with the high-density, high-speed Omron unit, to be ready in the fall, the computer may become the limiting factor.**

Hermetic package holds 3-in. wafer

A hermetic package capable of handling **a complete 3-inch-diameter LSI wafer or hybrid multichip substrates** will be the basic module in the All-Application Digital Computer (the AADC, formerly Advanced Avionic Digital Computer), says the Naval Air Systems Command. Singer Kearfott division, Little Falls, N.J., and Westinghouse Aerospace division, Baltimore, each developed a package. **The hermetically sealed region could be as much as twice as large as previous packages,** according to Plessey Ceramic, Frenchtown, N.J., which worked with Singer on the package.

It consists of a 4-inch substrate with a 3-inch-diameter hermetic enclosure that's sealed either with solder or is laser welded; 300 leads are taken out of the enclosure, 75 on each edge on both sides. A cam-actuated zero-insertion-force connector makes contact to each edge of the substrate. The module can dissipate up to 50 watts.

Honeywell adds eight minis

Honeywell Information Systems Inc. has added eight minicomputer systems to its line. The newcomers collectively are termed the System 700; **six use a new processor and two use a previously announced one.** All are for communications-oriented information-processing networks made up of a larger host processor and several of the new minis.

Statistics for the new processor are a 775-nanosecond cycle time, 16-bit word length, and compatibility with Honeywell's existing Series 16 computers. The minimum system will sell for $30,000 or rent for $1,000 a month, minimum; delivery will begin this July.

Union aims at N.J. Lockheed engineers

The 500 or so engineers and scientists at Lockheed Electronics Corp. are the object of a labor association organizing effort. **An organizing committee is seeking affiliation with the Association of Scientists and Professional Engineering Personnel** (ASPEP) located in Camden, N.J. According to the association, the committee has informed the company of its action, and that it can be certified as an official bargaining unit if more than half of the engineers join. The company says it is watching the situation.

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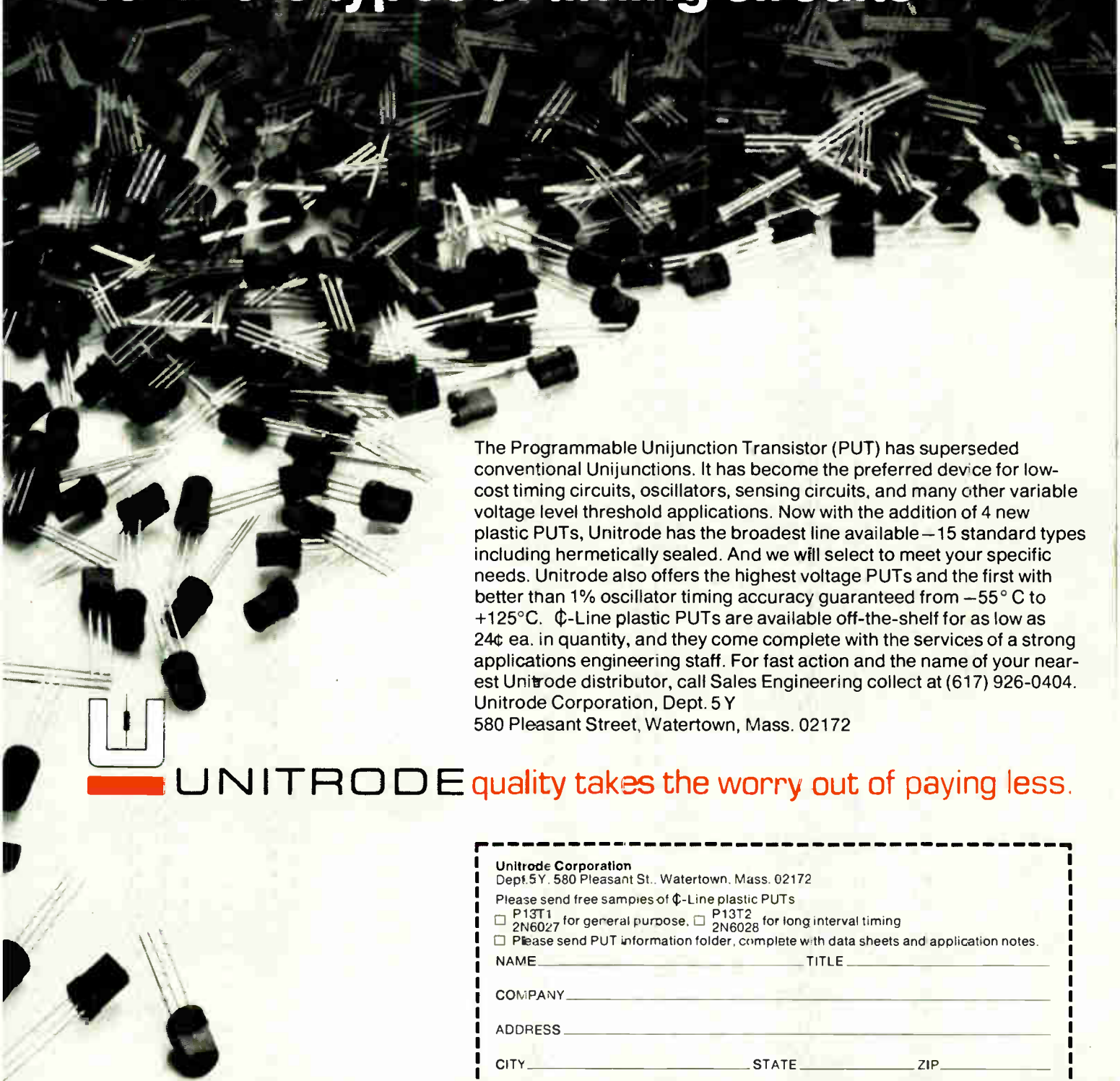

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Circle 27 on reader service card

TRAKATRON

The World's First Paging Eliminator

Today we can track astronauts all the way to the moon, but we can't locate them instantly in a building on earth. Trakatron closes this communications gap.

Trakatron stands for "tracking people electronically." Trakatron is available in three modes – manual (Trakapen), semiautomatic (Trakascan) and fully automatic (Trakafone).

With the basic manual Trakapen system, operation is manual through a standard touchtone keyboard which indicates on a readout the location of any person at any instant.

The semiautomatic Trakascan system automatically and continuously scans multiple numbers of people and displays their whereabouts on a TV-like (CRT) terminal.

Trakafone is a completely automatic mode in which the room sensors and other interface equipment are incorporated in the telephone system. This system automatically "searches" and rings the phone nearest to where a person being called may be at a particular moment. Trakafone also has a built-in memory which indicates when a person being called is not available, and notifies the caller automatically when the party becomes available.

Here's how one mode, Trakascan, works: a processor holds a list (see diagram) of all people tracked by the system and their Trakatron pen numbers. At specific time intervals, the processor sends a coded message, on private or telephone wires, to all ultrasonic transmitter-receivers (sensors) installed throughout a building, or buildings. In the room, or designated areas of this building, the pen code addressed by the processor will respond with its own coded signal to the receiving sensor in that particular room, or area.

That receiver will then send a coded message to the processor which identifies the area of the coded pen. The processor now places the room number, phone extension, or other code opposite the name of the person in the list and then moves on to locate the next coded person. By scanning the list, a complete directory of people is ultimately built up and is kept current by constant repetition of the scanning process.

TV monitors placed at strategic locations throughout the building can display the contents of the list continuously, thus making the current information immediately available to interested parties.

As people move from one area to another, the Trakascan system locates and displays their present location. If a person is unavailable, or has left the building, it will also report that fact. Personnel may be added, or deleted at any time.

Trakatron systems are designed to incorporate a number of options; digital synchronized clocks in any room sensor; after hours intrusion alarm; fire detection; provision for Trakavision internal video picture phone interface (the same screen can scan and display data on location of personnel and display actual live pictures of the person talking on the phone).

The versatility of the Trakatron system makes it possible to incorporate other features such as Penlok access control which permits a doorlock to "recognize" the pen of an individual without any conscious personal human involvement, insuring access only by cleared personnel.

Trakatron – automated locating systems for medium and large corporations, institutions, terminal facilities, etc.

For more information on licensing, write:

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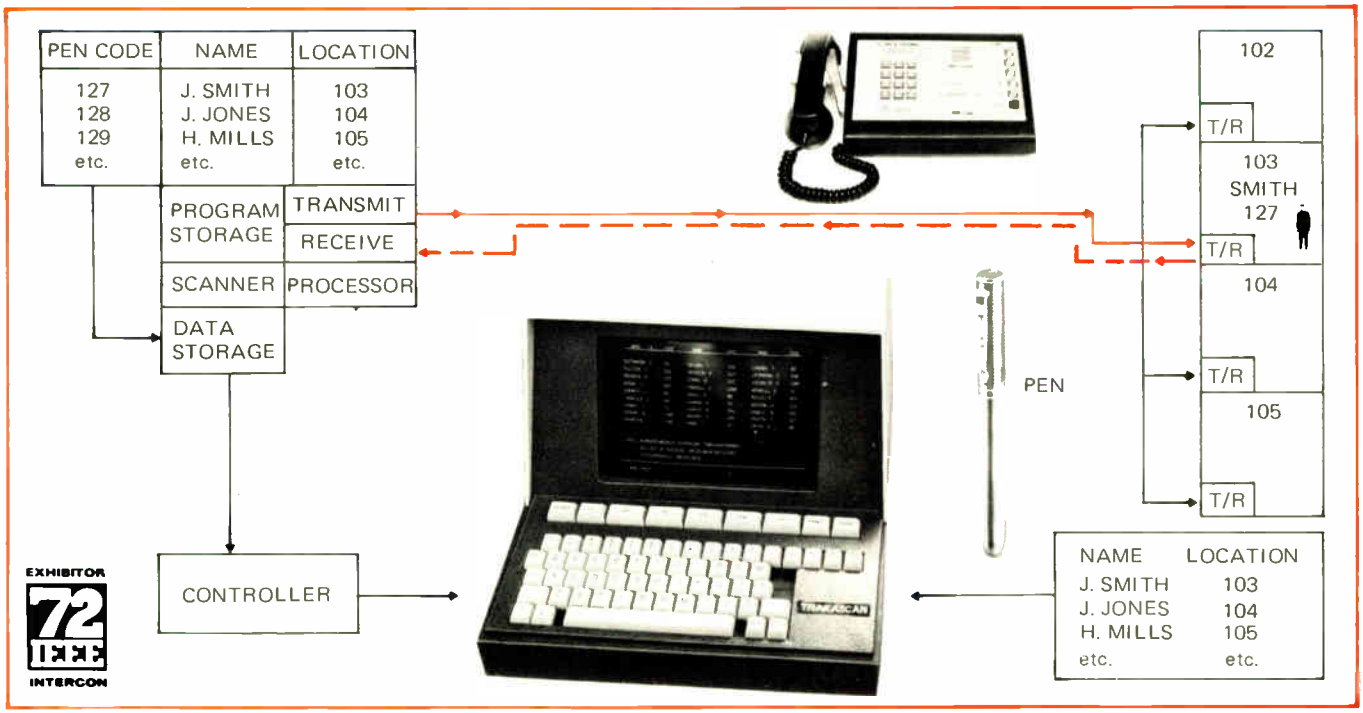
Trakatron patents and trademarks pending.

Recognition Devices Inc.



Circle 28 on reader service card

Japan shifts emphasis toward commercial sectors

New law seeks to restructure nation's industry as rest of world continues to do battle in consumer arena

The Japanese government is driving to restructure its electronics industry with new emphasis on commercial and industrial systems. While the United States and the nations of the Common Market continue to develop positions to grapple with the tide of consumer electronics exports from Japan, that government has been quietly working for more than a year under a new law to develop and expand 20 categories of products and materials for systems applications ranging from avionics and space to education, medicine, factory automation, and controls.

Staying up. A ranking official at the Commerce Department observes that the law "sounds typical of the Japanese—keeping several jumps ahead us," confirming the view of lower echelon State and Commerce Department sources who believe the Japanese action represents a serious threat to the strong U.S. position in world commercial and industrial electronics markets—a threat that they claim "no one seems to be doing anything about."

Popularly known as Law 17, the statute gives the Ministry of International Trade and Industry "overall policy direction" for the promotional development program. In addition, MITI gets funds to support it with awards to companies.

Law 17, formally titled the Specified Electronic Industry and Specified Machinery Industry Promotion Temporary Measures Law, went into effect April 1, 1971, succeeding the similar electronics Temporary Measures Law of 1957, that expired the day before and under which Japan rose to become a leading producer of consumer products. State Department records show that the U.S. Embassy at Tokyo first wired a translation of Law 17 and a list of products covered on Aug. 12, 1971—more than four months after it went into effect.

A sampling late last month of U.S. Government, industry, and congressional sources showed that most were ignorant of the Japanese action. Those who were not were either uncertain of Law 17's contents or unconcerned about its implications. The Commerce Department's director of international trade policy, for example, said he is "unfamiliar with the law; it has not

Japan's 20 varieties

Under Law 17, MITI has been empowered:

To develop technology and experimentally manufacture:

1. High-performance radiation measuring instruments;
2. High-performance medical electronics;
3. Communications equipment, gear using ultrasonics and lasers;
4. High-performance avionics;
5. Missile and satellite electronics;
6. High-energy particle accelerators;
7. Ultrasonic measuring, detection, and applied processing equipment;
8. High-performance digital computers;
9. High-performance automatic control systems;
10. High-performance "load-beam-applied" hardware for chemical reactors, industrial processing, and melting;
11. Teaching and training aids;
12. Printed circuits, structures, and circuit parts;
13. Tubes ranging from vhf, uhf, and millimeter-wave tubes "for large power use," plus high performance CRTs, imagers, storage, display, electrostatic memory, and gas laser tubes;
14. High-performance silicon and chemical compound semiconductors;
15. ICs stressing large-scale, low-noise, low-power operation, high-speed, and ability to withstand high powers and voltages;
16. Materials ranging to low-loss dielectrics.

To push industrialization and mass production of:

1. Facsimile equipment, including color systems;
2. Video recorders and tapes;
3. Laser-applied equipment;
4. Magnetic disks and disk packs;
5. ICs, excluding MOS, of less than 1,500 elements, insulated by silicon oxide and using aluminum internal wiring;
6. Semiconductor chemical compounds.

crossed my desk." The Electronic Industries Association mailed copies of the State Department translation of Law 17 to some members of its Communications and Industrial division.

Under Law 17, the MITI director is instituting an "upgrading plan" for the 37 electronics categories to develop technology and experimentally manufacture 17 new products; move six others into mass production, and improve quality and performance while cutting costs in all categories already in production (see table). Though the measure is defined as "temporary," it does not expire until March 31, 1978.

To achieve Japan's targets for its electronics "upgrading" drive, MITI is given broad, almost dictatorial, powers to impose on companies "restrictions on the kind of goods," they may make; where and from whom they will buy parts and raw materials, and how they will use their plants, including directing joint corporate efforts.

Make change. At the same time, MITI is given authority to control and alter product standards in the categories under Law 17, when a company "holds a considerably high ratio to the total amount of production" in a product category; when a manufacturer's "business activities" are deemed "a considerable obstacle" to goals of the upgrading plan, and "when there is a fear that the continuation" of a company's activities "will produce a seriously adverse effect on the improvement of the production formula."

U.S. officials contend that Japan's move implies recognition that it not only has a significant share of the world consumer electronics market, but also that its share is likely to diminish in years ahead. The reasons: the country's rising labor costs make it increasingly noncompetitive with operations such as U.S.-controlled TV receiver offshore assembly plants in places like Taiwan, other nations continue to restrict Japanese consumer product exports, and the nation's manufacturers move to exploit the higher profit margins in commercial and industrial electronics of its own manufacture while continuing to contract for production of consumer lines of manufacturers in other countries. On the other hand, sources in Japan say the law is merely the next logical step in the development of electronics. □

French electronic anesthesia system used successfully in 20 operations

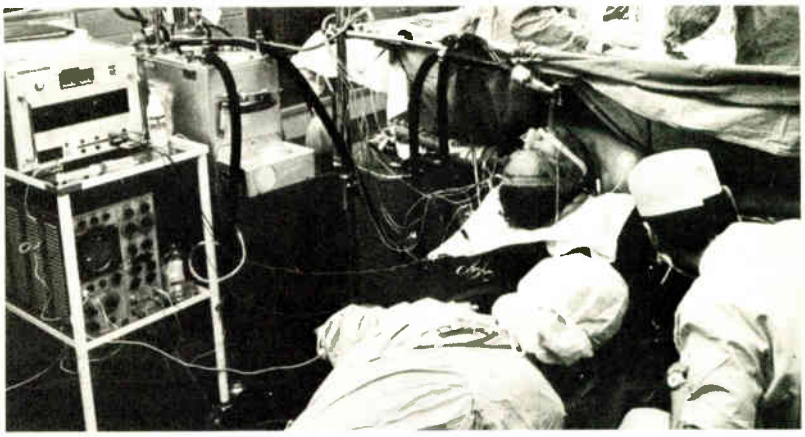
The first feasible electronic anesthetic system has been developed by a French dental surgeon, Aimé Limoge, and used on more than 20 patients at Necker Hospital in Paris. It consists of a signal generator, three electrodes, a potentiometer, and an oscilloscope to monitor the signal.

The system produces a deep sleep with 2-milliampere pulses when the electrodes are positioned in a special pattern that won't cause muscle spasms and variations in blood pressure. The cathode is placed between the eyebrows and two anodes are placed in the back of the ears behind the mastoids. The main flow of current passes through the sides of the brain instead of through the center.

Limoge says that his method was developed by trial and error. After experimenting with hundreds of variations of pulses, Limoge settled on a single-polarity current at 77 cycles per second, supplemented by the injection of 3-millisecond hf pulses at 130 kilohertz. These additional pulses are of 10-microsecond duration with 30-second intervals. There is a 10-ms interval between each of the three groups of hf pulses.

Three prototypes are being built by the French firm Sirel, and Limoge says that the U.S. Army has used his plans for construction of its own system. He says the Army is interested because of the simplicity of the system and its convenience for field hospitals. In France, the government-backed patent agency is negotiating with several electronics firms to commercialize the Limoge device. And at least one U.S. pharmaceutical and medical equipment house is considering purchase of U.S. rights.

Opinion at the American Medical Association is conservative, if not skeptical. The AMA says it has not heard of the Limoge system, but that electronic anethesia is not new and not without risks. Says a spokesman, "We would want to look very carefully at the device, and make tests on animals ourselves before sanctioning its use on human beings." □



In use. Elastic bands around patient's head contain electrodes of anesthesia system.

Communications

Comsat silences telephone echoes

The problem of echoes in long-distance telephone conversations is handled by echo-suppression devices that switch high losses into the send path upon detecting speech signals in the receive path. But too often when both parties try to speak at once, the switch falters so that part of the conversation is lost and some of the echo sneaks by.

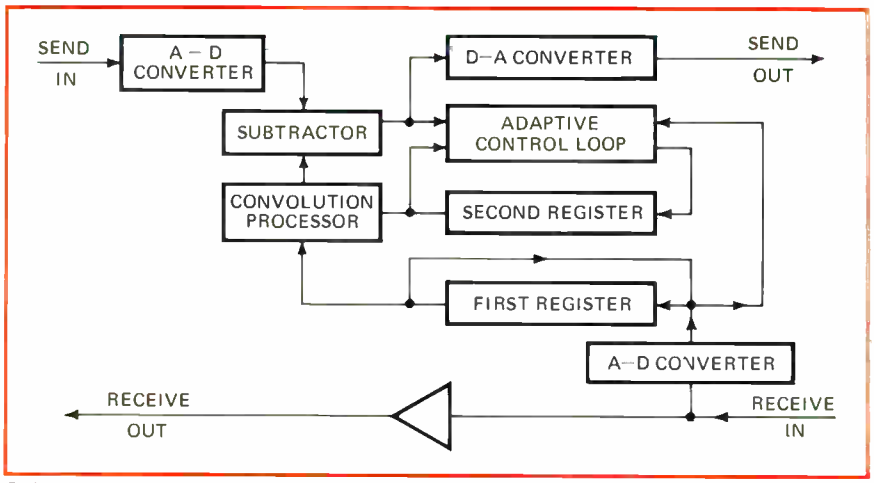
In satellite communications, the problem is magnified because propagation delays reach 270 milliseconds, compared to about 70 for long-lines cable. By substituting a minicomputer for a switch, communications Satellite Corp. Laboratories has developed what it calls an echo canceler. Comsat says the new digital processing scheme not only suppresses echoes but cancels them without weakening the voice signals.

Trials set. The device, introduced in late April at the American Institute of Aeronautics and Astronautics Conference on Satellite Communications Systems in Washington, D.C., will undergo field trials this year, says S.J. Campanella, broadband processing manager.

Campanella predicts a vast market for the devices because "you would need two for every channel in the telephone system." Mass production would lower costs to about $1,000 each, he says, compared with $600 to $800 for echo suppressors now in use. Essentially, the echo canceler consists of two memories, a multiplier, and an accumulator that combine to sample the line continuously to eliminate echo.

The heart of the device is a self-adaptive feedback control loop that generates a mathematical model that describes the echo path. The model's output is fed to a subtractor 180° out of phase that eliminates the echo from the incoming line, explains Michael Onufry, technical staff member.

"If the mathematical model isn't accurate enough (the echo has changed), we send an error signal above a threshold in to correct the model," he says. The conversation is sampled 8,000 times a second so that the canceler is continuously self-correcting. The canceler doesn't actually eliminate all echoes, Onufry admits. But since the ones that do get through are about 46 decibels below the signals—at the noise level of the phone system—they can't be heard anyway.



Quiet look. In this echo canceler, developed by Comsat Labs, digital signal processing is used to effectively cancel echoes often found in long-distance telephone conversations.

Basic system elements are two 256-bit shift registers, a convolution processor, a subtractor, and the adaptive control loop containing a correction sensor and an echo update. The convolution processor, consisting of a multiplier and a summer, multiplies the stored segment of conversation from one register and updated data from the model in the second register, sums the products, and feeds the result to the subtractor.

Messenger. If the sum is wrong, the difference is sent through the adaptive control loop, which adjusts the model, based on inputs from the first register, and sends the new data to the second register for resubmission. The system continuously samples by cross-correlating values from received speech and the error signal from the subtractor.

An echo canceler would be needed at each end of a telephone circuit, which is a four-wire, two-way transmission system. This is because a canceler at A's end only stops B's echoes and vice versa, Onufry says. Because the amplitude and phase of echo paths vary between phone calls, the echo canceler employs an impulse response storage to record the differences.

The canceler converts real speech to digital mode to process it and converts the signals back to analog mode to reconstruct the echoless conversation, says Campanella. □

Consumer electronics

TV tuner rule strains capacity

Television-tuner manufacturer Sarkes Tarzian Inc. has become a victim of its own success. The Bloomington, Ind., company can't deliver enough 70-channel detent ultra high-frequency tuners to enable set makers to meet Federal Communications Commission parity requirements [*Electronics* Feb. 28, p.95]. The Tarzian company is the major supplier for most makers using the 70-channel device, and the FCC has ruled that by July 1, 1972, 40% of the models in a TV maker's line must have the new tuner.

"We're swamped with orders," cheerfully states company president Sarkes Tarzian. "We have a backorder of about 450,000 tuners and the TV makers want delivery at the rate of about 25,000 a week." Tar-

zian also points out that the company still has to maintain production of its regular line of tuners. And although assembly time on the device is nominal, precise alignment of the new tuner takes more time.

Tarzian's solution has been to train additional people on the company's own assembly lines and to help its biggest customers—RCA, Zenith, and Admiral—train their own personnel in alignment technology. "It takes about eight weeks to train a good aligner," says Tarzian, "but we fully expect to be out of the crunch by June."

The FCC has been lending a hand, too. It has granted waivers to two companies, Philco-Ford and GTE Sylvania, to extend the compliance date. Admiral has also petitioned for a waiver. However, the FCC says waivers would be granted only where danger of a production line shutdown exists. □

Materials

Hunt for space leads to magnets

The need for a new traveling-wave tube for airborne phased-array electronic countermeasures systems has drawn designers at Varian Associates to new magnetic materials—and a new product line.

The motivating problem was size: the beam-focusing magnets inside the tubes took up too much space, so the tubes couldn't be stacked as closely together as was required by the array spacing. As a result, says Louis R. Falce, techniques and materials engineering manager at the Palo Alto, Calif., firm, "we developed our own rare-earth cobalt magnet materials."

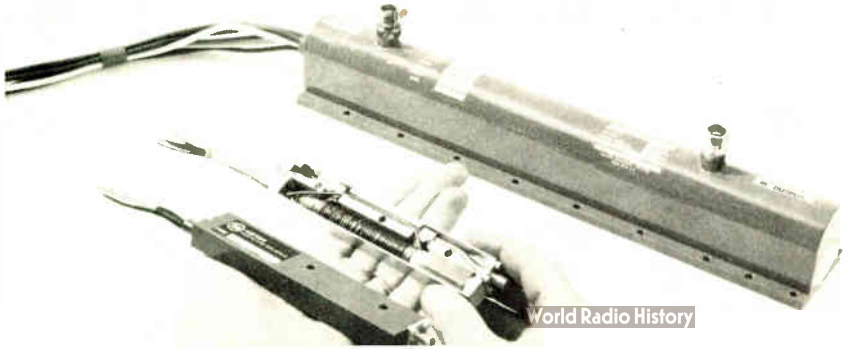
Rare-earth materials such as samarium-cobalt (SmCo) have magnetic energy levels that, says Falce, are "two to six times higher than those of Alnico magnets and are 20 to 50 times more resistant to demagnetization." For instance, a magnet with flux density equivalent to an Alnico magnet's is only a fifth its size. And now that Varian's space problem is solved, the company has decided to market the material to outsiders.

Equal flux. Martin M. Seldon, product sales manager, points out that while the SmCo magnets are more expensive, pound for pound, than Alnico, "the cost of equivalent magnets is about the same—the flux per buck is about equal." The large flux density in SmCo magnets results from the way they are made. Conventional magnets are made by placing the material in a strong magnetic field to align their internal domains. When the field is removed, the magnetization that remains is a function of the lattice structure of the material. If the magnet is then placed in a strong opposing field, it will demagnetize.

Rare-earth magnets, however, are made by a powder metallurgy technique. A SmCo powder is pressed into the desired shape in a mold surrounded by a strong magnetic field so that the powder granules orient themselves at the same time. This pressed powder is then sintered in an inert atmosphere and charged a second time to reach the precise magnetization desired.

The result is an extremely powerful magnet, which also is not easily demagnetized. It could be used in watch tuning forks, very small permanent-magnet motors, and medical transducers. According to Seldon, one potential customer is looking at a transportation system based on magnetic levitation. □

Drawing power. The need to save space in this traveling-wave tube for airborne ECM system led Varian Associates to new rare-earth cobalt magnet materials and new product line.



Satellites

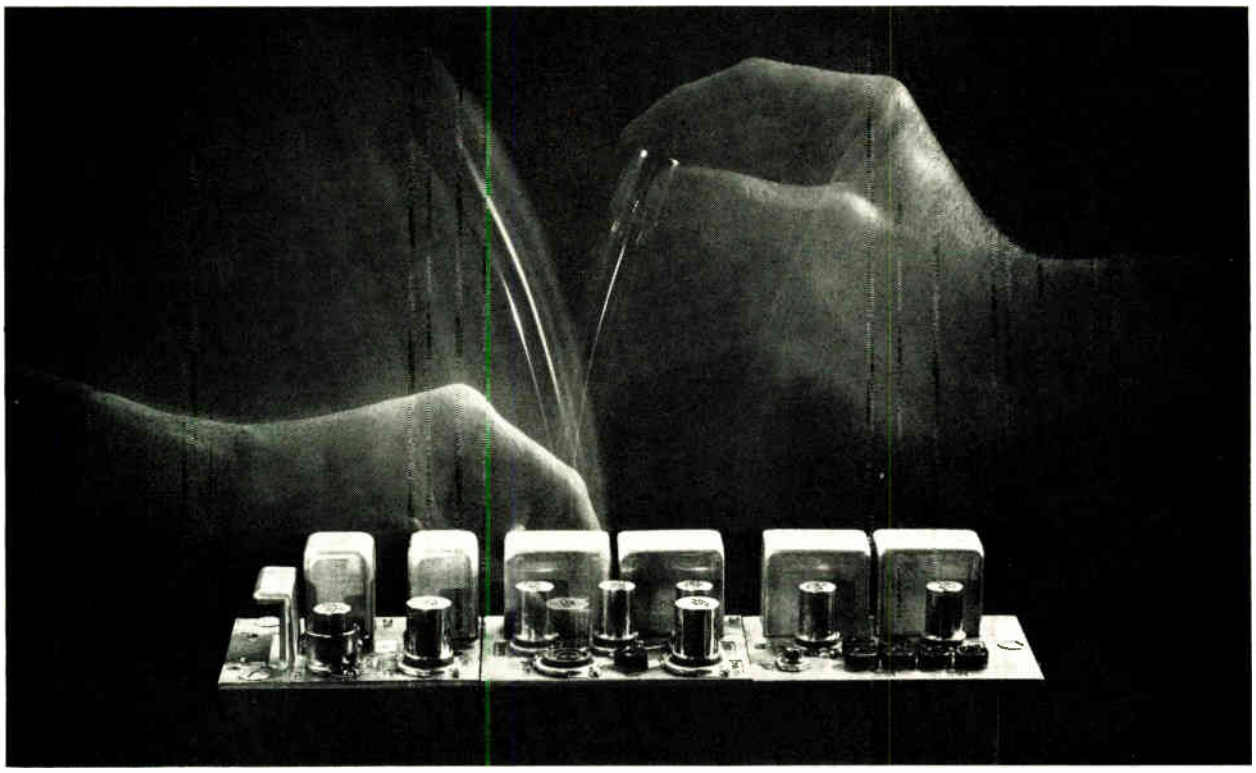
Intelsat dilemma: more or bigger?

Members of the International Telecommunications Satellite Consortium (Intelsat) are arguing over how to handle the large traffic increases forecast by 1980: build a few bigger and better satellites (next generation Intelsat 5 birds) or crank out more modified Intelsat 4 craft, or "4.5," as they are called. While it may seem logical to develop high-capacity satellites, strong sentiment within the 83-member consortium favors more small ones.

This thinking holds that using many smaller satellites will give system flexibility, lower cost to small users, and adequate redundancy in case one fails. Putting all one's eggs in one basket, the argument goes, is expensive, benefits the large users, and isn't as reliable. Smaller countries, which constitute most of Intelsat's membership, also are worried about added earth terminal cost for bigger systems. Compounding the issue are national priorities and jealousies.

One basket. "We think it is unwise to put the whole ocean traffic into one satellite," says a spokesman from the United Kingdom's post office, which reportedly wants alternative routes through five satellites for reliability and flexibility. "In 1985, the system (using bigger birds) might be okay, but in 1986 it busts," he says. The UK also thinks it "unwise for an organization that has many separate countries using it" to go for big systems, he says.

Disagreeing are some big users, notably the U.S. planners from Lockheed Missiles and Space Co., Sunnyvale, Calif., and Comsat, which operates the Intelsat network, who believe they have the answer for the 1980s: satellites using new



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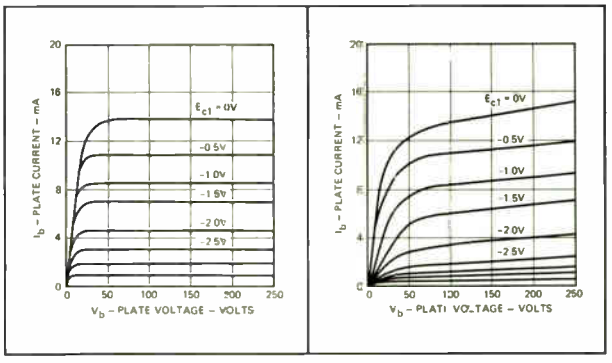

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communications techniques with capacities up to 135,000 circuits.

The new communications techniques that would be needed include multiple beam-steerable antennas, wideband digital transmission, and higher frequency bands. To handle these, the spacecraft would need better pointing accuracies for its antennas, plus more efficient means of generating power, storing energy, and using onboard propellants. Included in these projections are 10-year satellite lifetimes, redundancy to reduce failures, a standardized modular "bus" that could be changed as needed, and judicious use of the new 11- and 14-gigahertz bands allocated to satellite communications.

TDMA key. Satellite-switched time-domain multiple access is a key to high-capacity, large communications satellites. That's the view of John D. Kiesling, branch manager with Comsat Laboratories in Clarksburg, Md. The satellite switch, which is TDMA-controlled, connects the appropriate receivers and transmitters efficiently. The system's advantages are that the switches weigh little, the transmitters can operate at peak efficiency, and the system instantaneously adapts to any network modifications. The frequency-domain multiple-access system is less efficient and requires too large a share of satellite weight and power because of filter weight.

"Actually, there are many ways to skin a cat," Kiesling acknowledges, in order to achieve Intelsat goals of efficiency and economy. One alternative is to use FDMA on the 4- and 6-GHz, frequencies and TDMA on 11 and 14 GHz. Another is to take the model 4 satellites, change them to cross-polarization, and add spot beams. □

Thinking big

Strongly backing the idea of going to bigger Intelsat communications satellites are Lockheed Missiles & Space Co. and Comsat.

Assuming a 25% annual traffic growth rate, Lockheed proposes to build a 3,800-pound satellite. It would be dc-powered by 2,870-watt, sun-oriented, flexible-substrate solar arrays, recommends J.J. Knopow, communications satellite program manager. This craft would have 24 transmission channels in each frequency band, with 84,000 one-way voice channels at the 11-and 14-gigahertz frequencies, and 68,000 at 4- and 6-GHz, with multiple-spot beam antennas.

Lockheed's satellite would achieve operational flexibility and future growth by use of steerable antenna spot beams and onboard transponder and antenna switching, Knopow says. The antennas would use multifeed and unfurlable reflector techniques. Lockheed's projection is based on the three-year-old programs for the smaller development test satellite it is managing for 15 companies from nine countries. The engineering prototype will begin thermal and vacuum testing shortly, he says.

Comsat's projected body-stabilized Intelsat 5 satellite could come in several sizes, depending on technology, according to John D. Kiesling of Comsat Laboratories. Model 1, a simple extension of Intelsat 4, would use multiple spot beams, 40-megahertz transponder bandwidths, require more than 15 kilowatts of power, and weigh 37,000 lbs. to get its 270,000 channels, he says. A more efficient model 2 would have a wider transponder bandwidth and, by using fuel cells, ion engines, and better solar arrays, could drop its weight to 3,240 lbs. With a satellite-switched time-domain multiple-access system, model 3 would need only 1.3 kW and weigh 1,100 lb.

Solid state

TI weighs in on 10K end of scale with second-source MECL line

"The heavies are now all on one end of the ECL seesaw."

That comment from one industry insider sums up the effect of Texas Instruments' announcement that it is second-sourcing the MECL 10,000 line of emitter-coupled logic made by Motorola Semiconductor. And TI agrees. "We intend to supply the full 10,000 family and to have an impact on what that family might eventually be," says David Davies, new-product marketing manager at the Sherman, Tex., facility that TI has dedicated to ECL standard and custom services.

The announcement was by no means unexpected. TI's initial offering of 16 devices from the new SN 10,000 series is a full complement of dual, triple, and quad gates and line receivers, as well as several complex and MSI functions. Eight SSI parts and a dual D-type latch are now available from distributors, with production quantities available in six weeks. In early June, TI will begin sending out samples of four more SSI chips, plus a dual D-type master-slave flip-flop device, a carry/lookahead adder, and an ECL version of its TTL 54/74 four-bit arithmetic logic unit/function generator, the SN 10181J. Those seven parts will be available from distributors late in June.

Lucky number? Davies indicated that TI would announce 13 devices in the third and fourth quarters—seven SSI and six complex and MSI functions, including some proprietary part numbers—plus several memory products in the family.

"When you're going after form, fit, and function, the ability to deviate and still stay in the box is not that great," observes Larry Regis, manager of TI's advanced-circuits department. But the TI officials detailed these differences between their SN 10,000 family and MECL 10,000:

- 100% hermetic packaging: the announced parts are in 16-pin, ceramic dual in-line packages, except for the SN 10181, which, unlike other man-

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Representative RCA TEO's

RCA Type	Center Frequency Range (GHz)	Min. Power Out (mW)	Comment
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S494	2.0-4.0	10	Electronically Tunable, ± 40 MHz Linearity
S495	4.0-7.0	10	Electronically Tunable, ± 40 MHz Linearity
S496	7.0-11.0	10	Electronically Tunable, ± 40 MHz Linearity
S433	8.0-10.0	1-7 W Peak	Mechanically Tunable, ± 250 MHz
S437	10.0-12.0	10-120	Mechanically Tunable, ± 250 MHz
S479	12.0-14.0	20	Mechanically Tunable, ± 250 MHz

Other types are also available in the 2.0 to 16.0 GHz range

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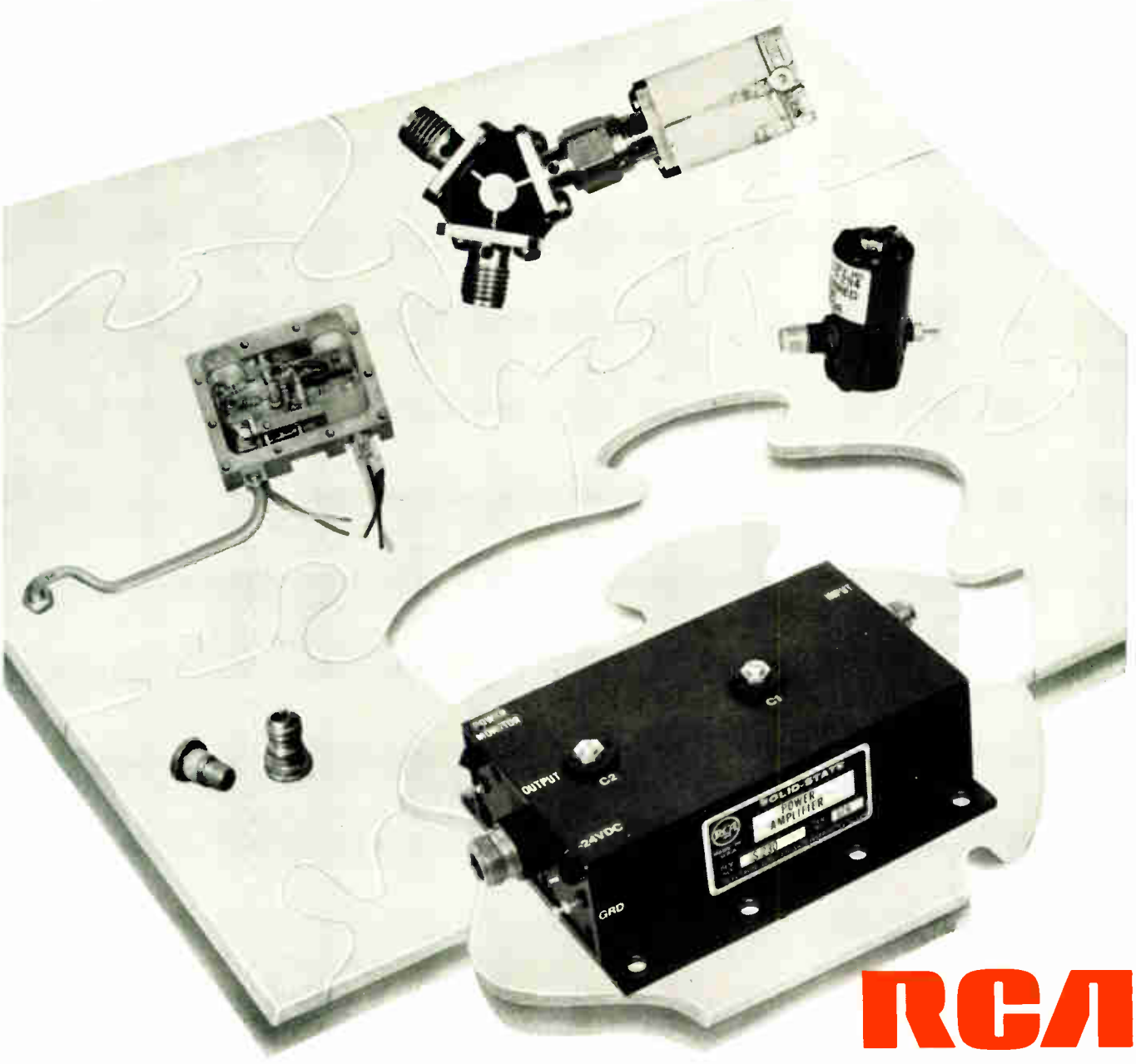

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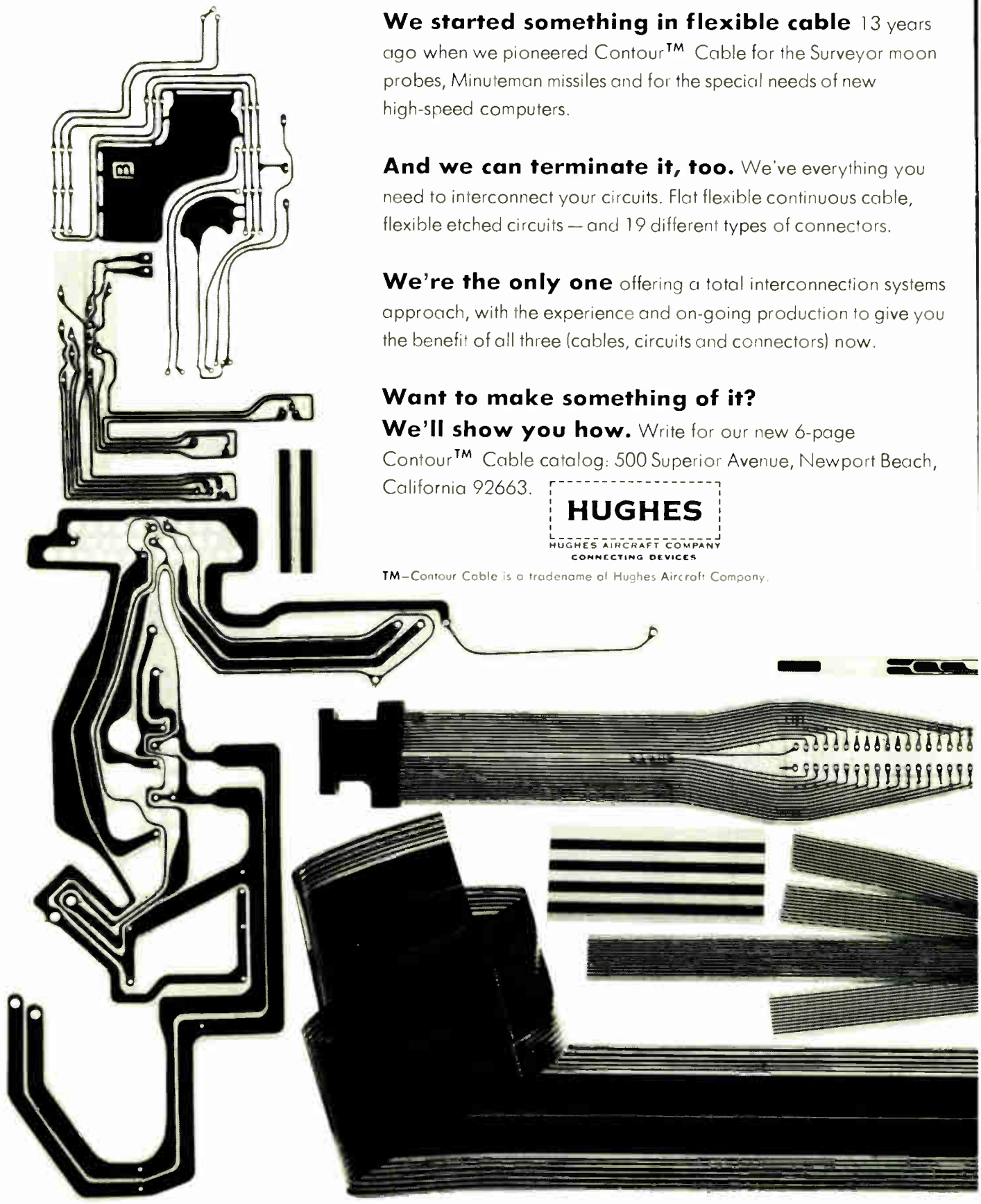

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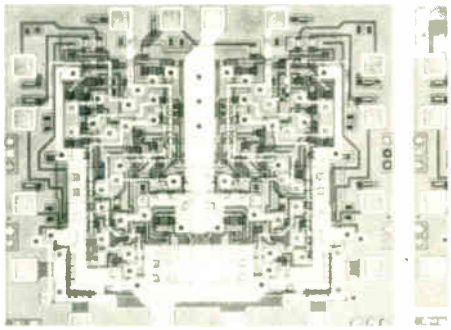

ECL echo. This is Texas Instruments' dual D-type master-slave flip-flop in new line.

ufacturers' 16-pin plastic packages, is available in a 24-pin C-DIP.

- The industrial temperature range, 0° to 75°C, instead of Motorola's and Signetics' −30° to 851°C range: "We just haven't found a market for the extended temperature range," Regis explains.
- An improved internal-reference generator to relax power supply tolerance and distribution requirements.
- An active current source in the gate, rather than a resistive source.

It's no secret that, through its experience in custom ECL based on the earlier 2500 line, TI controls perhaps 50% of the ECL business. Indeed, some sources estimate that the company sells twice as much ECL as its nearest competitor, Motorola. Yet the firm apparently wanted to wait until it had standard parts available through distributors and TI sales offices before it dropped its other shoe.

"Our assessment of the situation from a competitive standpoint was that a standard family should have the benefit of multiple sources, that Motorola probably offered the best choice for multiple sources, and that market acceptance of the 10K family was far greater than that of the Fairchild 9500," Davies says.

What price pride? "When we weighed the alternatives, our choice was to second-source the existing family, rather than to try to splinter the ECL market with yet another choice," he explains, "that would not necessarily be enough of an improvement to make its own way." Adds Regis: "Kicking in a TI proprietary family, just for the sake of pride and emotional gratification, financially would not add enough leverage to the ECL market."

That market last year was about $50 million worldwide, and $36 million domestically, estimates Eugene McFarland, TI's marketing man-

View from Phoenix

Officials at Motorola Semiconductor in Phoenix have adopted a sanguine attitude toward Texas Instruments' entry into the 10K emitter-coupled logic business. It could be due partly to the fact that Motorola has cut prices on its MECL 10,000 line an average of 15%—not, says the company, in response to competition. Rather, officials say, the lower prices are the result of natural progress along the production learning curve, plus increased user acceptance.

As for competition from TI, here's the reaction of Douglas Powell, Motorola's outspoken manager of computer industry marketing: "We aren't worried; it'll take them a while to get into the saddle. What can they do that we haven't already worked on? In fact, I'm surprised it took them so long."

Powell points out that MECL 10,000 is strong in Europe. "Motorola's guys in Europe have done a much better job than we have here in the U.S. They've sewed up the whole continent—and we may have Russia yet!"

Asked why he thinks TI chose MECL rather than Fairchild's 9500, Powell replies: "It only makes sense to follow a line that has gotten wide acceptance."

Meanwhile, back at Fairchild Semiconductor in Mountain View, Calif., Cliff Vaughan, ECL product marketing manager, says: "Some 10K people are designing in 9500 series parts. And now that 95100 is available, we expect to see more of this." He points out that at least three companies are now using 9500 in peripherals and mainframes. What's more, Vaughan doesn't expect an ECL version of the 7400 TTL price war. But prices are now lower than for Schottky TTL, he says.

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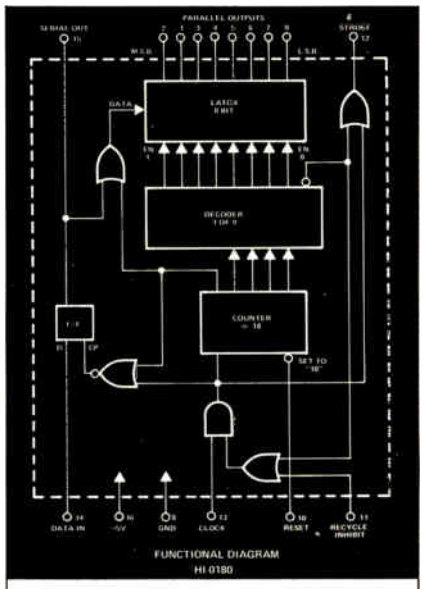
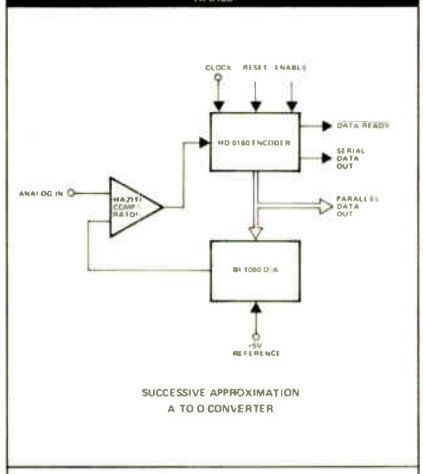
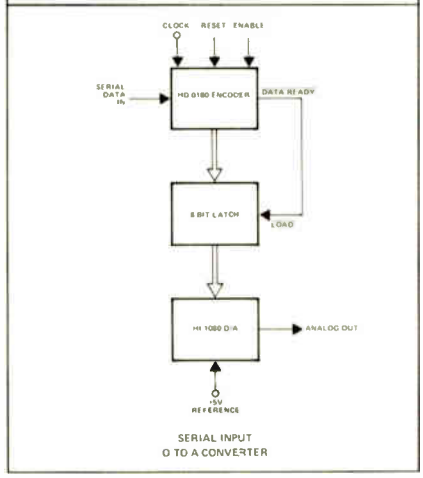


FUNCTIONAL DIAGRAM
HI-0180



SUCCESSIVE APPROXIMATION
A TO D CONVERTER



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ager, and is currently running about 70% custom. He foresees no increase in ECL business until the fourth quarter, and then not enough to increase over-all 1972 figures. "From the standpoint of the TTL market," he says, "the ECL market will remain small for some time; in the mid-1970s, it will remain about one-fifth of TTL worldwide." □

Medical electronics

Dorsal stimulator jams pain signals

Medical researchers are using military electronic countermeasure technology—against pain. The device they've come up with is the Myelostat, a dorsal column stimulator developed at Medtronics Inc., Minneapolis, Minn., to jam pain signals. It consists of an externally worn rf transmitter and antenna, plus a surgically implanted rf receiver. So far, about 300 persons are using the $915 device, principally through the University of Minnesota Hospitals.

Pain is sensed only when it reaches the brain via the spine. However, only a limited number of pain signals can be transmitted at one time. The impulses continuously transmitted by the Myelostat keep the pain "gates" full, blocking the entrance of signals to the brain. To relieve pain, the patient simply presses an "on" button.

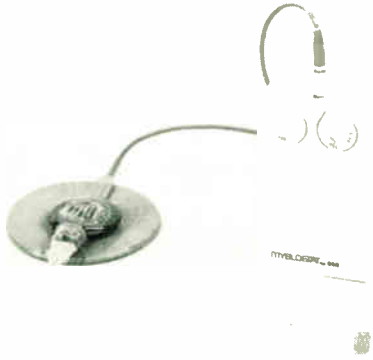
In order to implant the receiver, the surgeon opens the spinal column at shoulder level and attaches an inch-long electrode with three platinum prongs to the spine. The electrode is connected by a pair of wires to the receiver, which is implanted in the chest just beneath the skin. The signal travels through a demodulator and filter, and is passed on to a tuned coil through an ac coupling device. Then it is sent to the brain.

The transmitter, worn at the waist, is connected to an antenna that is taped on the skin directly over the embedded receiver. The transmitter is about the size of a cigarette pack, and contains a single printed-circuit card. Frequency is on the order of 460 kilohertz, and voltage level is 30 volts maximum peak-to-peak at 8 milliamperes.

Variable. Besides three transistors, the card contains an air-coupled transformer and a rate generator that uses a programable unijunction transistor. This permits nine to 250 pulses per second to feed into a monostable vibrator. The vibrator uses this output for the rf signal.

The battery-operated device has two sets of controls. One, which is hidden beneath the battery pack, is for the physician, who sets the maximum amplitude allowable for his patient. The patient, however, can adjust rate and amplitude beneath that upper limit on his own set of controls. Another built-in safety feature eliminates any chance of intermittent stimulation. □

Pain killer. Patient-controlled device is surgically implanted, jams pain signals.



Government

Challenges seen delaying domsat

The Federal Communications Commission is unlikely to meet the mid-May deadline set by Chairman Dean Burch on the dragged-out domestic satellite case. Timely decision

on the oral arguments scheduled for the first week in May is threatened by the mostly negative reactions that have been expressed by 31 affected parties to the FCC's staff recommendations for "limited open entry" into the potentially lucrative satellite market [*Electronics*, March 27, p. 34].

Seeking open approach. Crying for "unlimited open entry" are AT&T, Communications Satellite Corp., Western Union Telegraph Co., Departments of Defense and Justice, and the White House Office of Telecommunications Policy—among others. In fact, OTP threatens to take the matter to Congress if the commission turns down the "open skies" concept.

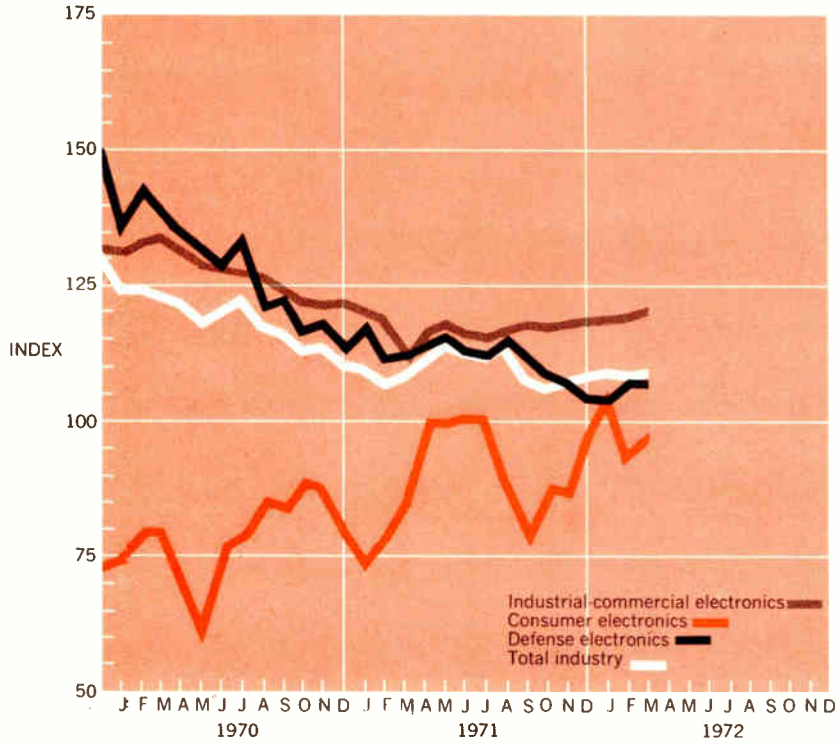
Opponents are questioning the economic practicality, the functional logic, and the legality of the staff's proposal to group proposed applications into four classes based on the status of technology and customers. In calling for "open skies," AT&T and Comsat blast the staff's recommendations that Comsat should either serve only AT&T or lease to other users, with AT&T limited to message toll telephone and WATS traffic.

AT&T says that it is "illogical" and "imposes restrictions and unnecessary constraints on the applicants that could well prove unworkable for reasons which neither the staff, nor the commission, nor even the applicants now foresee." Comsat argues that the staff's position would okay the same satellite capacity as the individual applicants seek totally, without preventing the "market fragmentation" the staff fears. Hughes Aircraft Co. supports AT&T and Comsat.

Western Union says, "It would be arbitrary and unreasonable for the FCC to order some applicants to enter into consortiums when consortium arrangements promise so many serious problems in negotiations and day-to-day administration." The Defense Department argues that restricting AT&T would be "to the detriment of the national defense," while the Justice Department says, "Limited entry would also increase the commission's regulatory burdens."

Grouping up. Essentially, the FCC Common Carrier Bureau has proposed to put Western Union, Hughes, General Telephone & Electric, RCA Corp., and Western Tele-Communications Inc., in one applicant group; American Telephone & Telegraph and Comsat in group two; the Microwave Communications Inc. and Lockheed Satellite Corp. team in group three; and Fairchild Industries in the last group.

Using this approach, the staff seeks a fair balance between markets, competitors and technology. Western Tele-Communications,



Electronics Index of Activity

May 8, 1972

The index for March showed a month-to-month increase of 0.7%, but there was no change from the March 1971 total. Major contributor to the slight rise was consumer electronics, with a 3.2% increase. Industrial-commercial moved up 1.0% while defense was off 0.1%.

On a year-to-year basis, consumer was 13.3% ahead of its March 1971 level, industrial-commercial was up 2.0%, and defense was down 5.1%.

Segment of Industry	Mar. '72	Feb. '72*	Mar. '71
Consumer electronics	97.9	94.9	86.4
Defense electronics	107.5	107.6	113.3
Industrial-commercial electronics	120.8	119.6	118.4
Total industry	109.9	109.1	109.9

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

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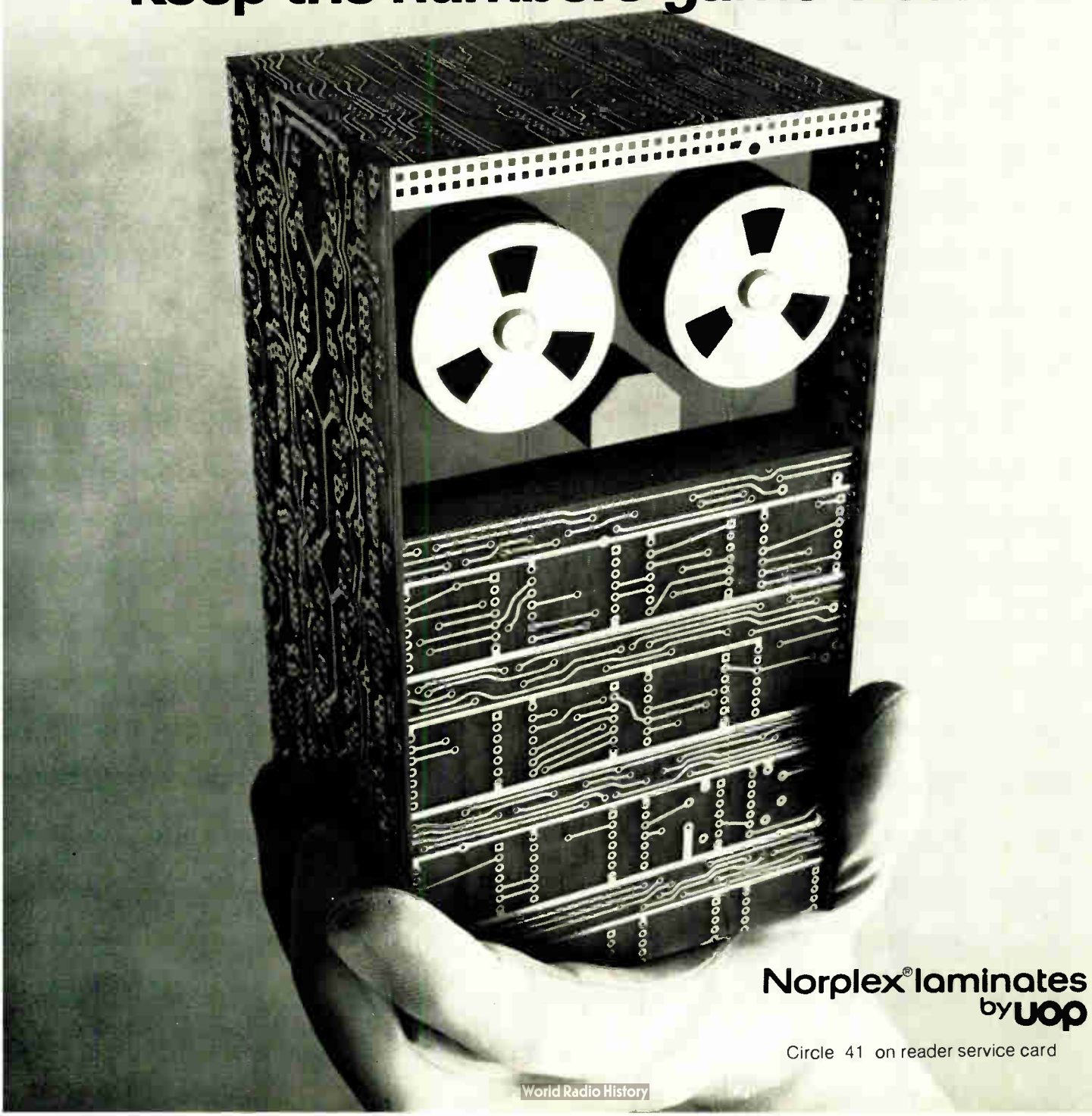
How the Lint-Pickers keep the numbers game clean.



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Circle 41 on reader service card

RCA and AT&T-Comsat would be given options, with restrictions, to go it alone.

Among the other applicants, Fairchild, RCA, Western Tele-Communications, and MCI-Lockheed, approve the staff's plan, but GT&E objects to sharing in a joint venture. Unlike satellite builder Hughes, General Electric also is in favor of limited entry.

Potential microwave and cable network customers find the plan to their liking. The National Cable Television Association expresses "general agreement," as does Data Transmission Co. (Datran). CPI Telecommunications Inc., arguing for several other microwave service companies, wants to own receive-only earth stations without having adjunct satellite operations. The educational broadcasters are asking for free or reduced fee service. □

Waiting. It looks as though that's what Dean Burch, FCC chairman, will be doing as the dragged-out domsat case is delayed. The reason this time is that most of the 31 affected parties have reacted negatively to "limited open entry" to the market.

For the record

Status. The U.S. retains a slim world profit lead only in industrial electronics with a 7% return on total assets, compared to 6.8% for Japan, says a private study of world electronics by Stanford Research Institute, Menlo Park, Calif. But in total equipment and components output in the 1965-1969 period, Japan recorded the greatest growth in both sales and profits, followed by Western Europe and the U.S., according to the 2,500-page analysis SRI has completed for an estimated 50 companies over a 27-month period.

The recently delivered study says that equipment and component sales, respectively, increased by 13% and 32% in Japan over the period; by 13% in both U.S. categories, and by 10% and 11% in Western Europe. However, return on assets in the four-year period for the respective categories were 7.6% and 9.0% for Japan; 6.5% and 2.8% for the U.S., and 4.6% and 6.4% for Europe.

Down to $75. A hand-held, four-function calculator to retail for less than $75 will be introduced late this summer by Master Calculator Co., of Dallas. The machine features a one-chip calculator circuit from Electronic Arrays with a contractual maximum price of $8, and it uses a Burroughs Corp. Panaplex 2 gas-discharge display with eight 0.25-inch digits. Master's price to mass merchandisers will be about $50.

Master is now shipping about 8,000 calculators a month, including an earlier hand-held model with an Electronic Arrays four-chip circuit for under $150, the same four-chip calculator in a desk model for around $85, and a 12-digit desktop calculator with memory using a Mostek two-chip circuit.

Rockets. Honeywell Inc. will develop a computer-based system for controlling the reusable liquid-fuel engines being developed by North American Rockwell's Rocketdyne division for the manned orbiter stage of the space shuttle. Honeywell's contract is for $35 million; estimated total cost of the engines is $450 million.

W.J. Brennan, Rocketdyne president, says that the three liquid-fuel engines used in each orbiter will be the most advanced ever designed in the U.S. He added that the Honeywell master control system is a significant step forward in rocket systems technology:

"This will be the first time that a digital electronic assembly has been developed as an integral part of a liquid rocket engine."

The system will contain dual sets of input/output electronics and two small digital computers to provide

Sales to rise

Electronics producers expect 1972 sales to rise by 7% over the level of 1971, while outlays for new plant and equipment will show no increase at all, according to the latest annual McGraw-Hill survey of capital spending plans. By 1975, sales will be 29% higher than in 1972, with about a quarter of the total attributed to new products now in planning, the survey shows.

Furthermore, it won't be until 1973 that capital equipment spending by the electronics industries steps out smartly—a 17% increase is predicted, followed by a mere 3% bump in 1974 and even a 1% decline in 1975.

Overall, American business plans to spend a total of $92.9 billion for new plants and equipment this year, a booming 14% jump over 1971, the McGraw-Hill survey predicts. Between 1973 and 1975, preliminary plans indicate an average of $100 billion will be spent each year. This year's Gross National Product (the total dollar value of goods and services produced in the nation) is expected to hit the $1,148 billion mark this year, up about 9.6% over 1971. □

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redundancy in the case of failure of one unit. Honeywell will build most of the electronics at headquarters in Minneapolis, with the computers supplied by its Aerospace division, in St. Petersburg, Fla.

Honeywell is scheduled to deliver the first developmental control units to Rocketdyne next year, and the first flight engines will be delivered to NASA in 1977.

Insurance. Cartridge Television Inc. has licensed Magnavox, already an RCA licensee, to use CTI's Cartrivision.

This word came with another CTI announcement: formation of a rental-cartridge distribution company, Cartridge Rental Network, jointly owned by CTI and Columbia Pictures Industries. However, says the new firm's president, Larry Hilford, "Since we are a profit-making center, we won't preclude distribution of cartridges for other systems also."

Acceptance. A 2-gigahertz digital radio built by Avantek Inc., Santa Clara, Calif., has received type acceptance from the Federal Communications Commission. The unit, designed for use in commercial microwave relay systems, uses a four-level phase-shift-keyed modulation scheme. According to the manufacturer, it is the first American-manufactured PSK system to be type-accepted.

The radio is compatible with the Bell System T-1 PCM wire-line carrier. The new unit (model DR2A-T1) will accept two non-synchronized Bell T-1 carrier bit streams (1.544 megabits per second each) and transmit them over a single 2-GHz rf channel. Two DR2A-T1 radios, using a cross-polarized feed on the antenna, will carry four T-1 streams (a total of 96 voice channels) on the same radio frequency, or the equivalent of over 6 megabits of data per second.

Package cost. Ceramic dual in-line IC packages cost just about the same as molded plastic packages. But when costs of maintenance and replacement are considered, the economics swing overwhelmingly to ceramic. That, says Owens Illinois Inc., of Toledo, Ohio, is what an 18-month study shows.

The study was made by Sakari Jutila, chairman of University of Toledo's Department of Operations Analysis. Jutila says that for a 14-lead DIP, Cerdip-type packages cost out to about $118 per thousand, while plastics come out to about $100 per thousand. But if the cost is, say, $30 per repair in a small system, the buyer is spending twice as much for the glass ceramic package as for the plastic package.

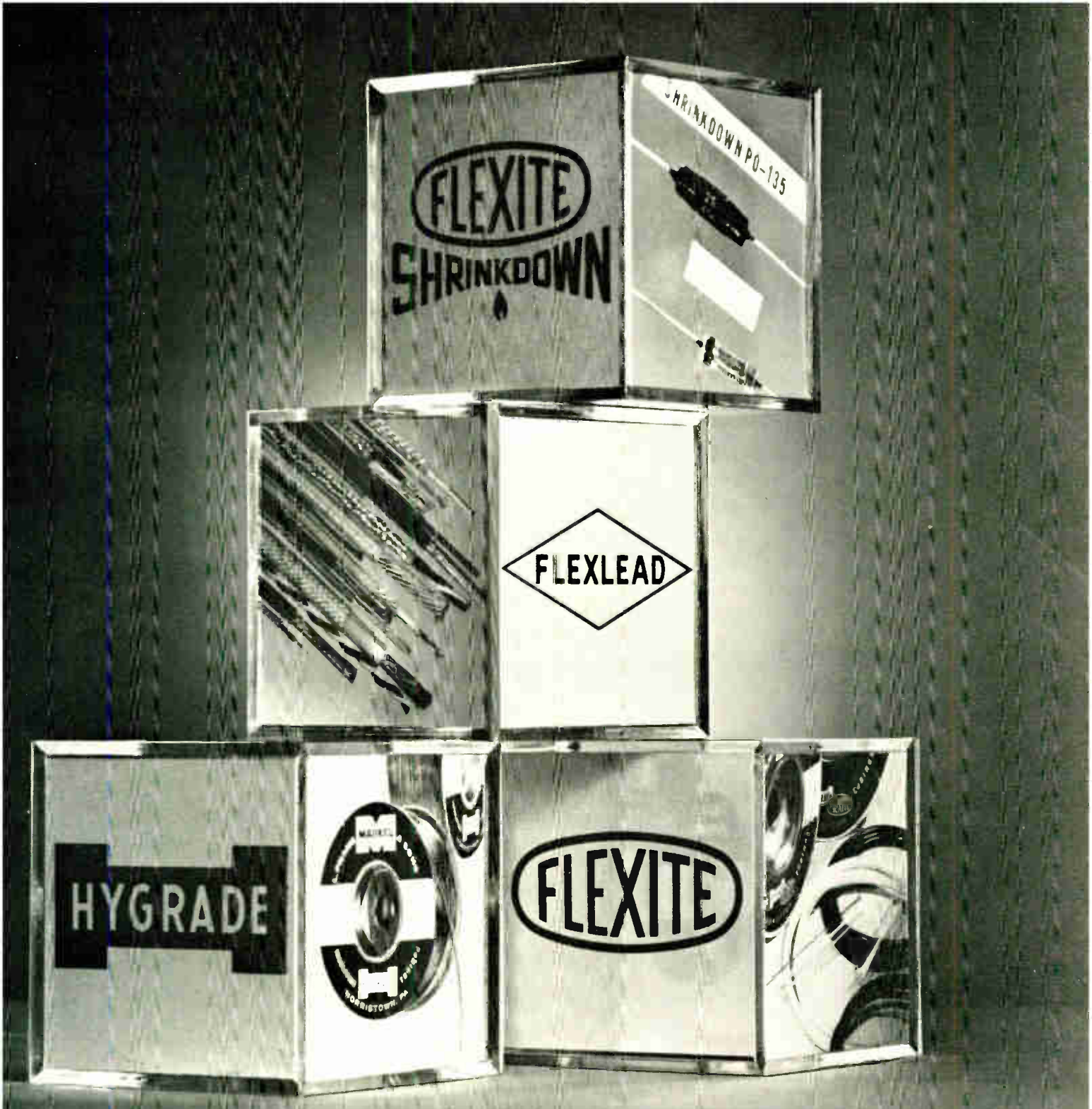
And, at $300 per repair for a large computer system, the glass-ceramic package could cost 10 times as much and still be more economical.

Polaroid clicks. Lifting its traditional veil of secrecy long enough to wow stockholders at its annual meeting, Polaroid Corp. has demonstrated a small IC-controlled camera that produces already-dry color pictures in a little over a second each. The IC, which controls the top-secret developing procedure and automatically adjusts the exposure, is to be supplied by both Texas Instruments and Fairchild. Each chip has 300 transistors.

Breakthrough. Fairchild Camera & Instrument Corp. has announced its first profitable quarter in two years. Net income for the period ending April 2 is $1,114,000, or 25 cents per share, on sales of $51,020,000. This includes a tax-loss carry-forward of $356,000, or 8 cents per share. For the comparable period last year, Fairchild incurred a loss of $1,614,000, or 37 cents per common share, on sales of $48,188,000.

Quits Italy. Philco-Ford Italiana, which was acquired some eight years ago by Ford in hopes of cashing in on the then booming European appliance and TV market, has given up the struggle against the European giants and has decided to join their ranks instead.

The company has been sold for an undisclosed amount to Robert Bosch GmbH, of Stuttgart, Germany. □



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Washington newsletter

Air Force faces sharp Awacs cuts by Senate alone . . .

The Air Force is getting little support from the Secretary of Defense and none from the White House in its **effort to get the Senate to restore the $227 million slashed from the Airborne Warning and Control System** by the Armed Services Committee. The nearly 50% cut drops two of three planes sought for procurement in fiscal 1973, and reduces the program, long politically chancy, to R&D status. Though the Senate authorization cannot be exceeded in the subsequent appropriation, **the Air Force may get some money restored in a final Senate-House conference committee,** since the more militant House membership is less likely to cut the program back. In a time of tight national budgets, top administration leaders appear to be listening to the arguments of Awacs opponents that **42 of the big command post radars will probably never be required** to counter a manned bomber attack on the U.S.

. . . Army loses $$ for Cheyenne, Marines for VTOL

The Army lost its battle with Congress to get $58.6 million in fiscal 1973 funds for its AH-56 Cheyenne helicopter gunship built by Lockheed Aircraft, as was anticipated. The Senate Armed Services Committee's deletion for the second year is **unlikely to be restored until the Army comes forward with results of competitive performance results from tests of Cheyenne as well as Bell Helicopter's KingCobra and Sikorsky's Blackhawk.**

Also reduced on economy grounds was the Marine Corps plan to increase its fleet of Hawker Siddeley AV-8 vertical-takeoff-and-landing fighter from 60 to 90. All $115 million for the 30 extra planes, to be produced under license, are **pending a judgment on the need for two distinct close air support weapons—the VTOL and the helicopter gunship.**

DOT ponders deterrents against truck hijacking

A sizeable market in electronic devices that will stop truck hijacking is a possible outcome of a Federal interagency committee on transportation security. Led by the Transportation Department, the group is coordinating research information among several Federal agencies, and is expected **to recommend safety procedures and security equipment for truckers and other transportation businesses.** Simultaneously, DOT's Transportation Systems Center, Cambridge, Mass., is looking into several electronic techniques, including a method of automatically shutting off a truck's ignition if it strays off a predetermined course.

Avionics imports from Canada, UK, are surging

A rising tide of imported navigational aids and aircraft flight instruments—mostly from Canada and the United Kingdom—will continue to threaten U.S. manufacturers, according to new Commerce Department data. Comparing 1971 with 1970, the department finds that **imports of navigational instruments and parts more than doubled in value, aircraft flight instruments and parts jumped two-thirds, and electronic ship logs and depth-sounding devices rose by almost half.**

Canada had the biggest gain, tripling its shipments of aircraft instruments to $6.2 million and doubling those in navigation to $5.8 million while the UK showed less steep but still significant, gains. **Significantly, U.S. exports of aircraft flight instruments, including automatic pilots, fell sharply** from $57.6 million to $44.7 million during the same period.

Washington commentary

Making it in world trade

After a long string of technological and marketing victories at home, the American electronics industry has dropped the ball overseas competing for exports. That is the impression given by Export-Import Bank chairman Henry Kearns and Secretary of Commerce Peter Peterson. Nevertheless, any assessment of U.S. world competitiveness must include its multinational electronics corporations—companies that are running hard with a firm grip on the ball.

Kearns, an accomplished globetrotter who has hit 10 countries so far this year for a total of 47 since 1970, says foreign industry and government officials have a high regard for U.S. technology but invariably ask: "When will American business present its products to us?" Americans, Kearns asserts, "simply are not competing with anything like the vigor of our Japanese, German, British, Italian, and French friends."

Peterson's principles

The view from the Commerce Department is similar, although Secretary Peterson puts it in a somewhat different perspective, suggesting that too many U.S. corporations for too long have taken a short-term view of their businesses—one that fails to extend beyond the next fiscal year's profit and loss statement. There is truth in that.

There is also truth in the contention of General Electric Co. chairman Fred Borch that "it boils down to the fact that other countries have placed international trade as a top national priority." The United States, of course, never has.

As America's deficit continues to mount, foreign trade is belatedly surfacing as a national issue in the capital to join such controversies of longer standing as the Vietnam war, tax reform, and environmental pollution. First quarter figures put out by Commerce at the end of April put the red ink at a record $1.5 billion—an astonishing figure in view of the figure of slightly more than $2 billion for all of 1971, when the country recorded its first deficit since 1893. Now the question is which way to go.

Several Federal programs are in varying stages of development, including authorization for industry formation of special domestic international sales corporations, or DISCs, as a means of spurring exports through deferral of taxes on half of a DISC's income [see p. 66].

But the Administration has rejected industry proposals for a 25% tax allowance against R&D expenditures, says Secretary Peterson, "as too expensive at this time" of tight national budgets. That spur to U.S. competitiveness could cost up to $3 billion a year in Federal revenues. Instead, Peterson favors "a program which would permit broad, joint research efforts by a number of companies with common goals," efforts now precluded by antitrust statutes.

Such joint efforts—uncomfortably reminiscent of what Japan's Ministry of International Trade and Industry has been doing for some time— would be carried out with "general Government oversight to guard against restrictive practices," explains Peterson. "Any patents resulting from such efforts would be privately owned but broadly shared—free of charge to all participants and at a reasonable royalty to other American companies."

Looking at MNCs

No one in the electronics industry has publicly opposed the proposal, but no one is heard promoting it either. Some of the more successful manufacturers suggest they prefer to continue down the road they are going—multinational. Popularly known as MNCs, multinationals abound in electronics. While the Commerce Department, in an internal study not yet released, concludes that MNCs in electronics and other high-technology industries are a powerful and positive world force, the leadership of the Congress is not so sure. Arkansas Democrat William J. Fulbright, for one, says his Senate Foreign Relations Committee is building up a special investigative staff prior to an extended examination of the role of multinationals.

When all is said and done, many of these investigations, studies, reports, and analyses by both the executive branch and Congress will have a shorter editorial life span than this commentary. That seems to be the American way of government, unfortunately. While too many people continue to make haste slowly, the balance of electronics trade shows no signs of turning up, much less of improvement.

It may be that the giant multinational corporations will prove the ultimate survivors of what shapes up as a worldwide technological shakeout. And that may be the way for American electronics manufacturers to make it in the international marketplace.

This is especially likely, given the slow U.S. Government response to the threat, and given also the truth of ExIm's Henry Kearns that too many U.S. corporations exhibit no enterprise, the truth of Peter Peterson that others have become shortsighted, and the truth of Fred Borch that foreign countries make trade a top national priority. **—Ray Connolly**

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Jerry Hartman, DVM Sales Manager

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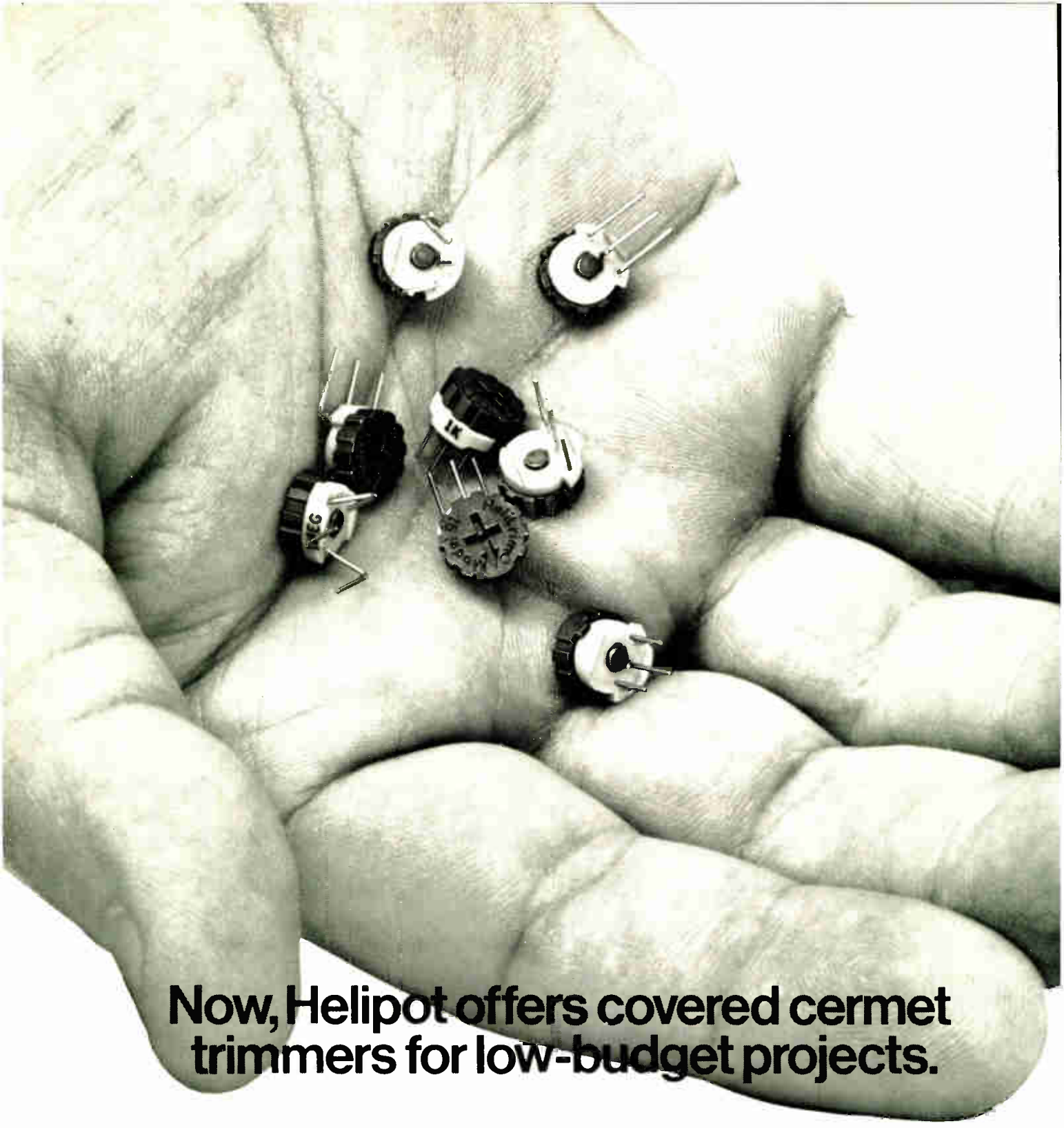

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Circle 52 on reader service card

Philips researchers get cost of core down to a penny a bit

Memory designers at Philips Gloeilampenfabrieken in the Netherlands, using improved fabrication techniques, have managed to get costs down to less than a penny per bit for a ferrite core memory with a capacity of 16 kilowords of 36 bits each.

The new techniques also make for a considerable savings in memory volume, with the basic 16 kiloword unit taking up no more than 11.5 by 14.4 by 2 inches—about the dimensions of a telephone book.

In Taiwan. The high packing density and small bit price are the prime features of the new ferrite core memory designated Q-14, of which first samples are now being offered to potential customers. Volume production, at the company's facilities in Taiwan, is expected to start next year.

To suit individual applications, the basic memory unit can easily be expanded.

Cost/performance. What will probably appeal most to prospective users is the Q-14's low cost. The penny-per-bit figure, elusive so far, has been the industry's goal because a fast-access memory at that price level would be competitive with low-cost storage devices, such as drums and disks, with access times in the millisecond range. With its fast access time—600 nanoseconds—the Q-14, Philips says, provides a cost-effective substitute for memory drums in, for example, minicomputers and office systems.

Ted Holtwijk, marketing manager for memory products, attributes the Q-14's low bit price/small volume combination to three factors. One is the use of continuous-wiring techniques possible with an in-house-designed machine that can wire up to 64 rows of ferrite cores in one strike. Another is the use of relatively large printed-circuit boards for core arrays and the associated electronic circuitry—boards that Holtwijk says his company can fabricate with high yield. The third factor, one that's responsible for the Q-14's compactness, is the special memory construction based on board-folding techniques. □

Switzerland

Slide sandwich varies display

In their search for new variable-data display techniques, scientists at Switzerland's Brown, Boveri and Cie. have hit upon a method that looks like a winner over other display schemes, at least as far as costs and simplicity are concerned. The BBC technique combines the electro-optical effects of liquid crystals with conventional slide projection to avoid the problems normally encountered in presenting variable and non-variable information on a common display screen.

Displays with variable data superimposed on static information are often found in control rooms monitoring industrial processes. They are also used as display boards in such diverse applications as traffic control centers and military command posts. In most of these jobs, the data that remains unchanged occupies the display's major portion, while the section with variable data is relatively small.

Sandwich. The Swiss display technique, devised at BBC's Research Center at Baden, near Zurich, does not need a computing system. All it uses are a slide frame in which a photographic transparency containing the static picture is combined with a liquid crystal cell and a matrix drive circuit for controlling the varying information on the display.

The system's key element is the two-slide frame, which consists of two 5-by-5 centimeter glass plates spaced about 0.1 millimeter apart. A thin layer of nematic liquid crystal is sandwiched between them. Attached to one plate is the transparency, and deposited onto the other are the electrodes for liquid crystal operation. A conventional keyboard drives the matrix. □

Japan

Bubble device gives rotation

Two-dimensional shift arrays built with bubble devices may simplify computer-aided pattern recognition. One register of this type is being investigated by researchers at the Central Research Laboratory of Hitachi Ltd. for use as a pattern rotation device for data preprocessing in optical character recognition.

Hitachi's experimental 10-by-10 T-bar arrays are fabricated on 52-micrometer thick $TmFe\ O_3$ orthoferrite, with a permalloy pattern that is 1.2 micrometers thick.

How they work. Rotation is obtained by skewing bubble detectors arranged along the left-hand or bottom margin of the array. The lag between the first bubbles in a given column or row to reach the detectors and the following ones causes rotation of the pattern. Two shift arrays, one with detectors arranged at a small angle along the right-hand side, can be used to rotate vertical lines in the character. Another array, with similar detectors along the bottom, can be used to rotate horizontal features in the pattern. □

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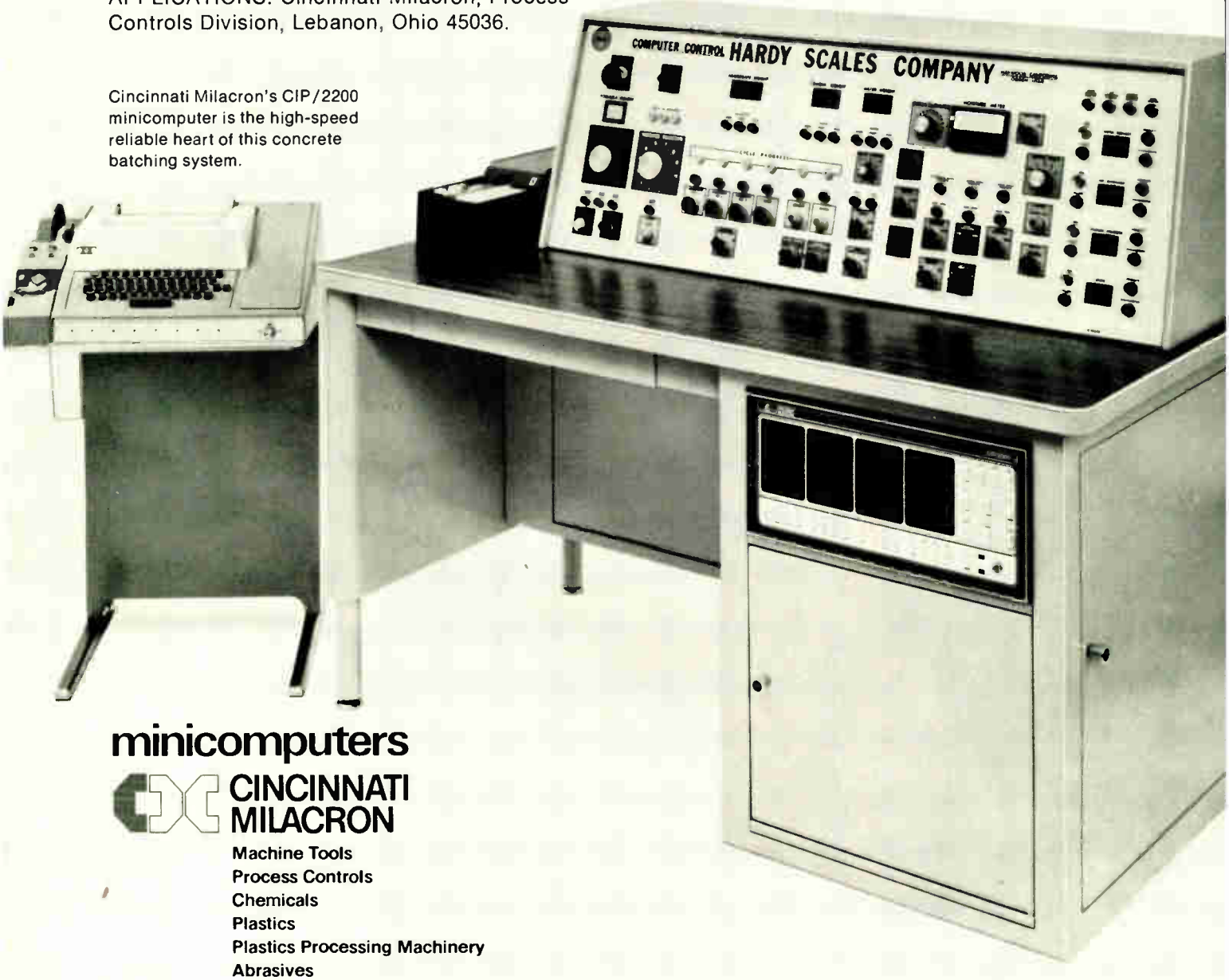

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Circle 54 on reader service card.

International newsletter

Japan exports technology: N/C to Russia . . .

The Soviet Union has reached a basic agreement to import technology for the production of numerical control equipment from Fujitsu. A 5-man team headed by B.A. Matkin, a Russian deputy minister, reached this agreement during their late April visit to Japan. Technology will include both numerical control electronics and pulse motors used for machine tool table and tool drive, but probably will not include computing control electronics.

In an unrelated move, **Fujitsu is also preparing to send a team to mainland China to discuss exports of telephone transmission gear, including cable, microwave carrier equipment, and exchange equipment.** Last year, the company sent a similar team to the mainland to discuss computers, but Fujitsu says the trip has not resulted in any equipment or knowhow sales.

. . . and consumer electronic plant to Poland

Poland has bought a whole plant from the Japanese for video and audio equipment—including black and white TV, radios, and tape recorders—plus knowhow. Sanyo Electric Co. is supplying the equipment to the Polish Unitra concern. The plant, which will be loaded on ships this autumn, **costs $5.5 million.** Sanyo's price for knowhow is $1.1 million. Unitra will pay 25% down for the plant and remainder in semiannual payments over six years, starting when it is loaded on ships.

Chinese technology shoppers view wares in Paris

China's increasing interest in Western products had the French electronics industry on pins and needles last month as a seven-man delegation from Peking made a three-week window-shopping tour of high-technology companies, beginning with booths at the Paris Components Show. Despite their follow-up visits to eight French companies after the show, the Chinese bought nothing on this round. **Particular areas of interest to the Chinese were lasers, microwave measuring devices, crt manufacturing equipment, and a variety of components for use in telecommunications.** One firm got the impression that the Chinese were sizing up French technology, especially in comparison with what they knew about German technology. "If the orders come at all, we expect a long interval," remarked one realistic-minded commercial man.

British microwave landing system set for 1975 . . .

The standard landing aid for tactical aircraft and helicopters in Britain's armed services starting in 1975, will be the system known as Madge, for microwave aircraft digital guidance equipment, developed by Mullard Ltd., and its associate MEL Equipment Co. The Ministry of Defence plans to equip about 1,000 planes and have about 90 two-man-portable ground units in use or in reserve. The system is likely to be used on all airfields from short temporary strips on up.

In Madge, **microwave interferometers on the ground use a pulsed 5-gigahertz transmission from the aircraft to measure azimuth and elevation approach angles.** The data is radioed to the plane in digital form in response to regular, automatic interrogations. The pilot's display indicates the error from a pre-selected path. Three ground boxes measure elevation, azimuth, and overshoot azimuth. Each box contains at least six antennas spaced at increasing ratios of two-to-one to form the inter-

ferometer. MEL says **this system eliminates all interference and multipath effects down to zero elevation.**

. . . as maker hopes for NATO sales

The ministry intends to buy Madge Mark 1, which is an approach aid providing assistance to instrument landing system category two standards through an elevation arc from 1° to 25°, and 45° either side of a datum reference point out to 15 nautical miles and 65° either side out to 2 miles. Angular accuracy is better than 0.04°. MEL, which is doing the operational system development, **is working on a civil version of similar performance and an automatic landing version incorporating a ground computer.**

The company hopes to sell it to other NATO countries, particularly the U.S., now that the Pentagon is buying proven foreign equipment abroad; there is no similar, developed U.S. equipment. **Basic cost of a ground set up is about $60,000, an airborne one about $10,000.**

West Germany's components outlook brightens

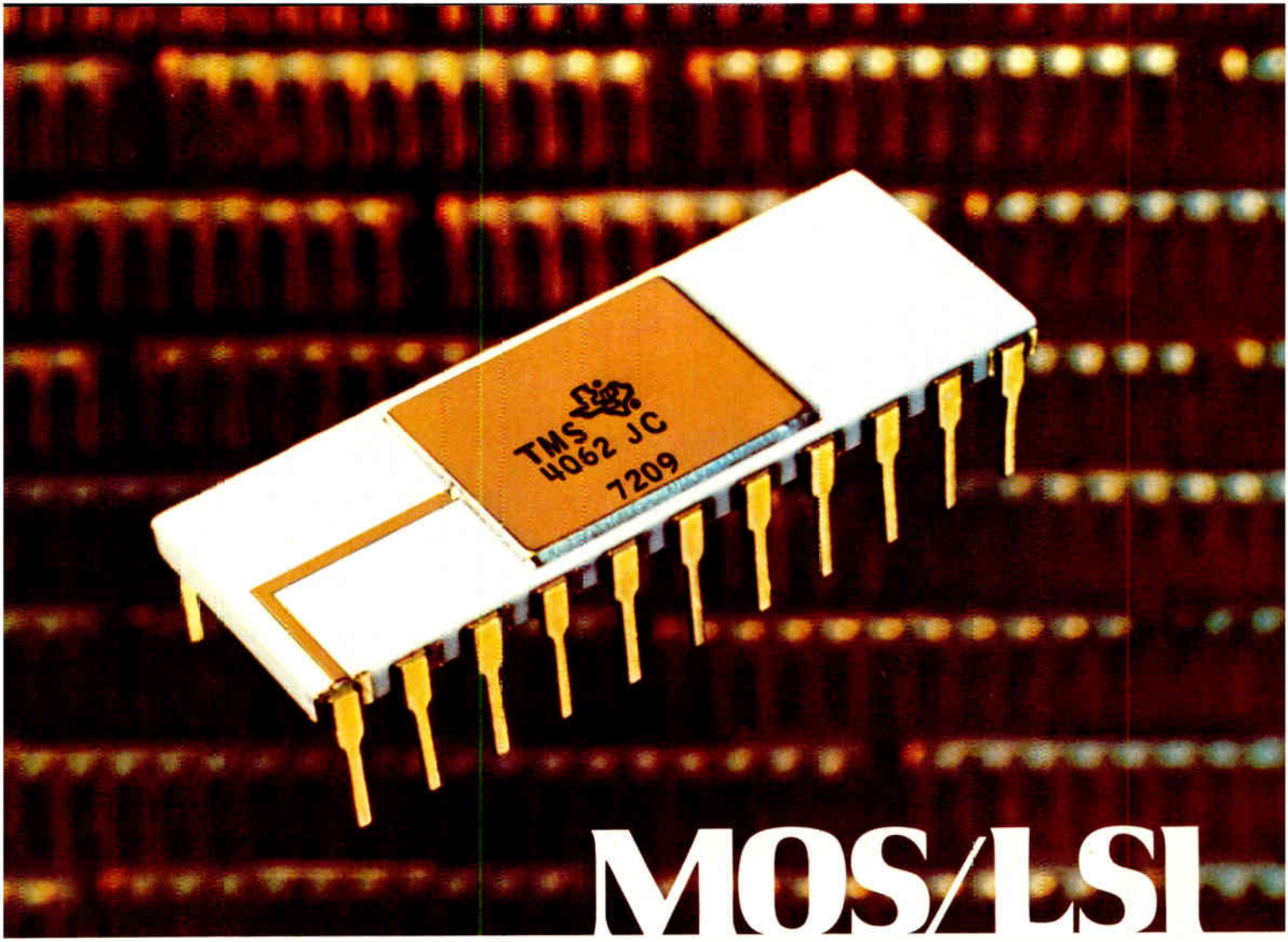
For West German components makers, hard hit by lackluster markets during the past year and a half, business is beginning to take a turn for the better. That's the word from producers returning from the just-ended Hanover Fair. **AEG-Telefunken, for example, expects a 6% to 8% increase in sales for this year.** A similarly optimistic forecast comes from Valvo GmbH, the Philips subsidiary. **The reason for the livelier components activity is stepped-up sales of entertainment electronic equipment, particularly of color receivers.** There are also indications, some companies say, that during the course of this year additional boosts will come from the industrial electronics sector, mainly from producers of automation equipment and test and measuring gear.

Hitachi plans TV set assembly in Canada

Add Hitachi Sales of Canada, in Montreal, to the list of Japanese subsidiaries making television sets in Canada. It's parent, **Hitachi Ltd., in Tokyo, says it is assembling 26- and 22-inch sets, with completed chassis coming from Japan—and picture tube and cabinet made locally.** Initial production will be several hundred sets per month. Hitachi gives several reasons for move into Canada, which it considers a trial. One reason is that these large size sets are not made in Japan. Another is that Hitachi's president, Hirokichi Yoshiyama, says that his **company must become a multinational company, not depending on just expanding exports to keep it healthy in overseas markets.**

From West Germany, a liquid-crystal quartz watch

A group of five West German watch makers, which last year teamed up to form the Deutsche Uhren-Kooperation, have announced the first result of their joint development efforts: a quartz-controlled wristwatch featuring liquid-crystal time indication. The watch, tradenamed Pallas, has a strong American accent, however. **The complete works—integrated circuit, liquid cystals and all—comes from Optel Corp. in Princeton, N.J.** The Pallas watch will go into serial production soon and, retailing for around $287, will hit the German market by September or October— about the same time that a 13-firm group in Switzerland will start marketing a similar watch using Optel-made works [*Electronics*, Apr. 24, p. 42].



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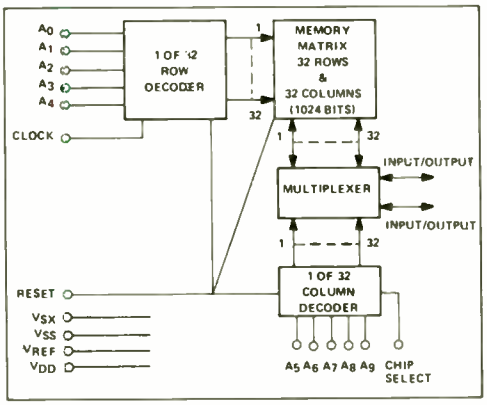

Delivery: One week, off-the-shelf.

Up to 5000 units can be delivered one week after receipt of order. Larger quantity orders can be filled by TI three weeks ARO. Priced at $10.50 in 1000-piece quantities, the TMS4062JC is available either from TI stock or from authorized TI distributors.

For data sheets on TI's new TMS-4062JC MOS/LSI RAM, circle 92 on Service Card. Or write Texas Instruments Incorporated, P.O. Box 5012, M/S 308, Dallas, Texas 75222.

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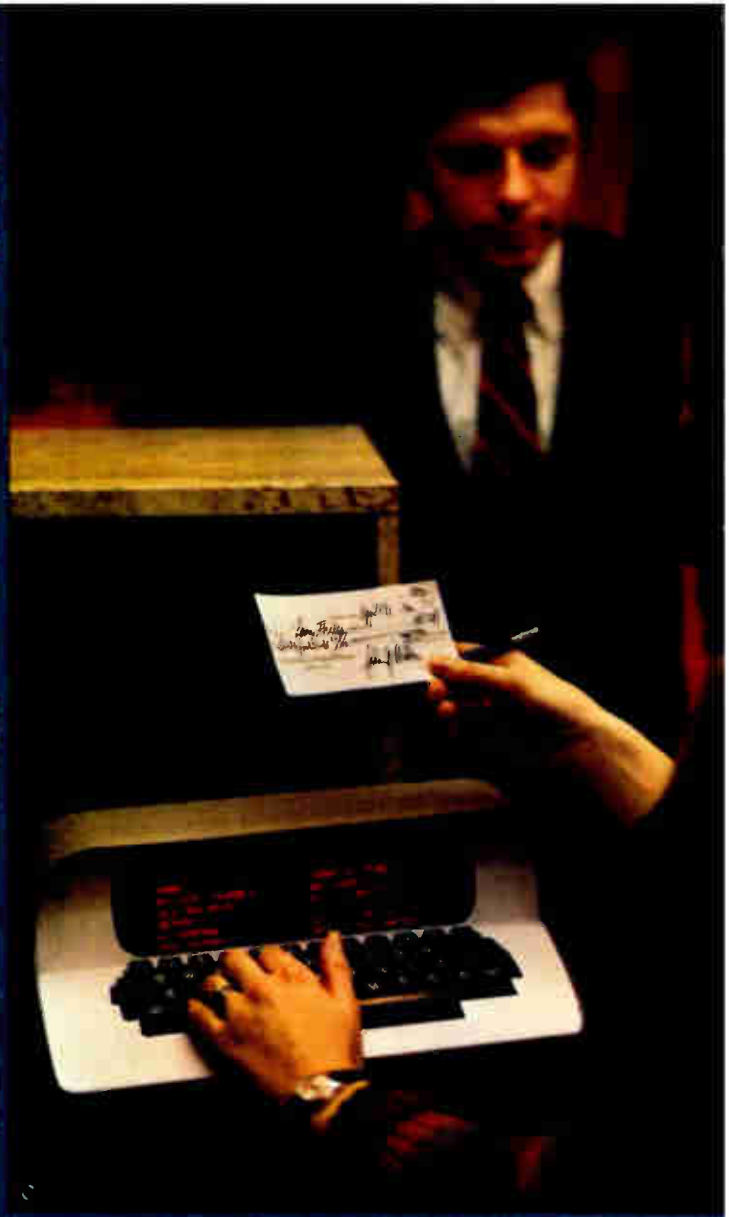

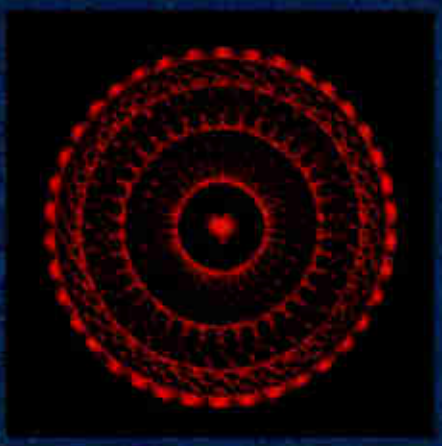

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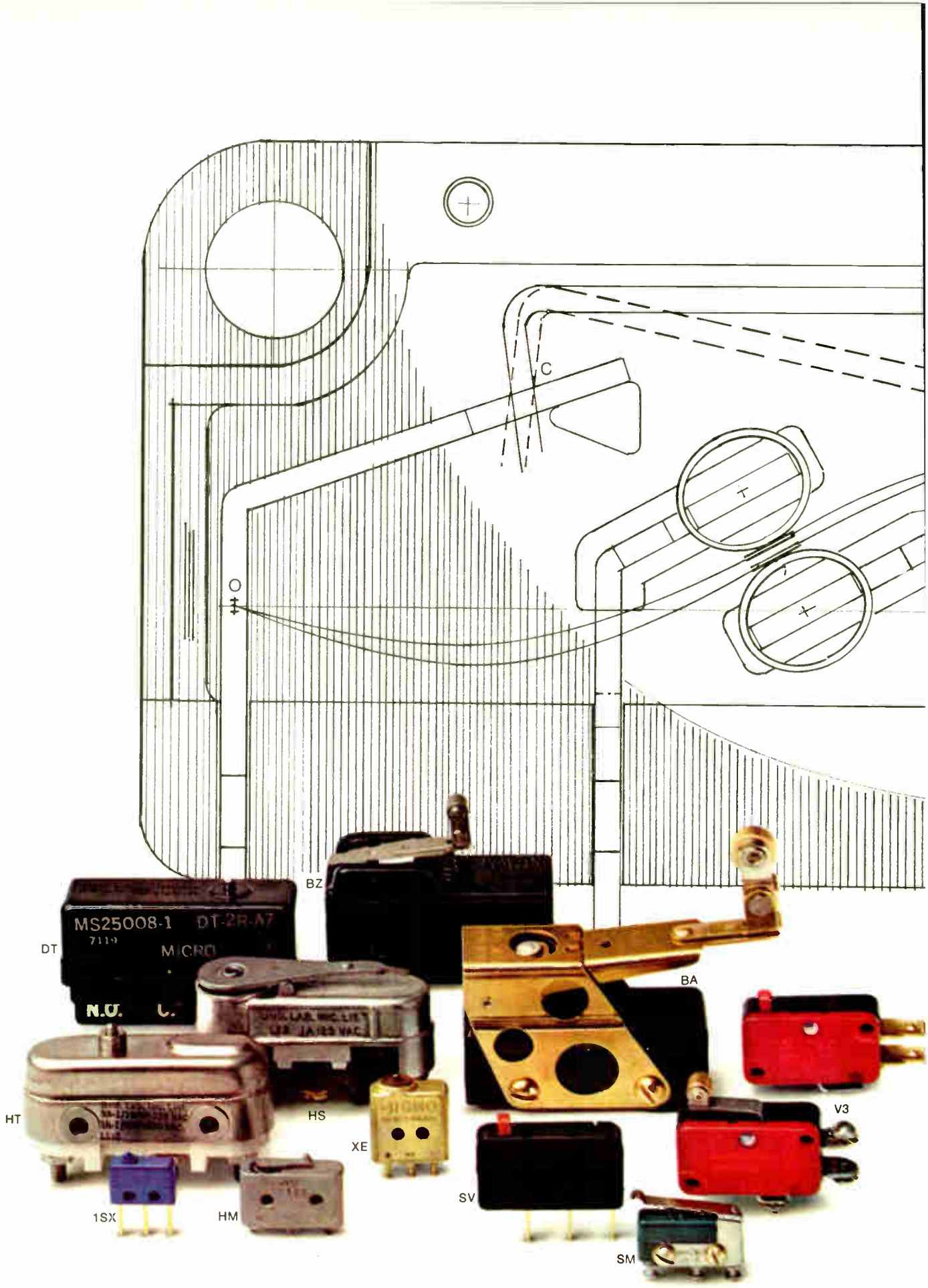
Circle 60 on reader service card



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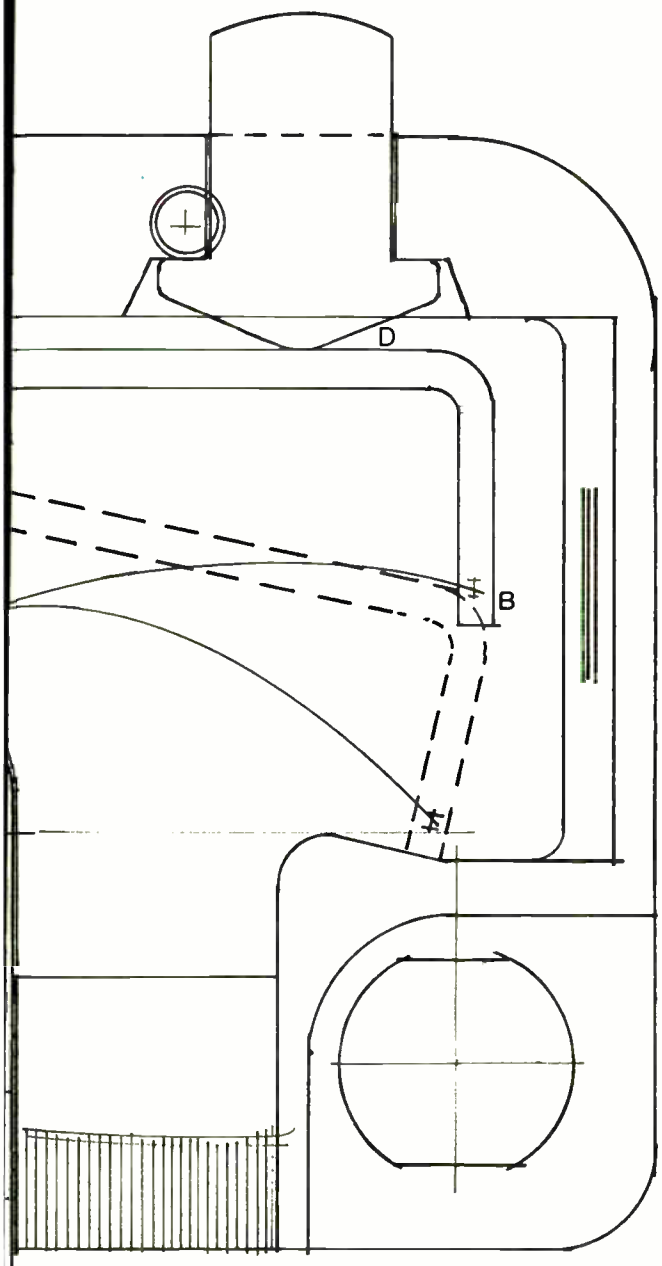

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Circle 63 on reader service card

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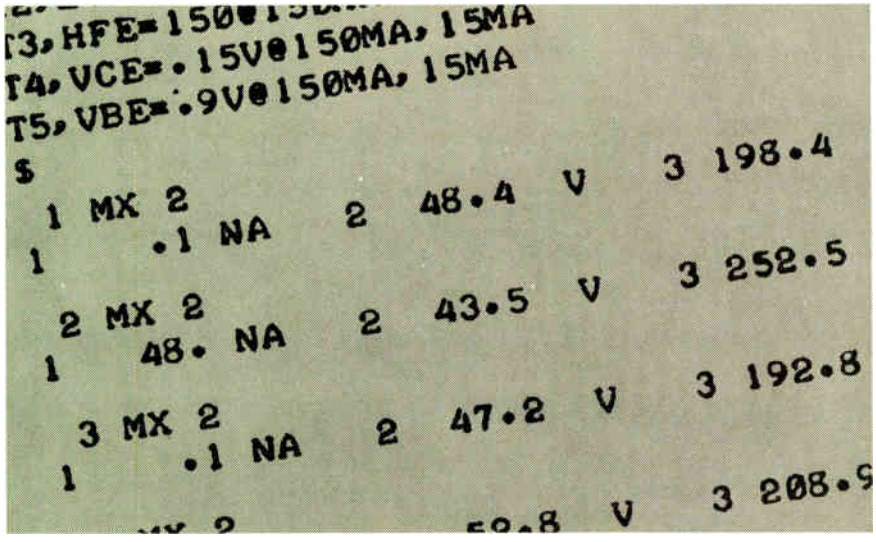

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TERADYNE

Electronics faces tough, new world

Government attempts to enlist technology's aid in righting the U.S. trade deficit meet with mixed industry reactions, labor opposition

by Ray Connolly, Washington bureau manager

Squeezed between the continuing "economic miracle" of Japan and expanding competition from Western Europe's economic community, the United States is calling on electronics and other high technology industries to erase the red ink from its trade balance ledger. But restoring trade in electronics to a surplus position in 1972 is viewed by both industry and Government as unusually difficult.

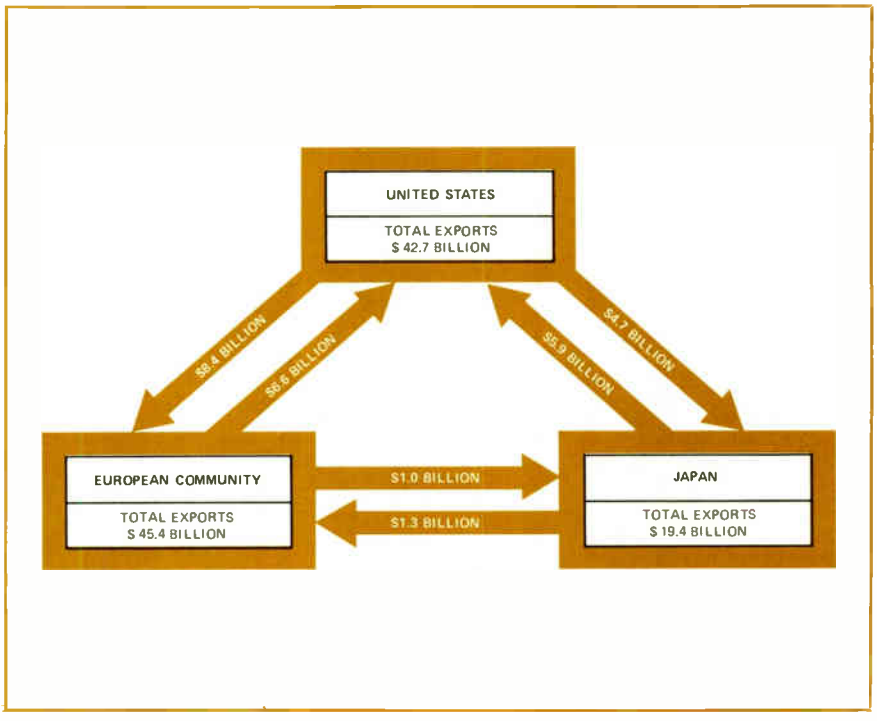
Last year, when total U.S. trade moved from a surplus position of roughly $2 billion at the end of 1970 to a comparable deficit—the first since 1893—the electronics industry recorded its first trade deficit in history. New figures for 1971 show that electronics, a leading contributor to U.S. exports, plummeted from a peak surplus of more than $1,334 million in 1970 to a loss of more than $174 million last year. Most of the $1,508 million electronics turnabout is attributable to a sharp decline in exports. They dropped by more than $1,475 million, while total imports rose by only $33.5 million (see table, p. 67).

One gloomy but hardnosed economic analysis circulating in Washington suggests that America's 1972 electronics trade balance will decline even further, despite an upturn in the domestic economy. Authored by the U.S.-Japan Trade Council, a non-profit association of more than 700 companies that draws substantial support from the Japan Trade Promotion Office and is registered as a foreign lobby, it concludes that "an optimistic forecast, in fact, would call for no sizable deterioration in last year's deficit."

The Council's arguments are all too persuasive. "The effects of a currency realignment will require many months to be felt," it maintains. "Even then, a reduction in the price of U.S. technology-intensive products, such as computers and aircraft, will probably not result in any major expansion of exports. In many of these products, the U.S. has no real international competition, and a price decrease will not by itself generate any increased foreign buying."

Programs. Moreover, a varied package of projects put together by the U.S. to spur electronics exports has only succeeded in generating mixed feelings within industry, opposition from organized labor, and no enthusiasm for the short term. The substance of the Treasury's programs affect U.S. trade agreements with Europe, and, it is hoped, other nations' tariffs.

The General Agreement on Tariffs and Trade (GATT) is set to be updated in 1973 as a result of pressure put on the European Community by Treasury Secretary John B. Connally. In addition, although the full impact of rewriting and expanding the agreement won't come until after negotiations, the U.S. plans to get after member nations now for current violations. France, for instance, has quotas on American semiconductors, the Netherlands slapped a quota on Japanese consumer electronics, and there are



Trade balancer. Commerce chief Peter Peterson faces labor and industry opposition.

Can Peterson right the trade balance?

Peter G. Peterson, the 46-year-old former boss of Bell & Howell Corp., is the man whom President Nixon has charged with the job of spurring America's industrial technologists to new competitive heights in the world marketplace. It is a tough assignment, despite the fact that Peterson, as Secretary of Commerce, will be working in tandem with Treasury Secretary John B. Connally, the Cabinet's most accomplished international trader. But whereas Connally has shown his mettle thus far in negotiating international money matters, Peterson is still an unknown quantity.

However, he's known to hold the belief that U.S. labor's declining productivity is in large measure responsible for America's trade problem. This opinion puts him in conflict with the views of at least one major top executive, GE board chairman Fred Borch. As Borch put it: the 1964-70 jump of 20% in U.S. labor costs is not the real reason for America's trade problem. The GE leader—who didn't make his reputation by arguing on the side of organized labor—notes that America's main trading partners have experienced comparable increases: "Italy is close to our 20% increase in costs; France is lower at 6% . . . Germany 26% and Britain, almost 33%."

The problem, in Borch's view, "boiled down to the fact that other countries have placed international trade as a top national priority and have adopted structural policies to promote their trade balances and their balance of payments." The U.S., he indicates, has not followed a like policy and must bargain hard to break down foreign barriers to equal competition.

Can Peterson meet that challenge? Since he took over the department in February on Maurice Stans' departure to raise funds for President Nixon's re-election, Peterson has given few signals as to how he will perform. Some electronics industry executives in the capital believe he has a better understanding of their particular problems than Stans did. But several other executives hear his proposals as inevitably leading to a bigger bureaucracy at Commerce, already long criticized for its lackluster operation.

multiple bilateral agreements on specific items between the European communities members that produce import tax breaks and handicap U.S. competition.

Besides opposing European quotas limiting U.S. exports, the Administration is pushing the European community to drop its stiff quotas against Japanese electronics. This is expected to take some pressure off the U.S., which now takes 30% of Japan's shipments. In addition, the U.S. plans simultaneously to press Japan to liberalize opportunity for direct U.S. industry investment and to accelerate reduction of its quotas of electronics.

DISCs. The value of the controversial congressional action last year permitting U.S. companies to create Domestic International Sales Corporations (DISCs) as a spur to exports still must be measured. Industry, of course, favors the Nixon plan that allows a company to create a DISC provided at least 95% of its revenues are derived from export sales. In return, the DISC is not liable for taxes on 50% of its export income until it is returned to this country. Since a DISC may extend loans to the parent corporation instead of adding it as income, and, critics say, "roll this money over and over" by regularly granting new loans, opponents of the plan have dubbed it "a corporate tax dodge." Moreover, they contend the effectiveness of DISCs may never be accurately measured, since it will not be possible to determine how much of the export sales they generate would have been sold abroad anyway. The reaction of U.S. industry: the Treasury department which is responsible for DISCs, has over 1,000 applications from companies that want to set one up.

Whatever the consequences for Federal tax revenues, the Nixon Administration believes U.S. industry requires new incentives to compete. Export-Import Bank chairman Henry Kearns summed up this view at the end of April: "America's reputation for technology is world-wide . . . but I find American salesmanship in most places at a low ebb.

However, these Treasury Department efforts on the international front, coupled with reported plans to accelerate anti-dumping actions, will not ease the pressures on U.S. manufacturers for a year or more—to judge by recent history. American TV-receiver makers, for example, were still waiting in April for the Customs Bureau to determine penalties to be assessed against Japanese monochrome receivers, though it was 1970 when the U.S. Tariff Commission ruled that dumping was taking place. And although Magnavox Corp. sought relief in March under countervailing duty statutes against alleged Japanese export subsidies on TV receivers, Zenith Radio Corp. is still awaiting a Treasury decision on a similar complaint filed in 1970.

Promotions. At the Commerce Department, Secretary Peter G. Peterson is still getting his arms around the job he took on in February after he left his prestigious White House assignment as Chairman of the Council on International Economic Policy. He plans to revitalize the department, having a Nixon mandate to keep U.S. industry competitive in increasingly tough world

markets. Specific proposals of his include:

- A computerized market intelligence service to be created within the Department on worldwide market opportunities for industry. But his proposal to sell the service to companies has arched more than one industrial eyebrow—"First, it would have to be far better than anything Commerce has ever done before we'd pay a dime for it," comments one Washington vice president of a multinational electronics manufacturer, "and second, any idea he may have that industry will contribute significant input is out of the question. We gather a lot of market data abroad, but it is intelligence; we consider it proprietary, and we are not about to share it." Those sentiments reflect the view of most multinationals.
- Development of the first Federal statistical analysis of the competitive strengths and weaknesses of America's main trading rivals. The assessment of comparative technological strengths, tax structures, subsidies, export and import policies and practices, antitrust statutes, and trends in market shares for products is expected to weigh heavily in the next round of GATT negotiations, if it can be readied in time. Once completed, the global assessment would be continuously updated for Government and industry usage.
- Takeover of the State Department's network of commercial attachés. Both Peterson and Secretary Connally believe the present organization is largely ineffective and unresponsive to industry's needs, and electronics industry executives agree. If Peterson takes over the International Commercial Services, he will put larger staffs in key foreign trade centers. Sure to appeal to electronics exporters is the prospect of expanded staffs and centers in the East Europe block of nations.
- Cooperation with Science Adviser Edward David in developing the New Technological Opportunities Program that will increase the spinoff from the $17 billion-plus annual Federal investment in R&D [*Electronics*, Sept. 27, 1971, p. 33; Jan. 31, 1972, p. 42]. Although this effort has less Federal money behind it than originally planned because of the tight deficit budget, Peterson believes it can be made to work. (While the U.S. dollar outlay on R&D far exceeds that of any other nation, Peterson's Assistant Secretary for Science and Technology, James Wakelin, points out that the U.S. investment on the civilian side is less than that of West Germany and Japan in terms of gross national product. The U.S. figure represents 1.2% of the GNP, Germany's investment was 2.9%, Japan's 2.8%. "Each plows back into commercial technology more than twice as much," Wakelin notes.)

Increased Federal support of civilian R&D however, has drawn a suspicious response in many quarters of the electronics industry, which in the past has drawn much of its R&D support from the defense and space programs that account for the bulk of Federal spending. "Rather than build up another Government superstructure that will drain off money into the bureaucracy," complains one communications company executive, "I would much rather see a system of tax credits for increasing our own investment."

Whatever evolves from Peterson's policies, many foreign governments are already doing a lot more for their industries. So says Robert C. Wilson, president of Collins Radio Co., Dallas, who points to support in the form of outright cash grants to offset capital plant and equipment costs, cash grants for R&D, long-term tax forgiveness, relaxed antitrust laws, and protection from foreign competition. America, on the other hand, "seems determined to give foreign industry a competitive advantage," he says, citing enforcement of vaguely worded antitrust laws, legal interpretations that discourage innovation, and condonement of monopolistic labor practices that cripple productivity.

"As somebody put it," he says, "our foreign competitors are lucky. They have two Governments working for them—theirs and ours." Wilson's view of Washington is that of "the central stronghold of a deadening bureaucracy," that has caused many to fail.

John Boyle, international vice president of Collins, points to two specific areas where the electronics industries could use more help from their Government. "Financing is probably the biggest aid you can give a man. The Japanese give very fine financing. The Canadians give very fine financing. The French give very fine financing. Of course, we deal with the Export-Import Bank,

U. S. EXPORTS/IMPORTS OF ELECTRONIC PRODUCTS
(in millions of dollars)

CATEGORY	1971	1970	1969	1968
COMMUNICATIONS & INDUSTRIAL				
Exports	1,170,252	2,438,855	1,896,857	1,495,917
Imports	346,684	514,319	437,917	341,584
CONSUMER				
Exports	95,009	76,946	106,587	85,223
Imports	1,333,600	1,152,498	995,952	711,732
SOLID STATE				
Exports	370,527	419,734	345,714	204,379
Imports	179,091	157,158	104,330	71,543
ELECTRON TUBES				
Exports	108,715	125,776	91,862	78,529
Imports	34,416	37,745	43,147	55,560
OTHER COMPONENTS				
Exports	304,837	463,004	423,862	337,116
Imports	329,583	328,138	243,888	176,783
TOTALS				
Exports	2,049,341	3,524,315	2,864,882	2,201,164
Imports	2,223,374	2,189,858	1,825,234	1,357,202

Source: EIA from Commerce Department data

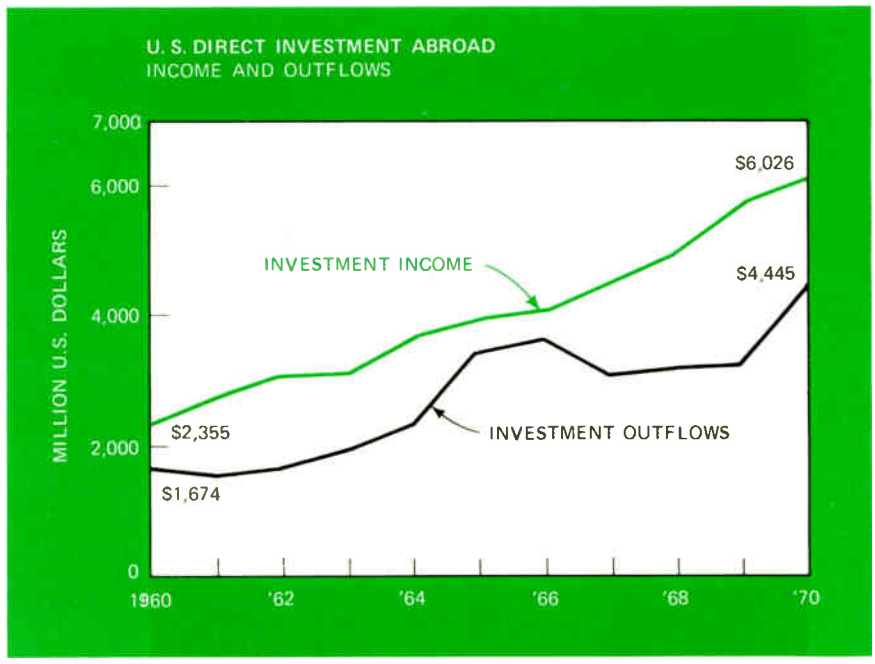
and they are getting better: we can now get up to eight or nine years on Eximbank. They're improving, but there's a helluva lot more that they could do."

On the issue of Government assistance in overseas sales, Boyle concedes that "we have civil and military attachés in our embassies, but they don't treat the American industry like, say, a Japanese embassy does. To the Japanese, the embassy is part of the sales team."

Where to look? While industry and Government officials agree that a fair international marketplace will undoubtedly take years to evolve, American manufacturers are being urged to move more rapidly on their own. The International Bank for Reconstruction and Development—the organization more popularly known as the World Bank (WB) and headed by former Defense Secretary Robert McNamara—sees a major telecommunications market evolving in the less developed countries.

"Typically, the developing countries are devoting about 3% of their total public investment" to telecommunications systems expansion, the bank says. In its analysis of telecommunications potential in underdeveloped nations, the bank says it "contemplates an increase of about 50% in the level of lending attained through fiscal 1971"—a level that reaches $592 million under 34 bank loans. But, though the Washington-based bank's study details the potential fully, including an outline of an enlarged program of research and technical assistance, one Federal official sees the opportunities in less developed nations as "small potatoes" when stacked beside the electronics opportunities for export expansion in Eastern Europe and the Soviet Union.

In Eastern Bloc nations, Hewlett-Packard Co.'s manager of international trade relations, Thomas A. Christiansen, sees a great instrument market potential. H-P has boosted its sales "from approximately $100,000 in 1967 to $3.5 million, or about 3% to 4% of our European business in 1971," he says. Though Christiansen says his com-



The multinationals, technology and labor

The electronics industry sees a threat to the multinational corporation stemming from a rising protectionist tide in the country. The most visible challenge is the "foreign trade and investment act" (H.R. 10914 and S.2592), popularly known as the Burke-Hartke bill, and strongly supported by the AFL-CIO. Though massive industry opposition to the bill has diminished the prospects of its passage, there is still industry concern that Burke-Hartke advocates will push to slip some of the bill's individual sections through as r ders on other legislation.

On the labor side, Nathaniel Goldfinger, AFL-CIO research chief, charges that American multinationals, including electronics companies, "have been exporting American technology and this is technology frequently developed at the cost of the American taxpayer." And, he says, American companies have been exporting American capital—building plants in foreign countries and displacing U.S. production in high technology and sophisticated products. "Multinationals," he argues, "should not be determining the basic economic policies of the U.S. government or of the American people."

Organized labor also leaps on former deputy Defense Secretary David Packard's turning the Pentagon on to foreign R&D for its programs, now being pursued as a cost-cutting device [*Electronics*, March 27, p. 31]. They cite figures from the U.S. Tariff Commission that some $430 million worth of foreign components—more than 2% of DOD's 1970 procurement spending—were imported, many of them allegedly from overseas subsidiaries of U.S. multinationals.

DOD, nevertheless, argues that it must import to survive, largely because of rapidly escalating U.S. contract costs, but also because European technology in some areas is good as well as cheaper. "Engineering R&D in France or West Germany costs half of what it does here," a Defense official points out, "so we buy that when we can and then license a U.S. manufacturer for production to keep Congress off our back."

Computers are another area of concern. While first 1971 trade figures don't break out precisely where U.S. exports of solid-state products and communications and industrial electronics declined, labor and some Government sources suspect much of the drop in industrial products stems from U.S.-owned computer plants abroad—like IBM's West German operations—which are now cutting the large dollar shipments of EDP hardware. These sources also contend that the declining U.S. dollar advantage in the world semiconductor market (exports slipped almost $50 million in 1971 and imports rose $22 million) stems from heavy licensing by U.S. firms overseas and a 20th century communications system that makes corporate secrecy increasingly vulnerable.

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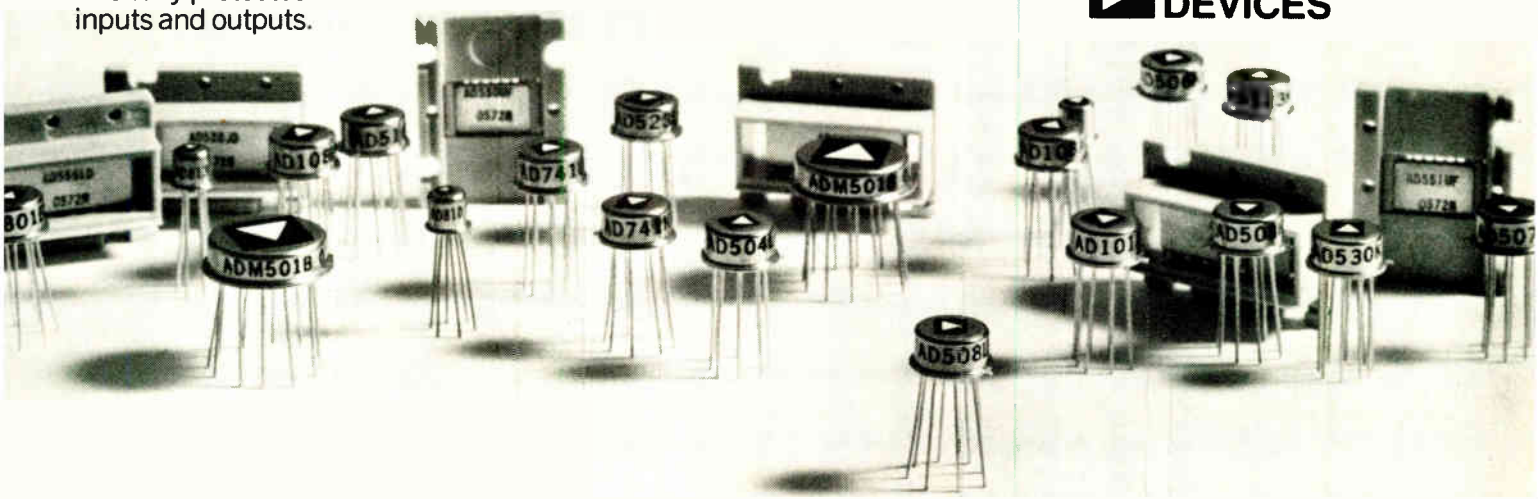


Circle 69 on reader service card

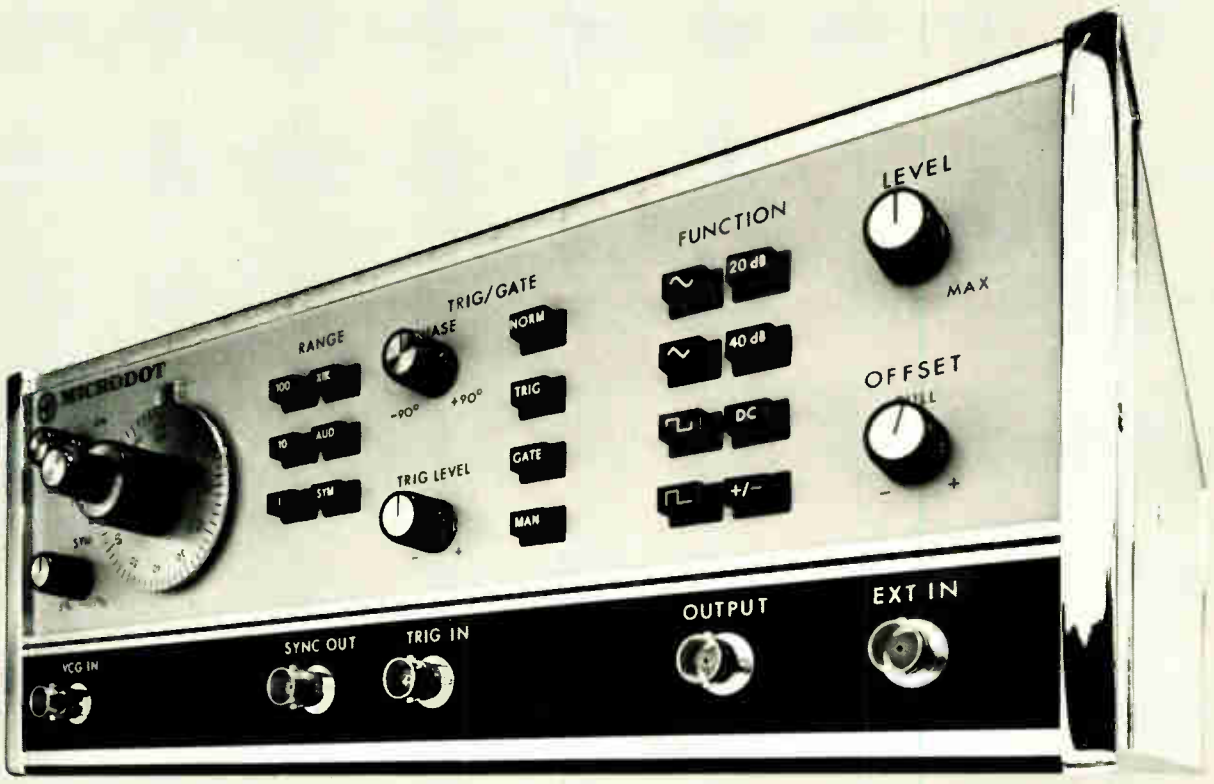
pany's total international sales could nearly double to $300 million by 1976, he adds that H-P doesn't foresee "great increases in our sales volume in the USSR and the Socialist countries of Eastern Europe" because of "various export controls which limit the products we can sell" and a market limited by lower technical sophistication.

Hangups. But, in urging the Congress to extend the Export Administration Act of 1969, Christiansen believes the U.S. should further limit the authority of the Office of Export Control to unilaterally turn down U.S. manufacturers' export requests. This authority—designed to protect against exports of technology with potential military value—is sometimes exercised too cautiously at the Pentagon, complain numerous manufacturers and some Federal officials. As one of them summed it up: "No one at the Pentagon ever got into trouble by saying 'no'."

However, the position of most instrument and computer makers anxious to open up the East European market was perhaps best expressed by the then H-P chairman David Packard in 1968, when he supported the first passage of the Export Administration Act: "The controls, in effect, serve to push East European purchasers into the hands of our West European and Japanese competitors."

And though some improvements have come since 1968, H-P's Christiansen makes clear that Secretary Peterson's Commerce Department still has much red tape to cut.

It involves the time tangle "required to make formal license applications and the delays encountered in obtaining licensing decisions." Such delays, he explains, "were not so important years ago when the U.S. had little interest in developing the market, and, in addition, enjoyed a near monopoly of the products of high technology. This, however, is no longer the case." The real loss, in Christiansen's view, "is in those orders which are placed with West European and Japanese firms, rather than U.S. suppliers, because delays for U.S. soul-searching cannot be tolerated." □



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Displays

Liquid crystals begin to turn on

Markets for the devices are maturing faster than expected as makers find ways to take advantage of LCD's low prices, low power and MOS compatibility

by Paul Franson, Los Angeles bureau manager

Electronic watches, consumer calculators, digital panel meters are just a few of the products in which liquid crystal displays (LCDs) are cropping up much sooner than most observers in the industry anticipated. And display makers are tooling up for what is expected to be more than the trickle of LCDs that have characterized pilot operations in the U. S., Japan, and Europe.

As recently as January, an official at Sperry Information Displays, Scottsdale, Ariz., said that his operation was still about two years away from production, but now it is gearing a pilot production line for later this year. Obstacles are being overcome and many companies are bringing to fruition the benefits of LCDs—low cost, low power consumption, direct compatibility with metal-oxide semiconductor technology, and thin displays, both large and small.

American Micro-systems Inc., Santa Clara, Calif., is producing 1,000 displays per month and expects the figure to rise to 20,000 per month by September. Optel Inc., Princeton, N.J., expects to sell 100,000 watch displays in 1972, North American Rockwell Microelectronics Co. (NRMEC), in Anaheim, Calif., will deliver over 200,000 units in the next 15 months as parts for calculators. Texas Instruments is engaged in pilot production of custom watch displays with standard units to follow.

Other U.S. firms in or about to enter the market include General Electric, old-time display house Industrial Electronics Engineers Inc., and newcomers International Liquid Xtal Corp. (Ilixco), and Riker-Maxson.

There's considerable activity in Europe and Japan in LCDs, but the only companies that seem to be close to production are Electrova in Vienna and, in West Germany, Siemens AG in Munich and AEG-Telefunken in Frankfurt. Siemens will offer standard four-digit, seven-segment displays starting in August, with production to start a few months later. AEG-Telefunken will have samples of black-and-white displays available in six weeks. AEG-Telefunken expects to be able to handle orders for custom displays by the end of the year and will have standard types on the market next year.

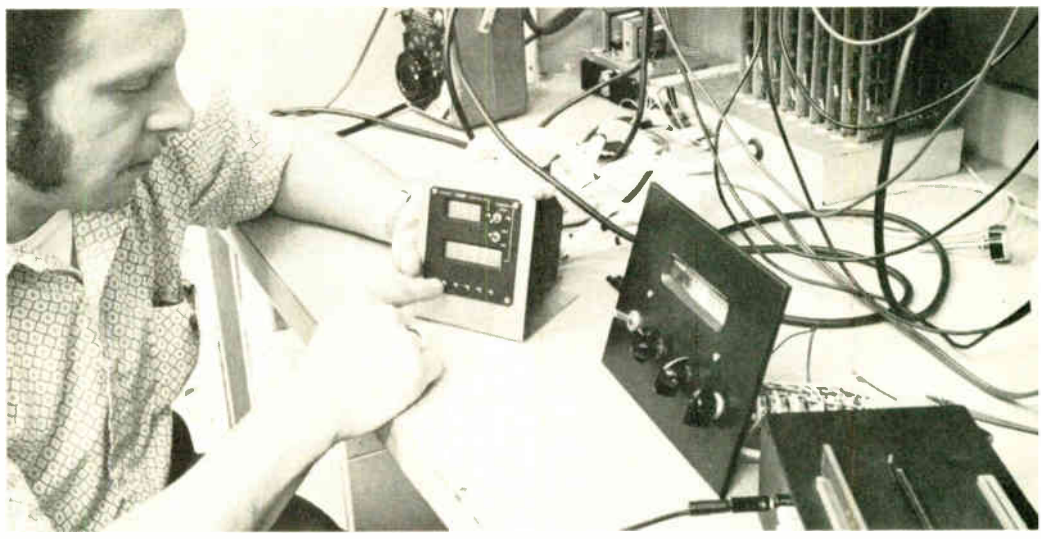
In Japan, Busicom Corp., will make LCDs for its calculators, as will Seiko for watches. Toshiba and Sharp Corp. are now making samples, and ISE Electronics is expecting to begin late this year or early in 1973. They're all after a slice of what could become a large business, but those who have estimates of its size are hesitant to let possible competitors know.

But Harry Weisberg, MOS product manager at RCA Solid State division, Somerville, N. J., is willing to stick his neck out: "There's no question in my mind that liquid crystals will be the dominant display by 1975 and beyond." He estimates that sales in 1975 could go as high as $20 million in a total alphanumeric display market amounting to five times that figure.

RCA is apparently nearing large-scale production: an imminent cut in LCD prices should bring four-digit panels, in quantities of 1,000, down to about $12 from the $75 level at which they were offered last summer.

New uses. Much of the market will come in applications where electronic displays aren't used now

On time? A technician in one of NRMEC's laboratories checks the clock for an LCD. NRMEC will deliver 200,000 LCDs in the next 15 months as calculator displays.



at all, such as wrist watches, clocks, gasoline pumps, odometers and speedometers, airport and sporting displays, and road signs. Other uses will come in such mushrooming products as consumer calculators and digital panel meters. Digilin, Inc. in Glendale, Calif., for example, has introduced a panel digital voltmeter with 3½ digits of LCD. Sales manager Stan Ericsson says that it's already the lowest priced DVM on the market at $125 in unit quantities and $55 in large quantities. Delivery is slated for May.

Liquid-crystal production has attracted a diversity of firms—some with related technology and some who see the potential. MOS houses AMI and NRMEC, for example, note the importance of compatibility of LCD surfaces for interfacing the displays with MOS. Sperry Information Displays, for another example, makes a gas display using flat glass plates and transparent conductive coatings such as those used in LCDs. IEE, Van Nuys, Calif., which has a joint venture with Japanese materials manufacturer Dai Nippon Toryo, will introduce a 5½-digit display in July. Efforts at Motorola's Semiconductor Products division in liquid crystals are confined to the laboratory, and Fairchild Semiconductor isn't working with them. Burroughs Corp.'s Electronic Components div., Plainfield, N.J., evaluated LCDs and decided to put its money on its Panaplex gas discharge display.

LCDs are simple in theory and structure. They consist of certain nematic organic compounds that change from a normally transparent state to opaque when placed in an electric field. Two types of operation are possible, reflective and transmissive. A thin film of liquid crystal material is sandwiched between two transparent conductive plates (generally glass with tin or indium oxide coating on the inside). When the material is energized, it becomes opaque and scatters light that is either reflected or transmitted through the display. Digits are formed by etching one coating into segments, and each segment usually has an individual electrical connection.

Transmissive displays require backlighting, usually by incandescent bulbs, but even here, the tiny amount of power required by the liquid panels can be supplied by low-level MOS logic.

LCDs offer a number of advantages over conventional displays in many applications. The primary features are extremely low power consumption and cost. NRMEC's eight-digit LCD with ½-in figures requires less than 2 milliwatts: Optel's watch displays require only about 15 microwatts, and a new field-effect reflective display developed by Ilixco in Cleveland, Ohio, requires only 0.01 μW per digit with all segments on and operates at 10 V. This power level is a low power record for LCDs; and the price of the displays is equally low—under $2.50 per digit, claims company president James Fergason. The low leakage current of the LCD is a result of the material "and the way me make it," Fergason says, declining to describe its formulation.

How much? Present small quantity pricing is not too relevant, since most applications are for custom displays and large quantities. NRMEC is apparently figuring prices at about $1 per digit in the large quantities it is supplying in calculators. Ian McCrae, optoelectronics marketing manager at Texas Instruments, Dallas, feels that $1.50 per digit will be required to have much impact in the market place.

Once underway, volume production costs should be minimal. The most expensive material used is the glass. Only about a drop of liquid crystal material is used in each display, and its cost is not significant. Recent Kodak prices were typically $1 per gram in kilogram quantities, but many users either make or mix their own materials.

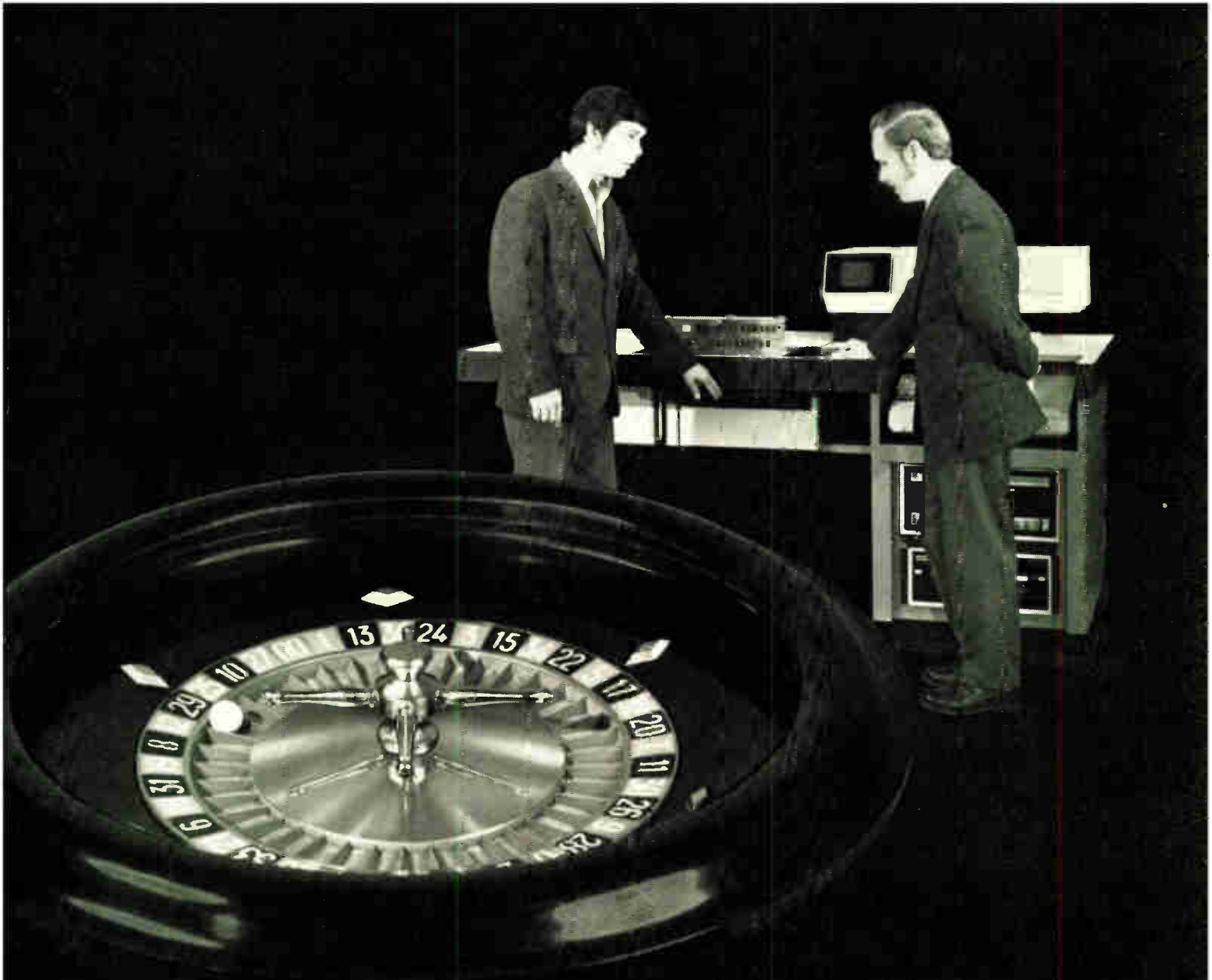
Problem solving. But all isn't rosy for LCDs. A major problem for many users is their limited temperature range. The maximum range, James S. Carlyle, head of the Information Presentation Products division at AMI, points out, is a 90°C window in the −30 to +130°C range: "We can move the window, but we cannot broaden it yet with different formulations." Optel says the range is 0°–50°, but Edward Kornstein, vice president, display marketing, says that wrist watches stay close to body temperature of the wearer even at low temperatures. RCA says that its 5°–55°C range is adequate for indoor use, and a small heater can be used for lower temperatures, such as for gasoline pumps outdoors.

Most manufacturers are trying to find materials that can tolerate lower temperatures, and L.E. Tannas Jr., supervisor, advanced techniques, for North American Rockwell's Research & Technology division, a sister division to NRMEC, says that the solution may lie in a class of suspended crystal materials that aren't liquid crystals, but could be used in a similar way in displays of the same type.

Another area of controversy and confused specifications is response time. Most LCDs have a noticeable time delay when switched. E.T. Fitzgibbons of NRMEC's processing engineering operation, is annoyed at the specsmanship in this area: "The rate at which the data can be changed and recognized is the important figure. Three character changes per second is nice and crisp to the eye, and this is about what we get." Rise times quoted vary from 20 to 80 milliseconds and from 50 to 200 ms

Display makes a point. AMI's 8-digit calculator display with decimal and polarity sign.

Experimental. TI's new LCD is ½-in. high and ¼-in. wide. Display is driven by TTL.



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for decay time.

LCDs are so new as products that life data isn't very complete. A number of manufacturers are claiming 10,000 hours of life, while Kornstein of Optel and Weisberg of RCA estimate that five years of operation is reasonable. NRMEC's Fitzgibbons points out a number of destructive modes for the liquid crystals: Excessive voltage can tear the molecules apart, and the cell can be attacked by contaminants.

A controversial failure is attributed to ion migration under dc operation. The mechanism isn't clear, according to a number of sources, but the solution is simple for some uses: don't use a drive with any dc component. "The answer is to apply an ac signal with no dc component at all," says Carlyle, "and AMI's MOS driving circuits do just that."

Togetherness. The display and its drivers must be considered together. For this reason, NRMEC says that it is interested only in systems business where it can make sure everything works together. AMI, which supplies the LCD to Digilin for its digital panel meter, also furnishes the MOS large-scale integration used in the product. North American Rockwell's Tannas adds that ac operation works so well and is so easy to do with MOS that there's no real advantage to dc." For watch use, though, dc is needed.

Another problem is how to make connections to all the segments in a display, which may have as many as 16 digits. The connections on the LCD panel itself aren't usually a great problem, but the connector into which it plugs can be a headache, says Fitzgibbons. The plug-in connectors usually cost about 1 cent per connection. Volume production will reduce the cost, as will the integration of the logic and drivers into the display panel, but great attention is now being paid to multiplexing to eliminate connections.

As these problems are being solved, the future seems to hold great promise for liquid crystal displays, with improved materials, and likely integration of displays and logic into one package being the next step. □

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Management

Vidar team takes time off for growth

To uncover new markets itself, top management at a California firm moved aside in favor of the next level—with marked success on both counts

by Steohen Wm. Fields, San Francisco bureau manager

"Who's gonna mind the store?" is the basic question that Vidar Inc. faced when growth stalled in the 1970 recession and its top brass decided to quit their regular jobs in order to dig up the much needed new business. The usual approach is to take a few bright MBAs and PhDs from the ranks and get them to brainstorm products that may break new ground.

But according to Vidar's Ted Keane, "you really should let your experienced executives do the investigating and give the MBAs and PhDs the experience of running a going organization." Keane has tried it and says it more than doubled the sales of his company in under one year with a single innovative product developed by a "phantom squad" of top executives.

Vidar is a 12-year-old Mountain View, Calif., manufacturer split about equally between an instrumentation division, which designs and manufactures sophisticated data acquisition systems, and its Vicom division, which makes telecommunications equipment. The former division, which Keane managed in 1970, was hit by the recession in Government business; the latter was doing well— but needed to do much better if the company as a whole was to grow.

Plan for profits. At that time, it had become obvious to Vidar's president, Vernon Anderson, that 1970 was a sad contrast to 1969—"a banner year," when the company earned about $15 per share on sales of $11 million. Together with the other corporate executives, Anderson put together a three-part plan which included: setting new profit targets for existing product lines so as to increase revenues by $5 million by 1975; looking into new market areas and new products, again to increase company sales by $5 million; and developing a program of acquisition to take place in 1973, and to add another $4 million in sales.

The most ambitious of these goals was the search for new markets, and Vidar put its most experienced people to work on it: Anderson, Keane, Dalton Martin, vice president of finance, and John McDonald, director of R&D. "We dubbed ourselves the phantom squad," says Keane.

Meantime, Richard Grey, who had been division manager of Vicom, was named acting head of the corporation, while Anderson retained responsibility for over-all profitability. Grey in his turn was replaced by L.R. Schultz, who was Vicom's marketing manager. R&D ceased to exist. Finance was handled by Gordon Hammond, who came from the management information services department, while Lew Jordan was brought from the sales manager slot to become acting general manager of the instrumentation division.

By August, 1971, the "phantom squad" had developed an electronic metering system to replace mechanical counters in telephone central offices. They had a contract with the Bell System for more than $20 million. The internship of the acting corporate staff was over—they had proven themselves capable of handling the organization. An unorthodox management maneuver had paid off.

Phantoms seek business. When the phantom squad set out to find new market areas, they picked on the telecommunications industry as their first choice. Eight potential product areas were picked out, then narrowed to three by asking what the production load on the company would be, what the cost of getting into the new business would be, and whether specific customers could be identified.

The marketing aspects were handled by Anderson and Keane. Product design was McDonald's job, and

In conference. Vidar's R&D vp Jack McDonald, vp Ted Keane, president Richard Grey, former president Vernon Anderson, and finance vp Dalton Martin consult on their new product.

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Martin was the operations man.

"By our June deadline, we had a proposal for a field trial," in which American Telephone & Telegraph was interested, Keane says.

The Vidar electronic metering system was to be installed in the phone company's central offices to record the number of message units used by each customer. The present system uses mechanical counters. Each month a photo is taken of the counter bank and the numbers are compared to those on last month's photo. The system, dubbed LMMS for local message metering system, uses an electronic scanner bank that monitors each subscriber's line and records the phone number, duration of call, and the time of day. This information is stored on magnetic tape and played back to the accounting machine for billing.

Interns promoted. At this stage in the game, November 1971, Grey, Jordan, Schultz, and Hammond had shown that they could run the corporation, and so they were promoted officially to the position they occupied on a temporary basis. And the phantom squad was able to work on the LMMS project full time.

By January, the field trial was completed, and last month Vidar and the Bell System announced the outcome. The New York Telephone Company purchased an electronic metering system that will handle approximately 3.6 million telephones. The contract was worth over $20 million.

Since—to say the least—this overshot Keane's plan of increasing sales by $5 million, the acquisition plan was scratched, and a new division was formed to manufacture the LMMS. It will be headed by James Conklin who had been managing the company's other manufacturing facilities. And, boasts Keane, "we did it all with existing people, and were able to use experience where it would do the most good."

As for the phantom squad, Anderson is taking a leave of absence from Vidar, and Grey has been named president, at the same time joining the squad. The squad, meanwhile, will draw a breath and then take a look at the future. □

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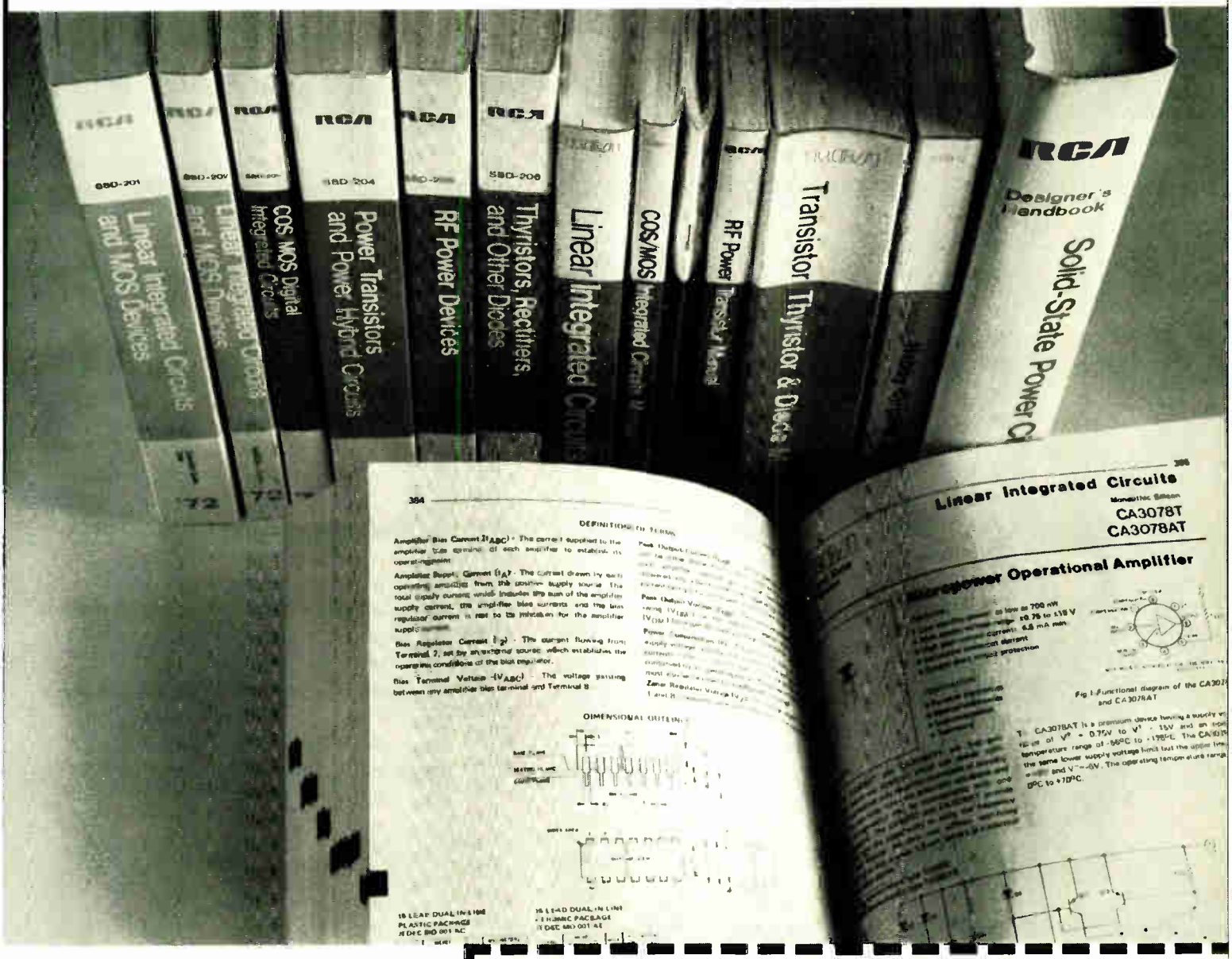

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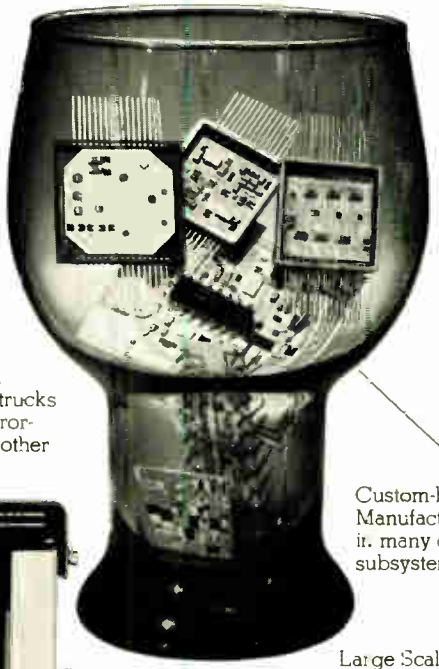

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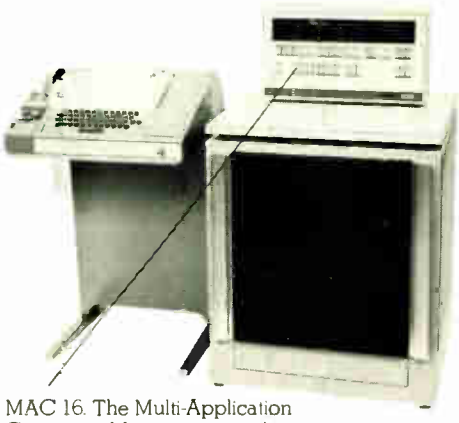

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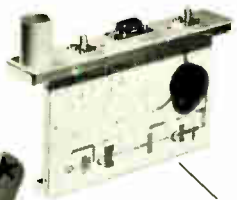

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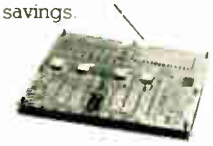

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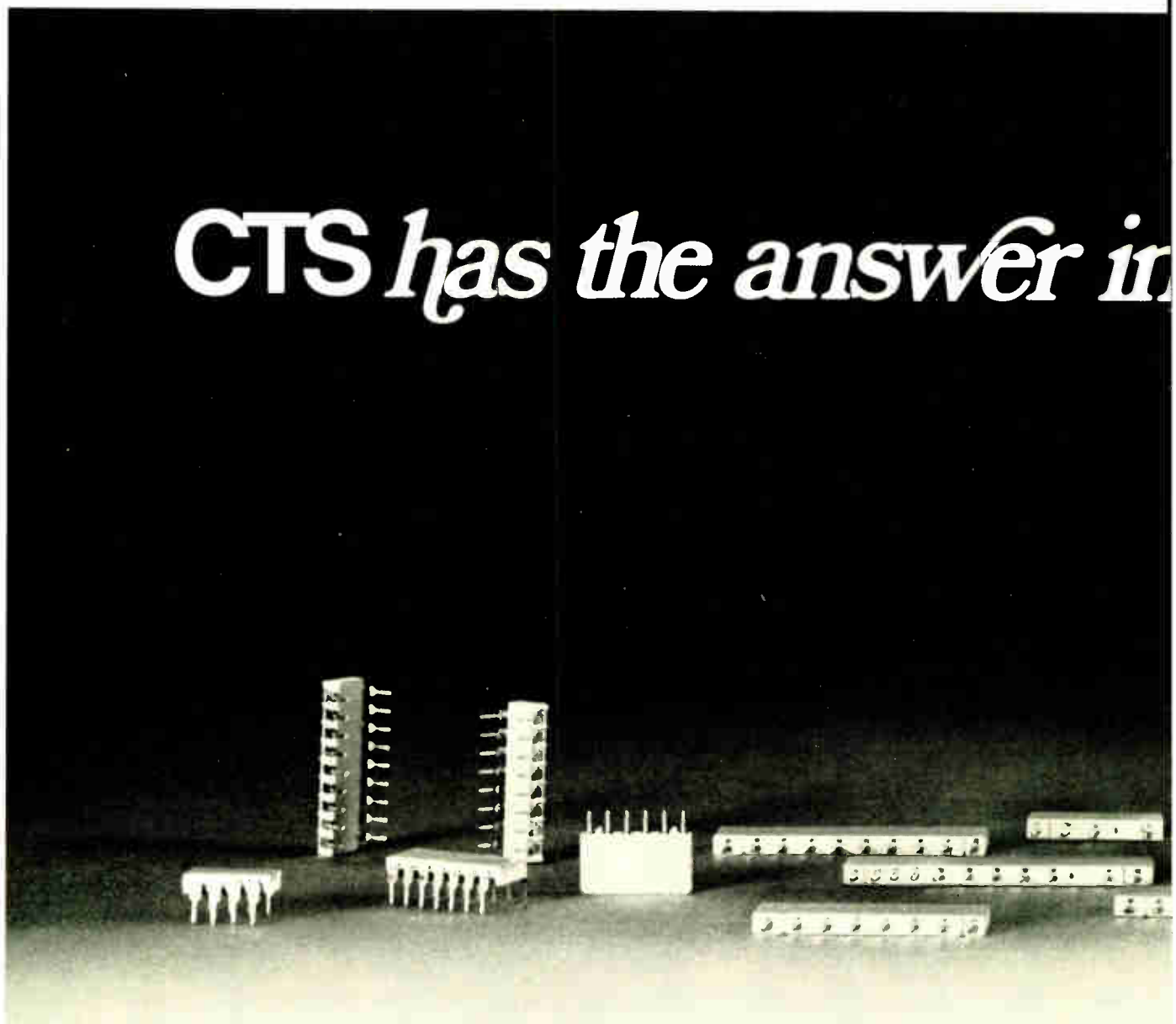

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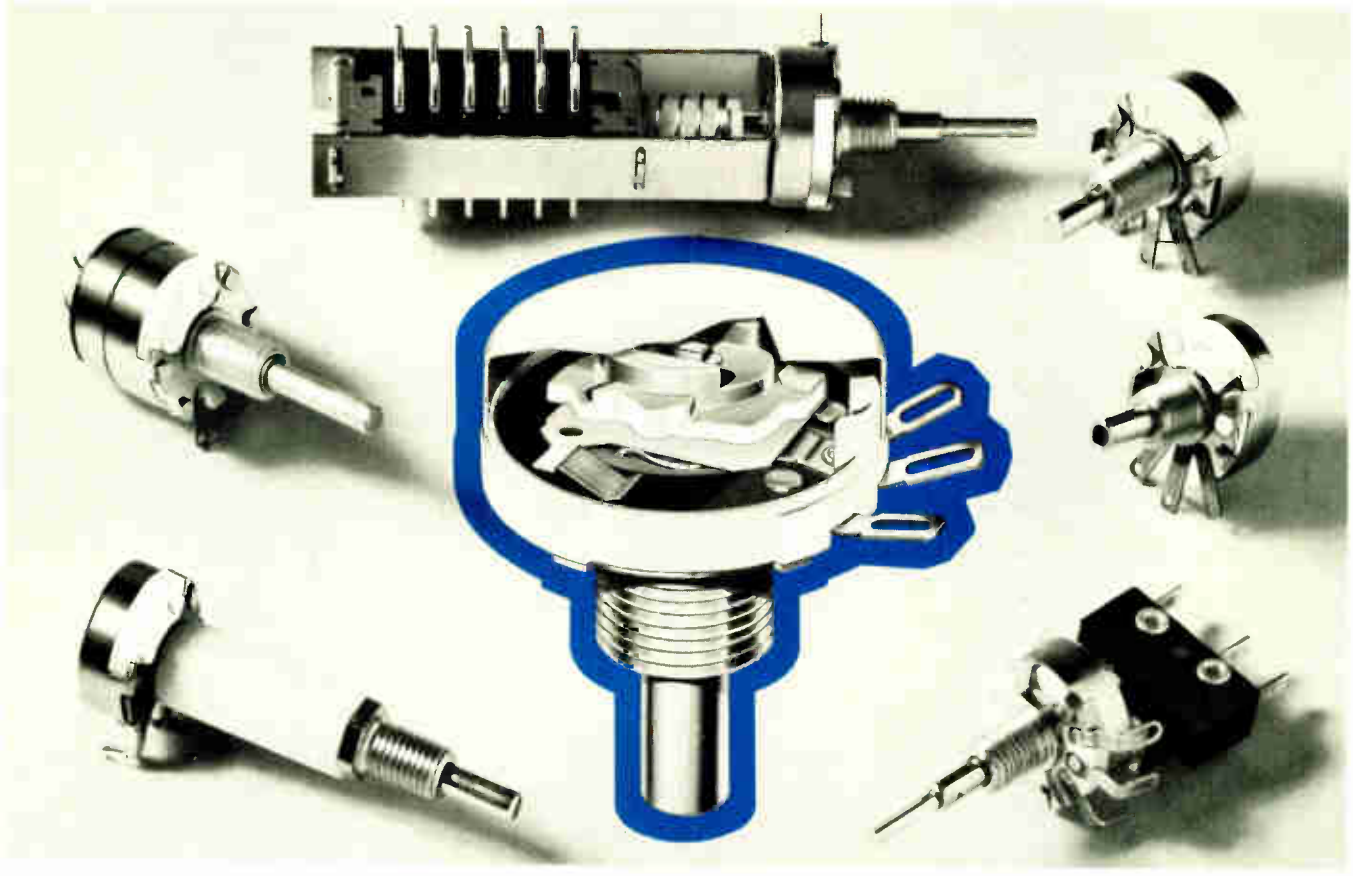

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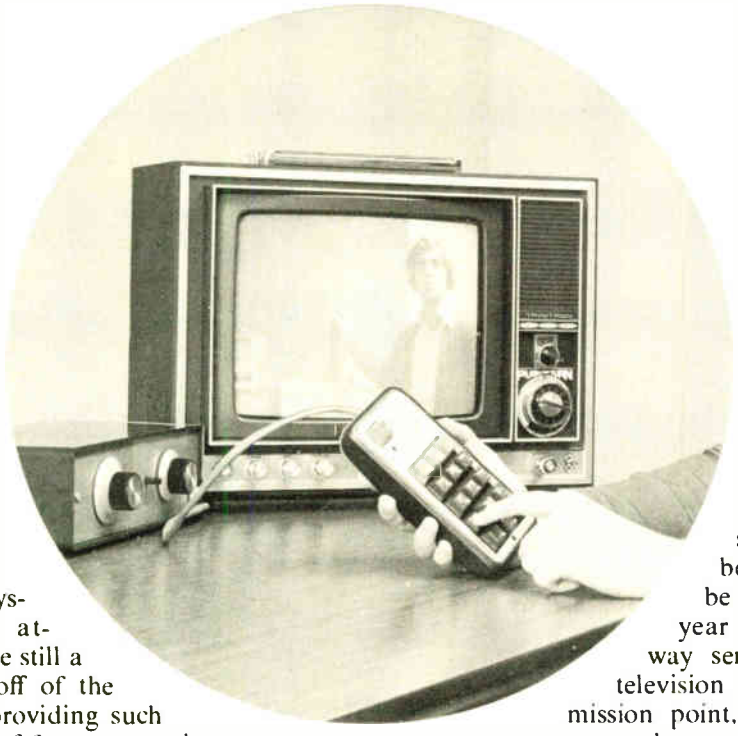
Special report: Cable's path to the wired city is tangled

CATV pioneers, inspired by the potential benefits and profits of interactive television, are finding in suburban experiments that many financial and technical problems remain to be solved

by Gerald M. Walker, *Consumer Editor*



□ Wiring our cities with reliable broadband communications networks has long been a dream of cable television operators. Turning the home television set into a communications terminal hooked to central computers to provide a variety of interactive services is part of this dream. It's a far cry from CATV's original objective 20 years ago of bringing programs to communities in fringe TV viewing areas.

Today the multiple system operators (MSOs) attracted to the big cities are still a long way from the payoff of the wired city. The key to providing such new services as a choice of first-run movies, customized college courses, shopping services, and fire and burglar protection, is two-way television capability. But adding a return channel for bidirectional communication requires much more than plugging in two-way amplifiers and some crossover filters.

It is possible to retrofit existing systems to make them bidirectional, but it is not as easy as hardware manufacturers had thought. It costs more than the relatively small CATV manufacturers have been able to raise in the past. And the Government—rather than advancing money for predicted benefits in such public activities as education— appears to be waiting for results before committing funds.

Meanwhile, private foundations have sponsored enough think-tanking on the wired city to raise expectations and impatience, but raising the necessary money is more germane at this point. A two-way system multiplies many times the costs and risks inherent in a simple one-way cable operation delivering off-the-air signals (Table 1). The problems involve system design, hardware and cable reliability, software development, marketing new services, and of course, financing the investment. Put it all together and you've got trouble on the way to the wired city.

What form two-way systems will take is yet to be decided and may not be ironed out for another year or two. Essentially, two-way service means wiring the television set to a central transmission point, sending signals downstream to the receiver, where a terminal makes it possible to return signals upstream to the sending point (Figs. 1 and 2). Such a cable system is like an audio/video/digital party line.

The technical approaches to bidirectional operation are varied and controversial. First of all, the upstream channels must be multiplexed to distinguish what signals come from each subscriber. At the same time, downstream and upstream channels must be separated to avoid interference. This task can be done by frequency-division multiplexing, time-division multiplexing, or space-division multiplexing. An operator can combine these three techniques within one system, depending on the amount of information to be transmitted. The bandwidth available with present-day amplifiers is approaching 300 megahertz, though requirements vary according to the type of signals transmitted. A digital response in an opinion poll, for

1. Interactive. This hand-held alphanumeric keyboard unit with a built-in microphone and push-to-talk switch makes two-way audio communication possible by cable. The Vicom Manufacturing Co. design has transmitter, receiver, and control electronics in a separate unit.

example, would require just 100 hertz per subscriber sent upstream. Audio return would be in the 3-to-4-kilohertz bandwidth, while color video transmission uses 6 MHz.

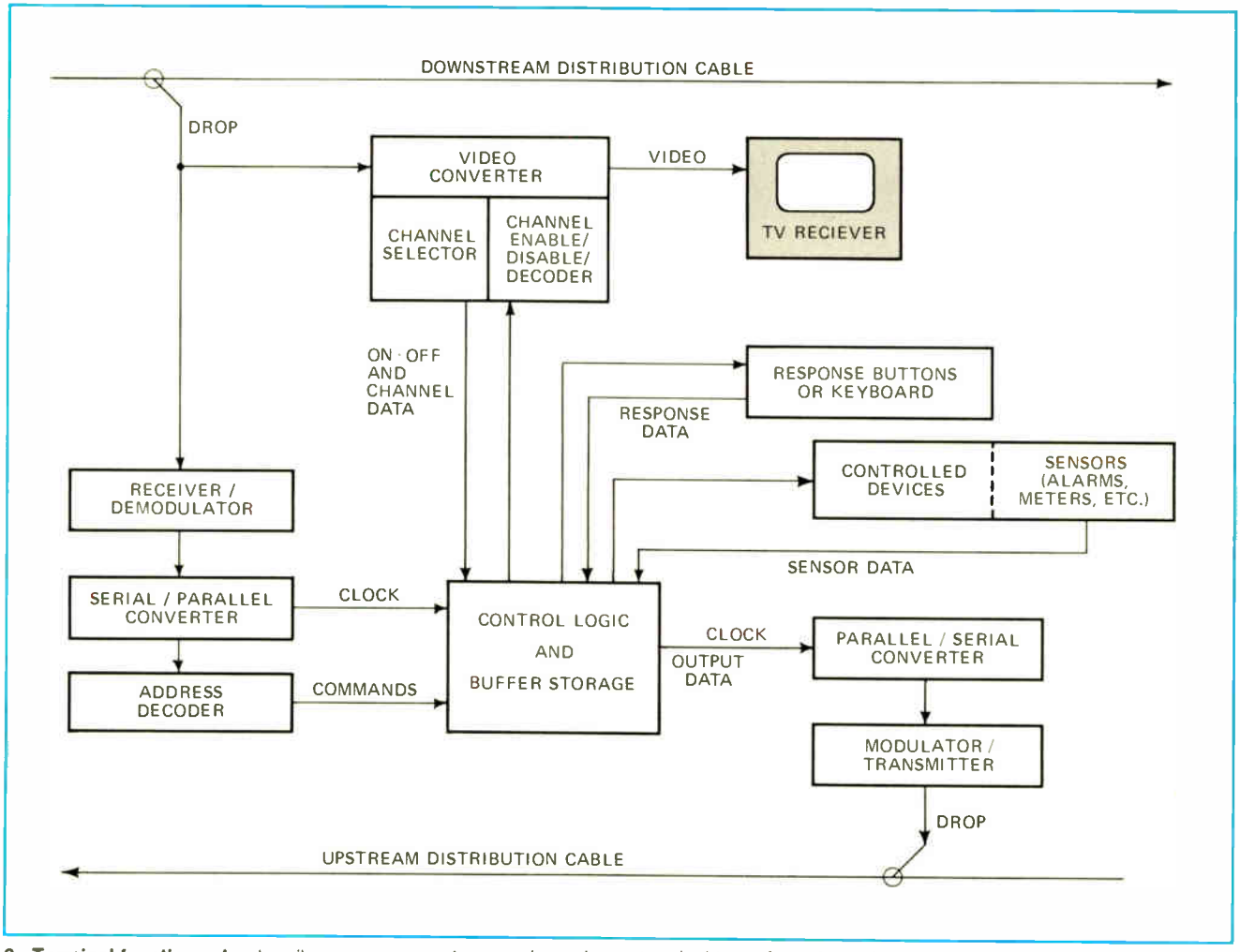
One-way cable television systems use frequency-division multiplexing for 12 or more video channels, each with a bandwidth of 6 MHz, sent downstream on a single cable. The technique that will probably be accepted by most cablecasters, it is the basis for the figures presented in Table 1.

However, there is controversy over whether or not frequency-division multiplexing is more or less expensive than time-division multiplexing. The latter divides a channel into separate time slots for each signal, then these slots are interleaved together. Computer data and other digital messages are handled via time-division multiplexing. The most expensive way to go, but the most secure from interference is to transmit signals physically separated by space—that is, over separate lines.

Return information, whether video, audio, or digital, is transmitted to the cablecaster's head-end in the bands between 5 MHz and 30 MHz. It is also possible to use the bands between 30 MHz and 50 MHz. These are also the bands used for ham, fixed-terrestrial, and citizens' band operation.

A computer can poll terminals and control services to subscribers. However, the operator has to decide whether the computer is to perform as an interrogator, addressing each terminal in sequence, or as a responsive slave, handling subscriber-initiated requests at random. The former is less costly to install, program, and maintain than the latter. However, the time will come when subscriber-initiated interactive programing will be necessary for complete development of the two-way potential.

The receiver for any two-way system, of course, is the television set. However, the subscriber also needs a terminal attached to the TV receiver to accept interrogation from the head-end computer and transmit responses upstream (Fig. 2). The terminal consists of a control logic and buffer storage module, a keyboard, and a modulator/transmitter. To date, keyboards have been designed with three to 15 keys, depending on the amount of response data required by the subscriber. The simplest three-key unit is basically for responding to polls with "yes," "no," or "no opinion." At its most elaborate, the terminal can send complete alphanumeric, audio, and visual signals.



2. Terminal functions. A subscriber-response system requires a home terminal to perform the tasks above—by way of either a separate return transmission line or a single cable used for transmission in both directions, according to a Rand Corp. report, "Interactive Television."

Overseas cable

While CATV supporters have long complained of unfavorable controls in this country and decried the lack of Federal support of the wired city, Europe is a veritable Siberia, by comparison.

The plight of would-be cable entrepreneurs overseas centers around government control of the entire communications network. To date, bidirectional cable systems are but distant dreams in Europe, since there is not much of a cable industry to start with.

In Britain, the government announced last January that it will allow half a dozen new channels for local cablecasting and invited applications for four-year licenses. No advertising will be permitted, and content must be entirely local. Only one company has taken out a license, although powerful Rediffusion has said it will also apply. Rediffusion has not seen fit to try out two-way services on its Dial-a-Program concept outside of its own laboratory—mainly because there are not enough channels available in Britain.

In France, operators and hardware suppliers have cried for liberty and equality with the government-run communications system, but thus far they have not even been told to eat cake. At a recent international conference on cable in Cannes, France, Henri Weill, director of the Television division of Compteurs Schlumberger, declared that his firm has decided it is "useless" for a French company to start developing a cable system at this time. "We hope that in the coming years the laws will become more flexible, and the development of equipment will become possible."

The French have recently created a company, jointly operated by the Post and Telecommunications Authority and the radio-television monopoly ORTF, to study the possibility of developing cable TV. Observers feel little of substance will come of it.

Belgium remains the Continent's leader in cable, mainly because the country is bilingual and has laws flexible enough to permit importation of foreign signals. Coditel, the largest operator, has more than 100,000 subscribers.

Several two-way CATV experiments have been set up to develop operating techniques. In suburban communities, local experimenters hope to learn if the equipment works, if the services perform as expected, and finally, what services are popular. Suburban communities were chosen largely because the costs of installation and equipment access are much lower than in the cities.

Experiments underway

The Hughes Aircraft Co. Theta-Com division has teamed with TelePrompTer, the largest CATV operator in the U.S., to install its Subscriber Response System (SRS) at El Segundo, Calif. Another duo, composed of American Television & Communications Corp. (ATC), Denver, and Electronic Industrial Engineering Inc. (EIE), North Hollywood, Calif., a recent RCA Corp. acquisition, is installing a similar two-way system in Orlando, Fla.

On the drawing board is an experiment being put together by Community Information Systems Inc. (CIS), using General Electric Co. terminal technology and patents, in Jonathan, a new town under construction near Minneapolis. TeleCable Corp., Norfolk, Va., is a comparative old-timer with its bidirectional video experiment—begun in mid-1971 at Overland Park, Kan., a suburb of Kansas City. Its main thrust is toward education.

Mitre Corp., a Government think tank that has diversified into CATV, is testing a system in Reston, Va., an upper-income community near Washington, D.C. Tocom, Dallas, will install a system, jointly sponsored by a consortium of CATV operators, in a prime TV reception area in Irving, Texas. Tocom will collect fees only for pay TV and home retailing, but this income is intended to support the experiment and pay the franchise license fee.

LVO Cable Inc. has set up a system to provide burglary and fire detection services in two communities outside of Chicago—Carpentersville and Crystal Lake, Ill. Rediffusion International Ltd., the British communications conglomerate, is trying a different approach with its Dial-a-Program switched network at Dennis Port, Mass.

Problems encountered

These experimenters have encountered a number of problems. On the transmission side, two-way broadband nets are feasible, as engineers have been saying for some time, but a technically feasible system is not always operationally reliable. Unfortunately, a bidirectional system picks up noise from the cable converter, the TV receiver, and outside rf signals.

In a sense, a coaxial cable layout with inadequate shielding and mismatched connections is a huge antenna able to pick up enough outside signals to garble data flowing in the sub-band frequencies from the subscriber to the head-end. At its worst, every home on a two-way net funnels noise and interference into a cumulative stream roaring back to the transmission point.

Until now, installation practices could be fairly lax, so long as the downstream subscriber received a clear picture; therefore, there has been little need to be concerned about noise and interference on one-way hookups. But two-way systems cannot live with mismatched, leaky installations.

The Overland Park operators have discovered that there is no such thing as a plug-in bidirectional cable system. Noise and interference caused a nightmare from the beginning—until every dropline was adjusted for rf integrity. "No matter how much testing you do, you get operational problems," James Dixon, TeleCable engineering director, comments.

"When dealing with interference, there appears to be a different mechanism in the sub-bands than in standard television bands. Conditions causing interference one day may not occur on another. In the future, we may want to avoid the ham radio band for return channels, or else get up into the television bands.

"The biggest problem with noise is that every receiver and converter contributes; so the time will come when

3. Two-way environment. A technician inside a Theta-Com temperature test chamber checks a two-way cascade of 15 upstream and 15 downstream amplifiers made by Jerrold Electronics Corp. before they are installed in El Segundo, Calif. Amplifiers are interconnected by a reel of cable to provide normal amount of cable attenuation experienced in the actual system.

we will want television sets in which we can bypass the front end and connect directly into the i-f. We will also probably need a separate maintenance crew for two-way equipment, because the average technician is lost with this system."

Despite criticism that audio/video is too expensive and invites troublesome noise, TeleCable officials are satisfied with over-all equipment performance.

ATC battles rf

ATC has also been struggling to improve the integrity of the cable layout. "To anybody who tells me that bidirectional cable is a bolt-on option," Edward J. Callahan, Jr., director of engineering and development for ATC, complains, "I say, 'no way.' No one in the industry was really prepared to handle rf interference in the 5-to-35-MHz region."

But after transmission trials for almost a year, ATC is now ready to deal with rfi. Callahan has installed high-pass filters at the television receivers, gone to 90% mesh in cable shielding, put double-braided copper coaxial cable into the home "drops," shielded the body and flanges of the pole taps with rfi gaskets, and installed silver-impregnated "O" rings in the cable connectors.

He has also discovered that the connectors, when clamped on the aluminum cable shielding, developed rf leaks caused by discontinuities that resulted from cold flow of the aluminum. Now ATC has a collar installed under the aluminum shielding at each connector point to prevent cold flow.

Rf integrity is more crucial upstream because a small amount of interference can wipe out a return channel, Callahan points out. ATC learned in Orlando to limit the size of a return area so that the accumulated noise of, say, 10,000 receivers doesn't come upstream. Instead, the total system is divided into return areas, each assigned a separate three-channel return path. Callahan estimates that a community with 300,000 TV sets on the cable would require 17 return areas. With three channels per area, 51 return channels would be required. However, if rf integrity were lost in one sector, it would not be necessary to shut down the entire two-way system while repairing the one offending sector.

Area control will become more important to ATC as it expands. Ultimately the PolyCom system, as ATC calls its two-way network, will interconnect with other nearby ATC cable systems so that many services can be shared.

"The industry is conditioned to put up anything and hope for the best, but the investment is too high and the need for secure lines too big to be careless," Callahan emphasizes. "We're not building a traditional cable hook-up, but a broadband communications system."

Theta-Com tests amplifiers

To be on the safe side, Theta-Com is putting some of its aerospace know-how to use by testing the amplifiers destined for El Segundo in environmental chambers. A dual-cable two-way cascade, consisting of 15 upstream amplifiers and an equal number of downstream amplifiers interconnected by a reel of cable to provide the normal amount of cable attenuation, has been put under extreme temperature conditions before installation, scheduled to begin this month (Fig. 3). The firm also runs SRS subscriber terminal modems through electromagnetic susceptibility and radio-interference tests in

an interference-free environment (Fig. 4). These tests should help weed out two-way noise prior to installation.

The first transmission trials of Theta-Com's SRS were run last year in Los Gatos, Calif.; the El Segundo system is a follow-up. Robert W. Behringer, president and general manager, says that the firm is committed to build 1,000 terminals now and is expected to begin paying back on the original investment by the end of 1973. SRS is a computer-interrogated system with the capacity to poll up to 10,000 terminals in 2 seconds. There will be three home terminal models—a three-key unit for simple yes/no/no-opinion replies, another 10-key numeric version, and later a full alphanumeric keyboard. According to Theta-Com, these terminals should sell for $150 to $300 in quantity.

Downstream signals are transmitted at 110 MHz and upstream at 23 MHz. Error rate measured at the Los Gatos experiment is 1 in 10^{-6}. Since the single-cable layout in Los Gatos experienced impedance-matching problems at the amplifiers, the El Segundo plan calls for a dual cable. A Digital Equipment Corp. PDP-11 computer, plus a communications interface unit from Hughes, control SRS. While Los Gatos proved out the transmission concept, Richard T. Callais, SRS division manager, observes, El Segundo will test software and cable service operations.

TelePrompTer plans to offer a few services at a time during the early going, including premium TV, security alarm, and remote meter reading. After all of the first 30 units are in place—15 three-key and 15 10-key terminals—Theta-Com plans to move them around to various homes to find out how different locations on the cable affect performance.

Educational TV tried

One of the first interactive experiments to transmit both data and video was begun by TeleCable in mid-1971 to six terminals in Overland Park, Kan. This trial attracted much attention because it went all the way to audio/video/digital, and featured education by TV for two shut-in children. Other services offered were opinion polling and shopping by television, operated for two months in cooperation with the local Sears branch.

Amplification equipment came from EIE, and the home terminals were developed by Vicom, Dexter, Mich., which had the only proven two-way terminal at the time, according to Gordon Herring, director of research at TeleCable.

The system uses the bands between 30 and 50 MHz for return information. A teacher in the TeleCable studio interrogates students from a control console and receives digital responses via the Vicom keyboard. However, if a student wants to make audio/visual contact, he requests permission from the teacher, who can then open the two-way channel. A camera and microphone in the home picks up signals for transmission to the studio, where they are modulated for downstream transmission, thus putting the child on all the home screens.

TeleCable's Herring was frustrated by the piecemeal approach to services that economics forced on the experiment. Recognizing that the best two-way system would be one that offers many services from the beginning, he contends that a lone operator cannot foot the bill.

However, TeleCable is going to expand services, anyway. Later this year Herring hopes to hook up a network to enable physicians at the Kansas University medical center to counsel nurses in Overland Park's schools. A microwave hop from the medical center to the head-end will be extended by cable to the schools so that a doctor can see patients and advise the nurses.

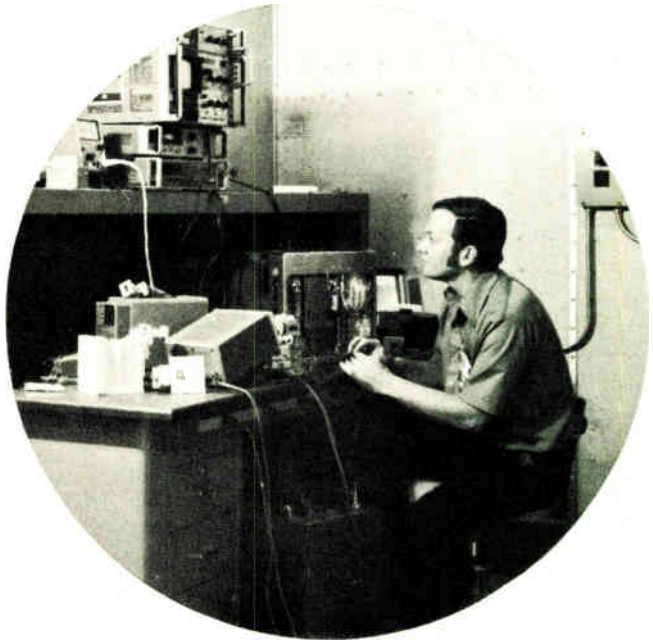
Mitre tries frame-grabber

Another year-old veteran in interactive TV, Mitre has installed its showplace in Reston, Va. To the Mitre planners who set up the experiment, the IBM 360/50 computer, the TouchTone telephone for return information, and the Sony reel-to-reel tape recorder used to capture and hold a single TV frame selectively seem primitive, compared to what a refined system would now entail [*Electronics*, Sept. 27, 1971, p.44].

The IBM computer and a Honeywell 516 process controller were used because they were available at Mitre's office in nearby McLean. (Data is transmitted by microwave to and from Reston and McLean.) The latest plans call for a pair of Data General minicomputers for control and memory retrieval. The Reston cable was not capable of two-way operation; thus the telephone link to the computer was necessary. However, a bidirectional link is to be installed soon. The phone set will be replaced by an alphanumeric keyboard that Mitre has designed to interface with the TV receiver. In light of the slow takeoff of home TV player/recorders, Mitre has scrapped the idea that most American homes would have inexpensive video tape-recorders to double as frame-grabbers to hold static images.

The silicon storage tube, an alternate means for

4. Terminal check. One of the subscriber terminals to be installed by Theta-Com in a home undergoes electromagnetic susceptibility and rf tests in an interference-free chamber to weed out potential noise problems before turning over the unit for field trial.



frame-grabbing, is being evaluated. It offers the possibility of cost reduction down to $10 a unit in large quantities, rather than $300 estimated for production-quantity VTRs.

The Reston system is weighted toward education, providing the subscriber with the option to order computer-aided instruction through the telephone keyboard for alphanumeric responses. Users can also order the computer as a calculator and use its random-access memory to store and forward figures as needed. A third service brings in directory listings and community activity reports stored in computer memory, demonstrating the ability to search files and present catalogued data.

The next step at Reston, says William Mason, director of Mitre's Systems Development division, will probably be demonstration of what he calls "pop" entertainment. This would include games with the computer, as well as shopping by TV.

Credit verification test set

In Florida, ATC and EIE are also set to install an interrogate-response system with 24 terminals in Orlando homes. The terminal has a 10-character numeric keyboard and a key-actuated switch to authorize pay TV reception. One terminal in a gasoline station is to test credit verification by cable. The minicomputer controlling the system can send 32 bits to each terminal at 42 kilobits a second and get back 128 at 675 kilobits a second.

By early 1973, EIE expects to have installed 3,000 to 5,000 terminals along dual cable lines. Then marketing surveys of the services—pay TV, security alarm, emergency alarm, and shopping, as well as the gas station credit verification—will be possible. As C. Edward Harmon, EIE program manager, observes, "We know how much it costs; now we have to find out how much it's worth."

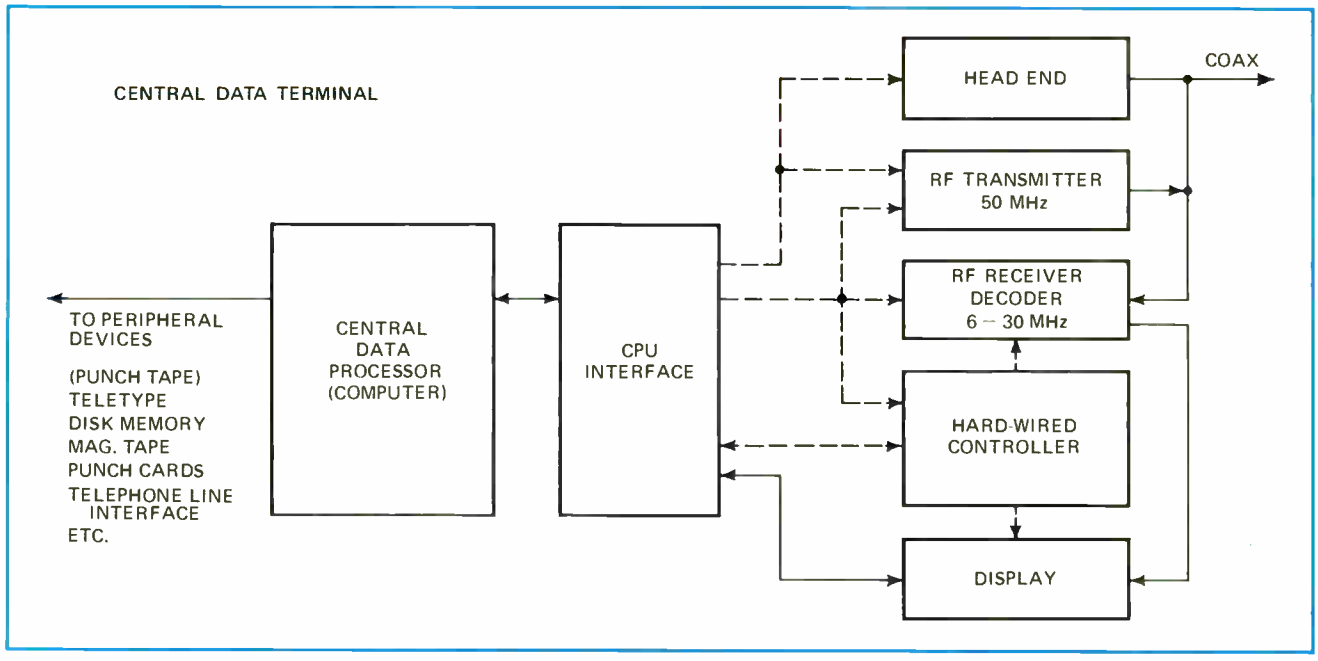
What may be cable's most untraditional installation is taking shape this summer in Irving, Texas, under the banner of Tocom, formerly CAS Manufacturing Co. The plan calls for a consortium of eight to 10 operators to support an experimental two-way program in a limited section of Irving. A special two-year franchise has been approved to permit this plan. To hold up its side, Tocom, a turn-key hardware company, will be part of the joint venture. Four MSOs had prepared to join as of last month, and two others are seriously thinking it over.

The Irving plan is designed to test two-way under fire, since potential subscribers already enjoy excellent TV reception of three networks, local channels, and an education station. So if the public goes for the Tocom concept, it will be solely because of the appeal of the extra services that cable can provide. The objective is to reach 100% penetration with an 18.1-mile aerial plant passing 1,234 homes, 1,150 apartment units, and about 40 businesses, plus two high schools. A line is planned to the Dallas Cowboys' new stadium, but how and when games will be broadcast to subscribers will be worked out after the team's owners have completed selling all the seats, which in Dallas shouldn't be long.

Tocom polls subscribers

Like the California and Florida trials, Tocom is a computer-interrogated system (Fig. 5) of polling 60,000 subscriber sets at a rate of 60 in 6 milliseconds. By the end of the year, Tocom expects to have installed about 1,500 terminals.

The transmission system will have a capability of 26 channels downstream at 40 to 250 MHz and an upstream capability at 5 to 25 MHz. The subscriber-response terminal has a five-key keyboard of one to four digits and a clear button, plus a key switch to authorize pay TV. All peripheral devices—such as burglar alarm,



5. TV computer. A central data processor, designed for the Tocom system to be installed in Irving, Texas, controls terminal interrogations and responses to returning data, such as fire and burglar alarms. The computer has the capacity to interrogate up to 60,000 terminals.

Table 1
ADDED COST OF TWO-WAY TRANSMISSION FOR A 200-MILE CABLE SYSTEM

Two-way Option	Added Cost				
	Trunk	Feeder	Taps and Drops	Total Cost	Cost per Mile
1. Wire pairs	$ 17,000	$ 36,000	$ 25,000	$ 78,000	$ 390
2. Single cable FDM	$ 41,000	$ 125,000	0	$ 166,000	$ 830
3. Separate cables	$ 84,000	$ 191,000	$ 50,000	$ 325,000	$ 1,625
4. Separate trunks, FDM on feeders	$ 84,000	$ 125,000	0	$ 209,000	$ 1,045
5. Switched distribution system	–	–	–	$ 425,000 – 900,000	

Source: Rand Corporation

fire alarm, emergency assistance request button, and utility meter—are connected to the terminal via a multiconductor connector in the rear.

Each remote unit is identified by a separate group and identification number and, upon interrogation by the central data terminal, will respond in the form of five 16-bit words indicating its condition.

The advantage of the interrogation speed is most apparent in alarm situations, Brian Belcher, Tocom engineering head, points out. When a remote unit responds to the computer with an alarm bit, the computer will interrogate that unit 100 consecutive times in 0.6 second. If, during the 100 interrogations, the computer accumulates 90 alarm bits, it assumes that an alarm condition exists. This triggers a display panel at the operator's console to show the location, and a bell rings to attract attention.

A Teletype then prints out the group number, identification number, date, time, and type of alarm. This system will also be able to interface with an optional automatic telephone dialer to notify the fire or police department, or a protection agency.

The subscriber Response Unit (SRU), to be tested at Jonathan, Minn., was developed jointly by CIS and GE. The SRU has a 12-key keyboard and a Nixie-tube display screen (Fig. 6) to show the codes being transmitted upstream. After a period of showing the system's capability, which will feature six interactive services, including video retrieval, installation will begin this fall in 50 to 100 buildings, launching a year-and-a-half trial. CSI estimates that it will cost about $4 million to wire 1,000 to 1,500 buildings in the new town. The LVO cable program near Chicago will use digital terminals developed by Scientific-Atlanta Inc., Atlanta, Ga. Oak Security Inc., a subsidiary of Oak Electro/netics Corp., will provide burglary and fire detection sensors, and operate the system's security portion.

An interrogation-type, time-division-multiplexed, single-cable net, the LVO/Scientific-Atlanta plan uses 12.5 MHz for downstream transmission and 5.5 MHz for upstream. Originally designed to be a security system only, the Scientific-Atlanta operation will include opinion polling and limited-access channels for pay TV, starting sometime this summer.

Rediffusion International has tested its Dial-a-Program concept for the last year and a half at Dennis Port, Mass. Dial-a-Program operates on a switched network, using multipair cables. Instead of each separate pair being dedicated to the distribution of an individual program, each pair is dedicated to connecting a specific subscriber to a program exchange, from which that subscriber may select a channel by means of a telephone-type dial.

Dial-a-Program tested

Rediffusion transmits all programs on the same carrier at 7.94 MHz, with the upper sideband suppressed. With all programs in the same carrier, it means that there can be no crosstalk between the carrier of one program and the carriers of programs on neighboring cable pairs; therefore, separation of about 45 decibels, or about the same as between two video-frequency circuits, is required.

At first glance, the Rediffusion home equipment looks like the offspring of mating a telephone and television set. Instead of a tuner and converter, the user has a dial selector to send his channel selection to a switching station, which connects the receiver to the proper channel (Fig. 7). An inverter at the receiving end converts the 7.94-MHz signals from the switching station to the high band for viewing on the home screen.

The exchange net requires four wires in matched pairs and has a 36-channel capacity, although Dennis Port subscribers have only six entertainment channels. At program exchanges, buses in banks arranged by switching level handle a maximum of 336 subscribers. These exchanges are connected to others by trunk lines.

There aren't any amplifiers between the program exchange and the TV receiver, which means that cable lengths are limited by the attenuation and the tolerable level of crosstalk from adjacent pairs carrying different programs.

The limit set by these two considerations is about 1,200 feet. Because of this, the Rediffusion concept may find early acceptance for internal systems with a limited number of users. Dial-a-Program has recently been accepted for a student-participation, random-dial-access, audio-visual setup at Case Western Reserve University

in Cleveland. A student will be able to dial a request for a video tape stored in a library and remotely control the tape recorder from his Dial-a-Program receiver.

Software is need

Cable integrity is a problem involving basic practice—tedious, but possible to solve with high-pass filtering and careful shielding. Software development, on the other hand, is a bed of quicksand comparable to the first applications of computers, when users invariably underestimated their complexity and costs of programing.

In cable television, software has two meanings—the programs transmitted to subscribers and the programs required for the computer to control this transmitted material. Thus, the MSOs must have programers. The importance of software in the cabled metropolis cannot be overstated; yet until more experiments get under way, it's impossible to judge whether or not standard software for multiple system use will be possible or if each CATV franchise will have to provide its own computer programs.

Vicom president Harold Katz says that software must be written so that generalized computer programs can be used. It should be possible for the various operators to use the same software, as well as the same hardware, he says.

Katz also points out that the technical trial at Overland Park underscores the need for a "generalized terminal," that is, a home unit capable of handling a number of services. Dr. Walter Baer, a consultant for Rand Corp. and author of a Markle foundation study on interactive TV, supports the total two-way service approach, pointing out that though terminals may represent a significant capital expense now, prices should come down when manufacturers go to large-scale integration. A two-way terminal in the $150 range is possible in large enough production quantities.

In a sense, operators and hardware designers seem to be saying, "We don't know where we're going, but we know how to get there." Like all innovators, the systems planners are open to criticism—most of it from each other. The MSOs are knocking competing systems as hand-tooled, gold-plated, under-designed, show-boating, impractical, short-sighted, and one-shot deals.

The two-way problems suggest the need for more engineers, particularly systems-oriented, development-thinking EEs. Operators and suppliers say they need engineers badly, but admit that the cable industry cannot afford fancy salaries.

While the engineers puzzle over the system design, cable integrity, and computer programing, the marketing side of CATV has yet to establish which of the 100 or so potential services made possible through interactive television will actually sell. And no one is sure how much the public is willing to spend for added features.

Will the public buy it?

While the two-way contenders sort themselves out, another potential detour has developed because of pay TV on one-way cable. Some observers contend that pro-

6. Double check. The keyboard, designed jointly by Community Information Systems Inc. and General Electric Co., features a four-digit tube display to show the subscriber the codes being sent upstream. This response confirmation eventually will appear on the TV receiver.

viding first-run movies via single-cable will whet the public's taste for cable and provde quick profits for operators. And Rand's Dr. Baer suggests that, once attached to the subscription movie business, operators may be slow to reinvest in wider two-way services requiring more sophisticated terminals.

Among the results the experimenters hope to ascertain later is what services are popular. Potential weaknesses in these trial efforts are an almost complete absence of business or industrial users because CATV is a home-oriented industry. Secondly, these affluent test communities may not reflect what services economically and socially diverse core-city residents will want from cable. On the other hand, since the primary goal is engineering shakedown, these early installations must be considered test tubes rather than full-fledged operations.

Mitre's Mason observes that none of the experiments will break out into the real world until cable operators are shown the commercial benefits of two-way investments. "The social benefits are so great that the U.S. Government will have to be involved—at least to the point of providing seed money. System operators do not want 'blue-sky' services. They won't be motivated until they are shown that the rate of return is better on two-way than on a typical one-way transmission."

While the FCC has provided mild encouragement, other Federal agencies that might reasonably be expected to support education, transportation, and law enforcement experiments via two-way cable have not provided much funding.

Small Government grants received

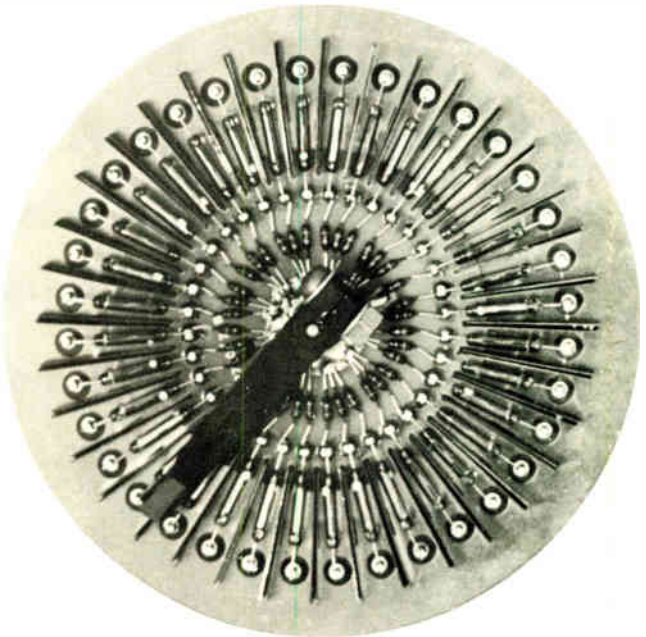
One encouraging move is a grant of more than $2 million by the National Science Foundation to Mitre for an experimental program to provide instruction over TV in mathematics and English at two junior colleges. And CSI has obtained a $175,000 grant from the Department of Housing and Urban Development to aid the experiment at Jonathan, Minn.

The FCC has provided an entry into the major cities with the agreement hammered out with the White House Office of Telecommunications, broadcasters, cable operators, and entertainment producers on rules for importing distant signals, along with the ruling on bidirectional capability. As in most compromises, operators did not get all they wanted. The MSOs contended that in order to earn enough income to finance bidirectional services, they had to be able to import signals from other cities. They received authority to import signals from only a limited number of sources.

Because of this restriction, cablecasters may have to grab pay TV first, says a Rand Corp. investigator, Nathaniel E. Feldman, since the FCC has not given cable a wide enough entry into the 100 top markets.

"On the issue of importing distant signals, the FCC's ruling was like putting a man on 800 calories a day," Feldman contends. "It's enough to stay alive, but not enough to prosper." Consequently, there will be less income available to support two-way investment, and the Government seems reluctant to spend more money until the benefits are more fully demonstrated.

As for the hardware suppliers, Feldman chides, "There has been more distortion and baloney about two-way cable than any other subject. To date, manufacturers have sold more stock than hardware."



7. Switching channels. Selector switches used by Rediffusion International Ltd. have reed relays operated by a magnet mounted on a rotating arm. It is stepped by subscriber-dialed impulses.

But the big boys on the block are moving in. Hughes has entered with Theta-Com, and RCA's acquisition, EIE, is a partner in the ATC system. GE is entering with its technology in the CIS experiments, and more companies are sure to follow. Their help will provide a big boost to the risky business of CATV financing.

The investment necessary to get a wired city is much higher than MSOs have ever known, however. A recent study conducted by Mitre for the Markle foundation on bringing two-way CATV to Washington, D.C., indicated just how risky this move can be. Mitre estimated that in a 10-year period, total expenditures to provide all the bells and whistles could amount to $192.98 million. Income from this period is estimated at $199.70 million, which is too close for comfort. The largest MSO in America, TelePrompTer, grossed $50 million in 1971 with about $156 million in total assets.

Of the capital expenditures, estimated to be $61.21 million, terminals would account for $40 million, according to Mitre. And this projection assumes a high percentage of penetration which CATV does not yet have in this country. Multiply these figures by 100 cities, and the risks take on enormous proportions.

With these technical, software, marketing, and financial obstacles, the wired city may be seen as far away as Camelot, rather than a practical communications plan. Yet experimental programs continue to take shape and show promise. The potential of bringing new life to TV—which has become to many a dull, repetitious medium—serves to make CATV's immediate problems more frustrating for those who are involved. For the extra, interactive services possible in the wired city will not only make new fortunes for CATV, but in all likelihood revitalize television viewing. □

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Control one-shot divides frequency by up to 30

by Jerome Snaper
Leach Corp., Controls Div., Azusa, Calif.

A three-gate control allows precision frequency divisions of up to 30 merely by changing a resistance. A crystal oscillator acts as the frequency source so that all subharmonics of the reference frequency have crystal stability.

NAND gates G_1 and G_2 and the crystal comprise the oscillator that generates the reference frequency. The one-shot, consisting of NAND gates G_3 and G_4, controls gate G_5, which is synchronized by the oscillator.

After one pulse of the reference frequency passes to the output, the one-shot locks out gate G_5 for a period of time determined by the setting of potentiometer R_t. When the one-shot resets, another single pulse reaches the output, and the cycle repeats.

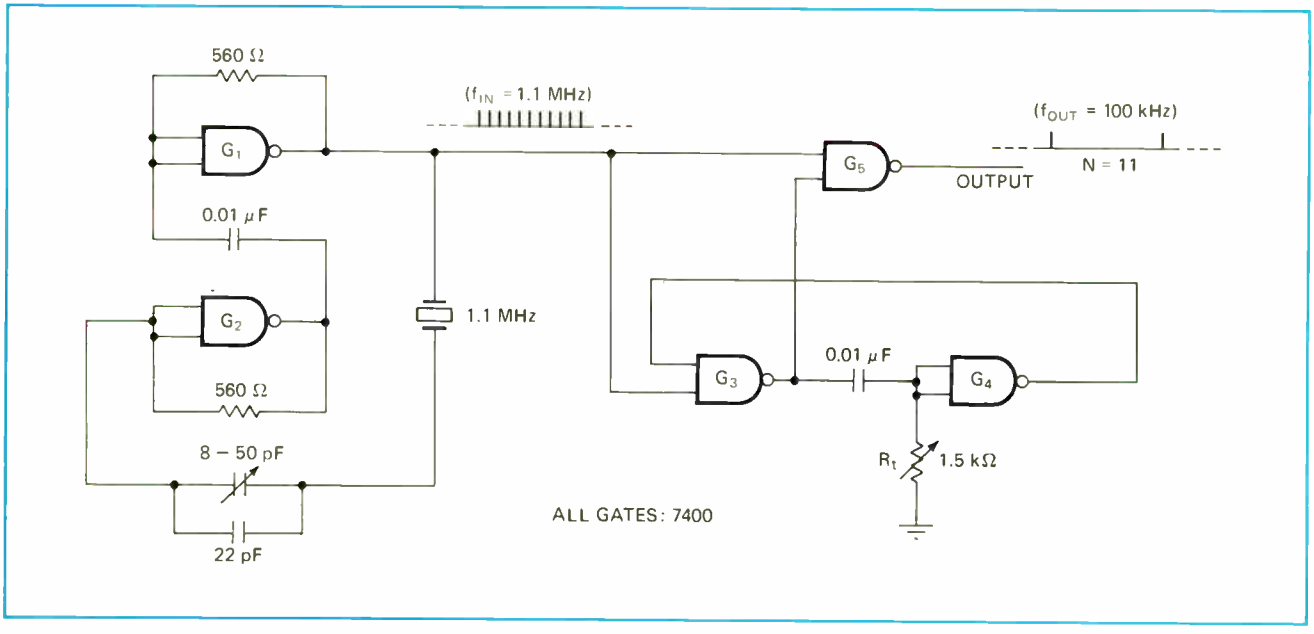
The input frequency, f_{in}, is simply a multiple of the output frequency, f_{out}:

$$f_{in} = Nf_{out}$$

where N is the division factor. N can have any integral value between 2 and 30. The circuit shown divides a 1.1-megahertz reference frequency by 11 to yield an output frequency of 100 kilohertz.

Additional versatility is possible by substituting a field-effect transistor or voltage-variable resistor for the potentiometer. Then, frequency divisions can be electronically swept over a wide range. □

Precision division. Crystal oscillator supplies reference frequency for three-gate divider scheme. NAND gates G_3 and G_4 form one-shot that controls gate G_5. After G_5 passes single reference pulse, one-shot inhibits this gate for period selected by adjustment of potentiometer R_t. When one-shot resets, another reference pulse passes to output. Crystal frequency can be divided by up to 30 without loss of stability.



Pulsed standby battery saves MOS memory data

by K. C. Herrick
Fisher Berkeley Corp., Emeryville, Calif.

A simple pulsed battery supply can reduce standby power necessary for MOS random-access memories to one-thousandth of the operational requirement. In many systems, this power-saving scheme allows inexpensive batteries to be used with essentially shelf-life longevity. In some cases, merely a capacitor can supply enough standby power to sustain memory until an auxiliary power source can come on-line.

A typical RAM cell consists of a cross-coupled multivibrator with active MOS transistor loads. When there is a power failure, the potential across the multivibrator declines toward zero. As long as its inputs are kept off, the cell is isolated from external influence, except for

leakages, when the MOS transistors cease conducting.

The charges remaining on the gates of the cross-coupled transistors then begin to leak off exponentially. If power is reapplied within a short period of time, however, sufficient differential charge levels remain on the gates to re-establish flip-flop conduction in the same state as when power failed.

It is this cell characteristic that can be exploited to save standby power. The potential across the multivibrator must be reapplied periodically, at a rate fast enough to replenish the MOS gate charges before they decline below threshold levels and for long enough to re-establish fully the charge levels. Usually, a sufficient rate is 1,000 hertz with a pulse width of 1 microsecond. For any given type of memory and upper temperature limit (leakages increase with temperature), the required duty cycle may vary.

Of course, the potential needed must be reapplied within the maximum period of time that is allowable (for example, 1 millisecond). The little-used series multivibrator and a 14-volt battery (a) will do the job. The nominal memory cell potential is 15 V, less one diode drop, or about 14.3 V.

When power fails, diode D_1 disconnects the RAM's V_{DD} line from the main supply. The memory potential of $V_{CC} - V_{DD}$ declines in magnitude until the voltage of $14 - (V_{CC} - V_{DD})$ is large enough to start the series multivibrator. Oscillations usually begin when the voltage across the multivibrator becomes about 0.75 V. The components shown yield a pulse width of about 1 μs and a pulse interval of about 500 μs.

If a rechargeable battery is used, the diode and resistor connected with dashed lines may be added to allow the battery to charge while the main power is applied. The memory's peripheral-circuit supply voltage V_D can become zero and remain zero during the loss of main power, without any effect on data retention.

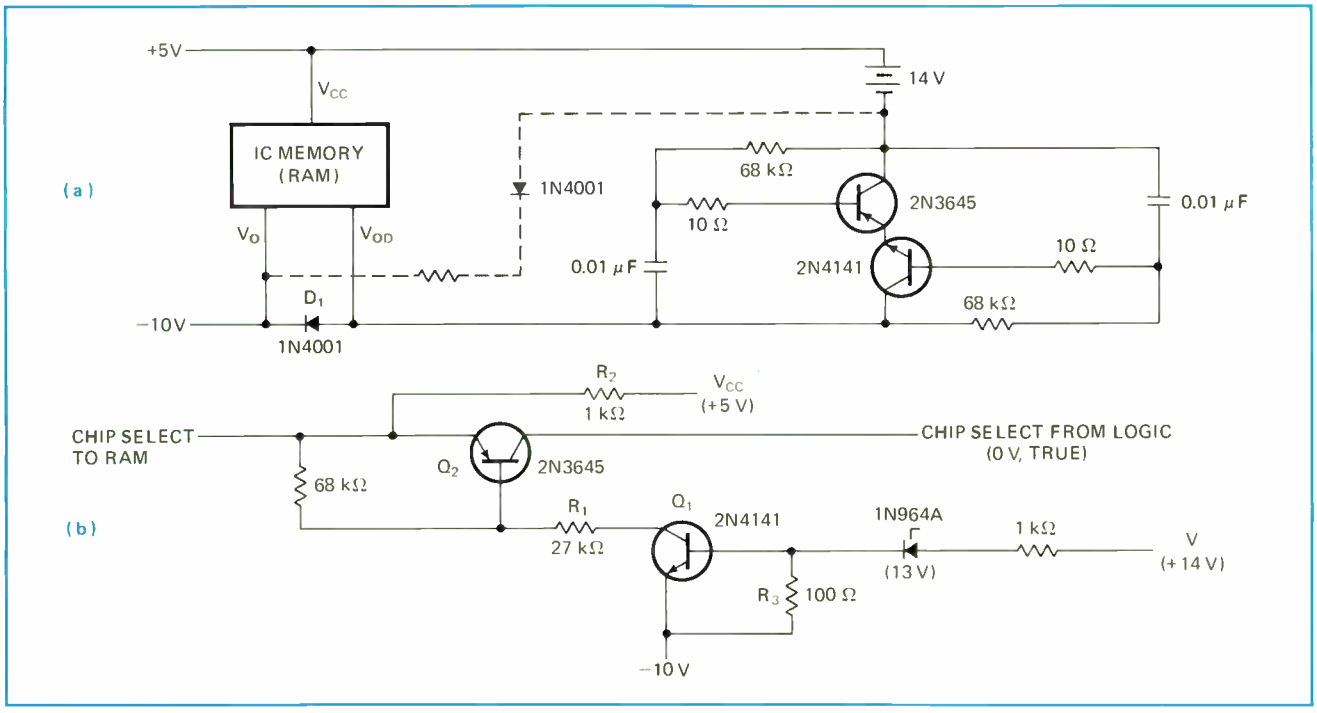
While the memory supply voltage is decreasing, the memory's chip-select input must be held FALSE at the V_{CC} (+5 V) potential. TTL devices or other elements driving this line may change state erratically when the 5-V logic supply loses voltage. The presence of these stray signals may cause a RAM cell to change state.

A circuit for maintaining the chip-select line at the instantaneous V_{CC} level is shown in (b). Since the 14-V (in this case) semi-regulated supply is the power source for the 5-V regulated logic supply, in the event of power failure the 14-V source will lose voltage before the logic supply.

Transistor Q_1 is normally kept on by base current from the 14-V supply via zener diode D_1. Collector current from Q_1 biases Q_2 on. Base current from Q_2 causes only a negligible drop below 5 V in the FALSE voltage level of the memory chip-select line, due to the high resistance ratio of R_1 to R_2. Whenever a zero chip-select voltage is applied to Q_2's collector from the control logic, Q_2 conducts, and its emitter voltage changes to the TRUE level (0 V).

Upon power failure, the 14-V and 10-V supplies begin to lose voltage. Transistor Q_1's base current will become zero when resistor R_3's voltage drops below about 0.7 V. At this time, voltage V equals 10.7 V—20.7 V above −10 V or 5.7 V more positive than V_{CC}—a value that still maintains the 5-V V_{CC} level. When Q_1 stops conducting, Q_2 is cut off, and the memory's chip-select input line is connected only to V_{CC} via resistor R_2. Therefore, even if V_{CC} decreases in value, the chip-select line remains at the V_{CC} potential. □

Preserving memory contents. Series multivibrator and battery (a) allow MOS random-access memory to retain data when power fails. Circuit takes advantage of MOS charge retention property so that pulsed voltage is sufficient to refresh memory. Dashed components let battery recharge when main power is restored. Protection circuit (b) for chip-select line prevents erratic logic signals from changing memory state.



Triangular-wave generator spans eight decades

by William S. Shaw
University of Texas, Applied Research Laboratories, Austin, Texas.

Because of its nonsaturating design, a triangular-wave generator can cover eight decades of frequency—from 0.01 hertz to 2 megahertz. Lower and upper frequency limits are set by resistance adjustment. Circuit layout is not critical, and complementary circuitry assures output symmetry and amplitude stability, as well as the absence of dc offset. By decreasing output voltage swing and increasing current, the generator's frequency range can be made to span 1 to 20 MHz.

Transistors Q_1 and Q_2 are constant-current sources whose outputs are switched to produce the charging and discharging currents for the output capacitor. Transistor pairs Q_3-Q_4 and Q_5-Q_6 are differential amplifiers that function as comparators; Q_3 and Q_6 conduct whenever Q_4 and Q_5 switch off, and vice versa.

The series string of diodes D_1 and D_2 and resistors R_1, R_2, R_3, and R_4 set comparator voltages V_1 and V_2. Diodes D_1 through D_4 compensate the four-transistor integrated-circuit array so that the generator maintains its frequency stability with changing temperature. Comparator input and output currents are:

$$i_1 = 28.7R_1/(R_1+R_2+R_3+R_4)R_5$$

$$i_2 = R_7 i_1/R_6$$

When Q_4 and Q_5 are on, Q_3 and Q_6 are off, and output capacitor C_1 charges at a constant rate (since i_2 is a constant) until the upper trigger level (V_U) is reached:

$$V_U = V_{E1} + V_{BE1} + V_{D5}$$

where V_{E1} is the voltage at Q_1's emitter, V_{BE1} is Q_1's base-emitter voltage, and V_{D5} is the voltage across diode D_5. Once output voltage equals V_U, transistor Q_1 conducts and Q_2 switches off, turning Q_3 and Q_6 on. Since R_7 is larger than R_6, Q_4 and Q_5 will switch off.

Due to the symmetry of the circuit, capacitor C_1 is discharged by transistor Q_6 at the same constant rate as it was charged and by the same current, i_2. The capacitor discharges to the lower trigger level (V_L):

$$V_L = V_{E2} - V_{BE2} - V_{D6}$$

where V_{E2} is Q_2's emitter voltage, V_{BE2} is Q_2's base-emitter voltage, and V_{D6} is the voltage across diode D_6. When V_L is reached, Q_1 turns off, Q_2 turns on, and V_2 becomes larger than V_4. This switches on Q_4 and Q_5, causing Q_3 and Q_6 to switch off by feedback through capacitor C_2. The cycle can now repeat.

Diodes D_5 and D_6 allow the output to slew above and below the limits imposed by the emitter-base breakdown voltage (about 6 v) of Q_1 and Q_2. The generator will oscillate without latch-up as long as V_{E1} is less than V_1 and V_{E2} is greater than V_2.

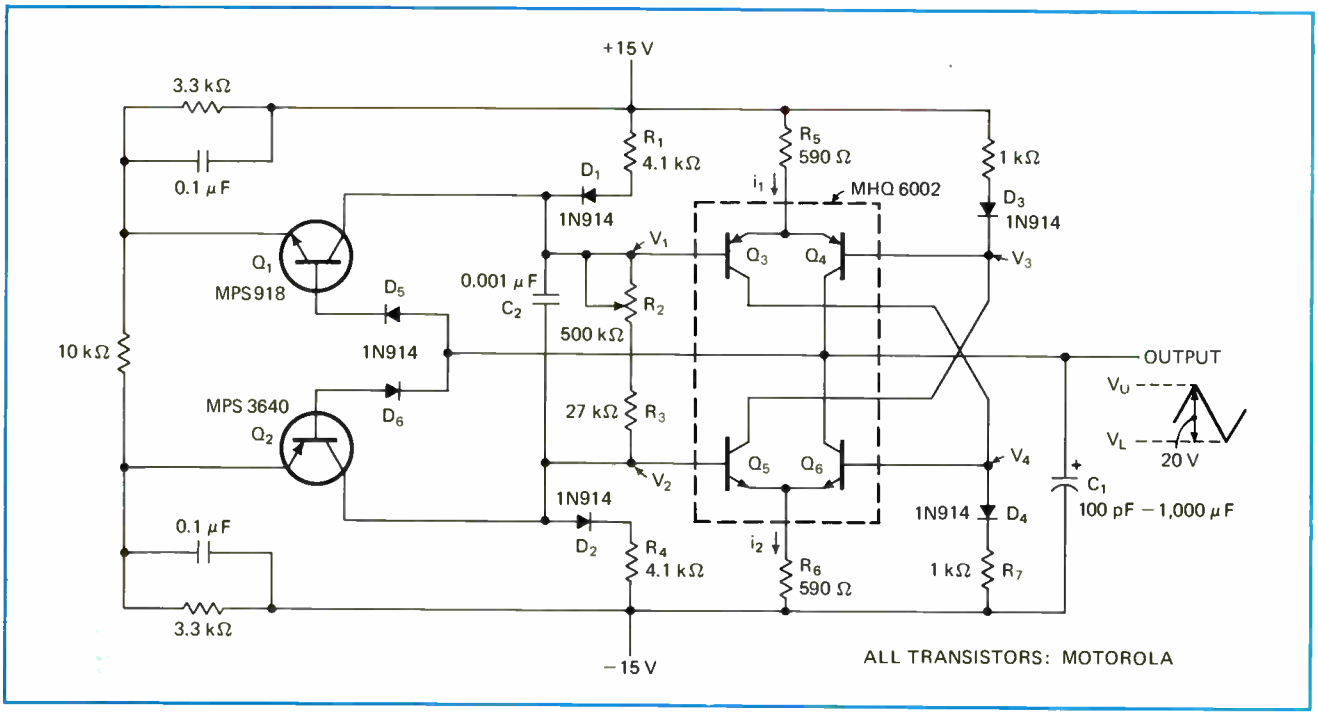
For a 20-v peak-to-peak output, the frequency is:

$$f_{out} = 0.0425 i_1/C_1$$

Capacitor C_1 determines nominal output frequency, while resistor R_3 sets the lower frequency limit and potentiometer R_2 sets the upper limit in addition to providing a linear frequency span of 20:1. When R_2 = 500 kilohms and C_1 = 1,000 microfarads, f_{out} = 0.01 Hz; when R_2 = 0 and C_1 = 100 picofarads, f_{out} = 2 MHz. □

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

High-frequency triangles. Complementary nonsaturating circuitry permits triangular-wave generator to provide 20-volt output at frequencies as high as 2 megahertz. Output triangle is obtained by charging and discharging C_1. Current from Q_2 charges C_1 until output voltage reaches threshold V_U, then Q_3-Q_4 and Q_5-Q_6 comparators switch, and Q_1 supplies discharge current until threshold V_L is reached.



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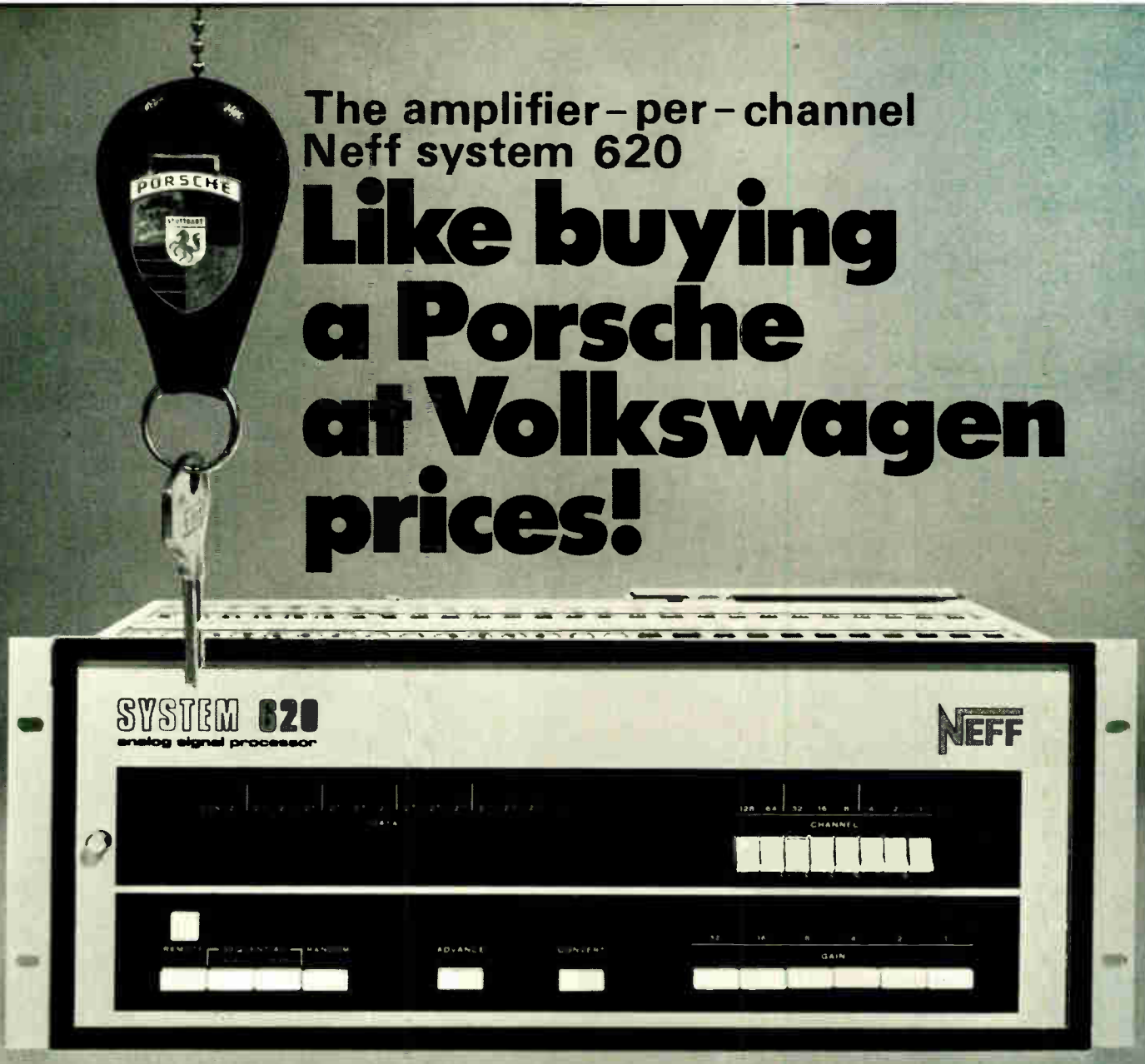

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SPECIAL REPORT

Improved n-channel processes make their move in memories

Adding silicon gate to n-channel structure gives a new look to semiconductor memories: faster, denser, and ultimately cheaper

by Laurence Altman, *Solid State Editor*

☐ With the silicon-gate n-channel process finally under control at many semiconductor houses, builders of MOS random-access memories are out to conquer the world.

The designers say that n-channel devices give them the performance edge they need over p-channel devices for large RAMs. As proof, they point out that:

- n-MOS memories will be two to three times faster than most p-MOS memories (100-nanosecond or even shorter access times for n-MOS, typically 200 to 300 ns for p-MOS).
- n-MOS is two to four times denser (four to eight thousands bits per chip for n-MOS, one to two thousand for p-MOS).
- n-MOS is potentially cheaper per chip function than p-MOS memories (perhaps settling at 1 cent per 100 bits of memory for n-MOS as against 1 cent per 10 bits for today's p-MOS).
- n-MOS is generally lower-threshold than p-MOS (2 to 5 volts for n-MOS, 10 V for p-MOS).

What got the n-channel process on stream is a new ability to make reliable n-impurity diffusions in p silicon—long a vexing problem to IC manufacturers. Anxious to get MOS products on the market, they at first stuck with the easier p-channel process. But as the designers gained more n-channel experience from their complementary MOS efforts (C/MOS has both n and p devices on the same chip), they turned again to n-MOS. Adapting silicon-gate techniques to n-channel structures was the clincher: n-channel MOS was a going thing.

Several properties of the silicon-gate n-channel process are responsible for better device performance and increased bit packing density: carrier mobility, electrical characteristics, and device geometry. Because n carriers have higher mobility than p carriers, n-channel devices are from two to four times faster, depending on clock voltage. And because of reduced parasitic conduction, reduced spacing between memory elements, narrower line widths, and smaller contact holes, memory elements are smaller and can be placed closer together—typically 0.2 mil widths and spacings for n-MOS, as against 0.6 mils for p-MOS.

By now, just about everyone has an n-channel process—from the large across-the-board manufacturers like TI, Motorola, and Fairchild, to tiny new companies like Cogar, Ragen, Standard Microsystems, Electronic Arrays, and others that are putting a large share of their resources into exploiting the technology. Then there are the memory-oriented companies like Intel, which pioneered the silicon-gate process and is now adapting it to n-channel memories.

Surprisingly, there may be more to n-channel than memory, for n-channel logic is in the wind. Because of its high speed, delays of better than 20 ns are in the offing with n-MOS logic circuits— speeds that are comparable to TTL gate performance. An entire logic and memory technology could be built with one n-channel process, resulting in a truly homogeneous LSI technology (see panel, p. 113).

There is competition, however. New bipolar techniques threaten to crowd n-MOS in the memory field. High-bit (1,024) RAM processes, such as Isoplanar from Fairchild, Oxium II from Bell Labs, V-ATE from Raytheon, CDI from Ferranti, and compose masking from TI are all on the breadboard. And new bipolar circuit techniques, such as dynamic memory operation (Bell Labs), the all-transistor cell that eliminates resistors with lateral pnps (IBM, Germany), and ion-implanted high-resistivity resistors, all promise to reduce bipolar cell size even further, and lower power dissipation to levels even below those of n-MOS circuits.

The two articles that follow explore the two ends of the n-channel performance range. First, designers at Intel discuss a production reality: a moderately fast, moderately dense, recirculating dynamic shift register that is directly TTL-compatible and needs only a single +5-V power supply. The second article describes a promising but more exploratory process that puts the n-channel technique through all its paces: 4,096-bit RAMs with access speeds of 200 ns.

N-channel goes to work with TTL

Two dynamic shift registers and a static RAM operate from a single 5-V supply, have 1-V thresholds

by R. Abbott, H. Gopen, T. Rowe and D. Bryson,
Intel Corp., Mountain View, Calif.

Nearly ten years of increasing success with p-channel devices have brought MOS technology to the point where it can tackle the much harder job of n-channel processing. With the addition of silicon gates, such devices can outdo their p-channel forerunners in speed, packing density, and low threshold voltage. They also offer direct compatibility with transistor-transistor logic.

For instance, a family of dynamic recirculating shift registers now being built with a silicon-gate n-channel process has speeds typically of 2 megahertz and threshold voltages of less than a volt, and is TTL-compatible; it enables an entire memory subsystem to operate from a single +5-v power supply. The same process is being used to build a static 1,024-bit random-access memory, which also operates off a single +5-v supply.

A different n-channel process is being developed that will yield a 4,096-bit dynamic RAM. Like most MOS devices, this will require both positive and negative supply voltages.

An alternate approach to designing n-channel devices is to forego compatibility with TTL and instead go all out for speed. This requires the device to be operated like its p-channel equivalent, at drive voltages of 10 to 17 v. But for this initial family of circuits, TTL compatibility was preferred, in order to promote its use in existing systems.

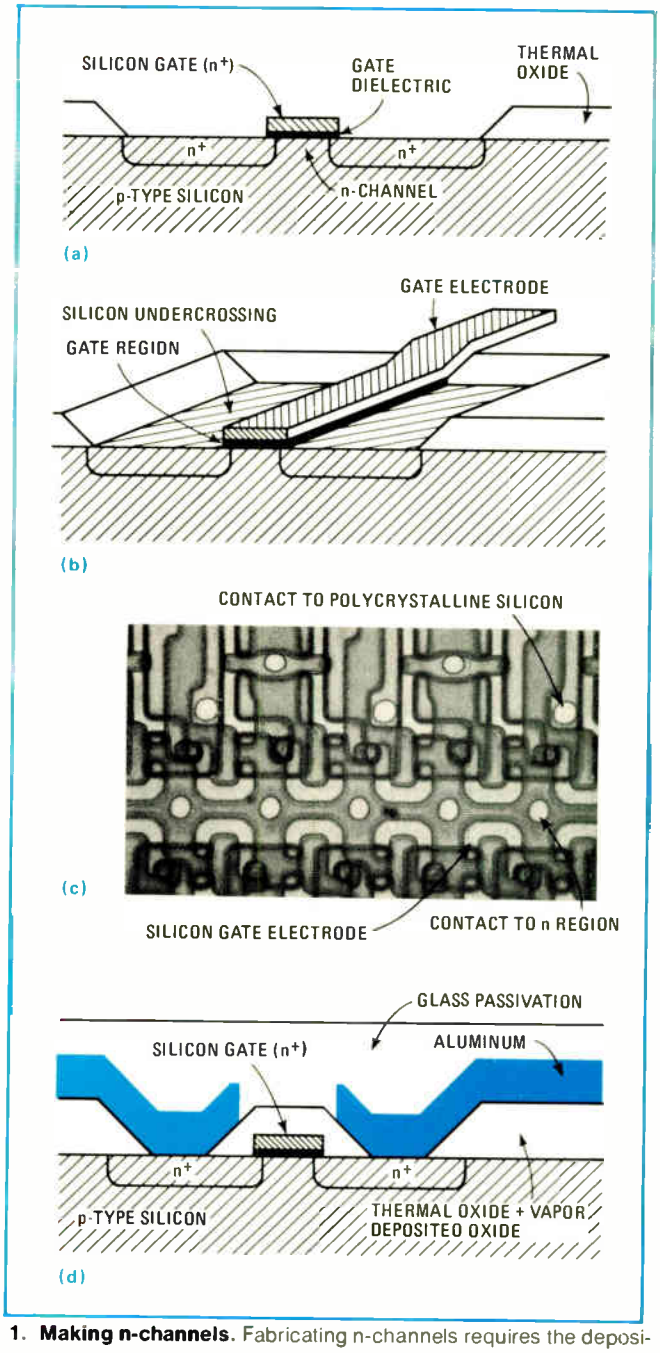
How to make n-channel devices

The processing steps used in building the shift registers and the static RAM are much the same as those for p-channel silicon-gate structures. The difference is that with n-channel devices the starting wafer is boron-doped, p-type silicon. The device threshold is then maintained at less than 1 v by controlling the impurity of the boron and the thickness of the gate dielectric.

Fabrication starts with the p-type wafers being thermally oxidized to a thickness of about 1 micrometer, and parts of the oxide being removed to define the diffusion and gate regions in the first of five photomasking steps. Then a gate dielectric and a polycrystalline silicon are deposited, and areas defining the gate regions of the transistors and the deposited silicon undercrossing are etched out, again by photomasking.

Next comes a diffusion operation, in which n-type impurities form the source and drain regions and the diffused undercrossing (see Figs. 1a and b). Glass formed by the oxidation of silane is then deposited on the wafers at low temperature, and contact holes are etched through it to the polycrystalline silicon and the diffused regions (see Fig. 1c).

Aluminum is evaporated onto this surface, and a fourth photomasking step forms interconnection patterns. Finally, the wafers are heated (alloyed) to insure ohmic contact between the aluminum and silicon, and a glass passivation layer is vapor-deposited over the surface. The fifth photomasking step removes the glass



1. Making n-channels. Fabricating n-channels requires the deposition of a gate dielectric and polycrystalline silicon (a), after which an etching step defines the gate regions and the silicon undercrossing (b). Next, contact holes are etched through the glass to the polysilicon and diffused regions (c). The finished device has the usual aluminum interconnection and glass passivation (d).

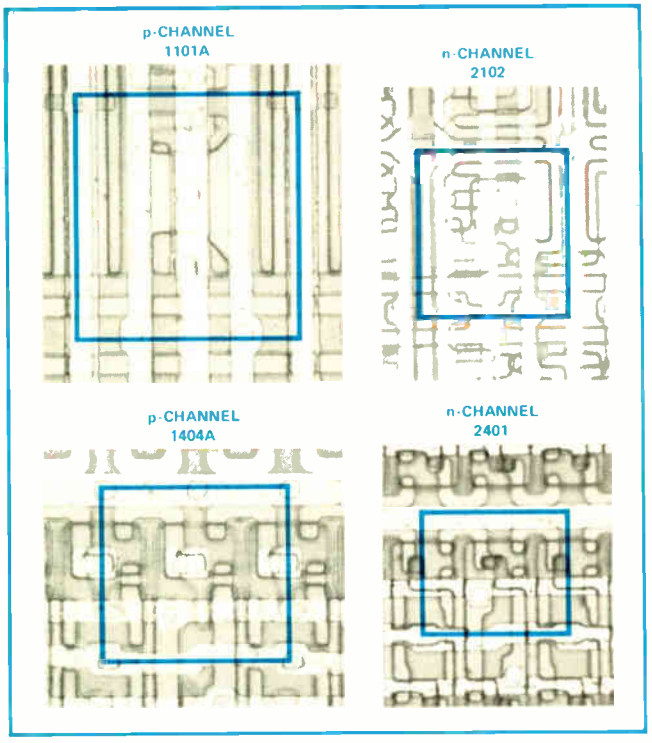
from the bonding pad area and the scribe line.

A cross section of the completed device is shown in Fig. 1d. For some more complex n-channel arrays, a buried contact may be desirable to save silicon space. The price is an additional photomasking step, used to etch contact windows before the polycrystalline silicon is deposited, so that the polysilicon may make direct contact with the diffused regions.

Low voltage payoff: greater density

There's more to this low-voltage n-channel silicon-gate process than just the convenience of its compatibility with TTL. The size of a given chip layout is a function of the voltages applied to the various junctions, and since the low-voltage device requires only a +5-volt supply, and since the internal nodes are at even lower voltages, diffusions may be placed close together (0.4 mils) and channels may be short (0.25 mils). Indeed, tighter and smaller layouts are possible without the expense of tight alignment tolerances.

The resulting high packing density permits larger arrays at a lower cost per bit. Table 1 lists the area savings it makes possible, and Fig. 2 shows the photomicrographs of the cells for the devices listed in the table. For a RAM, the n-channel array needs a memory cell less than half the size of a comparable p-channel device cell, enabling a chip that could handle only 256 bits as a p-channel RAM to accommodate 1,024 bits as an n-channel RAM. A similar density advantage applies to shift registers.



2. Making room. Photomicrographs of RAMs and shift registers made with p- and n-channel technology show higher device density achieved by the n-channel devices. Compared here are static RAMs and a dynamic shift register, all units that are in production.

Table 1: Comparison of p- and n-channel static RAMs and shift-registers

Product		Process	
		p-channel	n-channel
Static RAM	Device #	1101A	2102*
	Size	256 bits	1,024 bits
	Organization	256 x 1	1,024 x 1
	Cell size	17.2 mil^2	7.9 mil^2
Dynamic shift register	Device #	1404A	2401
	Size	1,024 bits	2,048 bits
	Organization	1,024 x 1	1,024 x 2
	Cell size	10.0 mil^2	5.6 mil^2

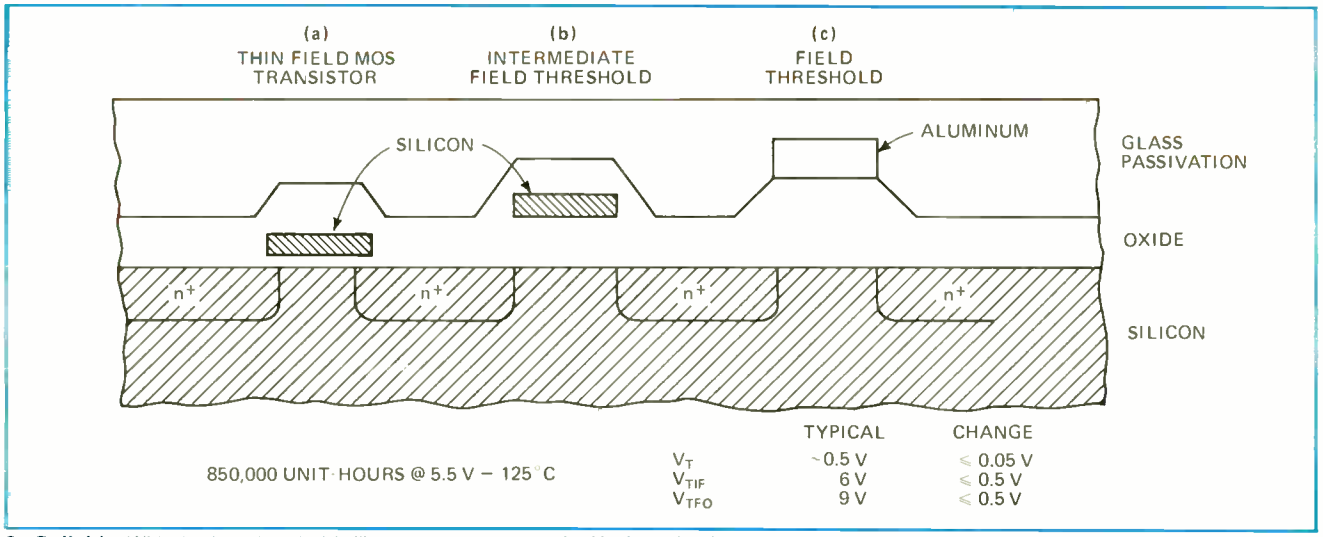
Table 2: Comparison of p- and n-channel products

Parameters	Products	
	p-channel dynamic shift register	n-channel recirculating shift register
Size	1,024 bits	2,048 bits
Organization	1,024 x 1	1,024 x 2
Chip size	118 x 136 mils^2	125 x 151 mils^2
Cell size	10.0 mils^2	5.6 mils^2
Power supply or supplier	+5/−5/−12 V	+5 V/ground
Data levels	V_{CC} −2 / V_{CC} −4.2	2.2 V/0.65 V (TTL)
Clock levels	+5/−12 V	2.2 V/0.65 V (TTL)
Number of clocks	2	1
Clock capacitance	140 pF	7 pF
Maximum power dissipation at 25 °C, maximum frequency	500 mV (not including clock generator)	350 mV (including clock generator)
Maximum frequency (over temperature range)	5 MHz	1 MHz
Minimum frequency	10 kHz @ T_A = 70 °C	25 kHz @ T_A = 70 °C
Output requirement	External R_L needed	No external R_L needed
Other features	None	Recirculating and chip select

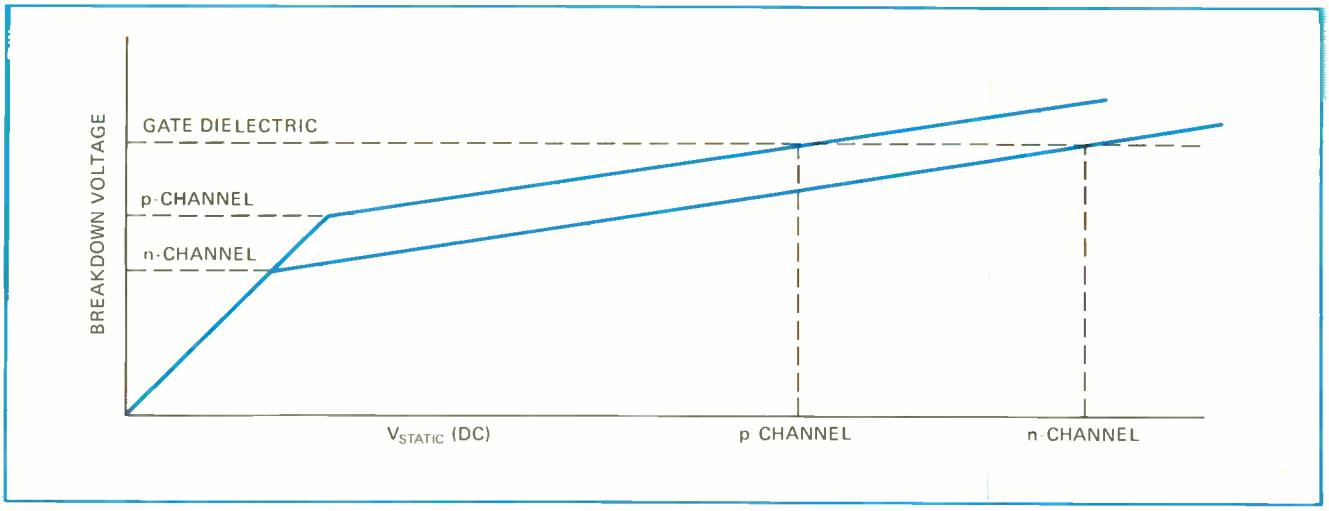
Another advantage of the low-voltage technology is the reduction of parasitic device interactions, which are caused by interconnection levels that have higher threshold voltages than the voltages used for the operation of the circuit. This eliminates both large leakage paths and high capacitance caused by field inversion—problems that needed solving before n-channel devices could be implemented.

The reliability of n-channel silicon-gate technology is dependent on the stability of the threshold voltages of the MOS transistors and the two levels of interconnects used in the array. In addition, the stability of dynamic storage circuits will be determined by the change in junction leakage, since it is this leakage that determines the retention time of the memory cell.

The basis for the inherent high reliability of silicon-gate n-channel devices is the way the layers are arranged. In the cross section of an n-channel MOS transistor and the interconnects used in the silicon-gate process shown in Fig. 3, three parts of the device are



3. Reliable. With the low-threshold silicon-gate process reliability is maintained in all parts of the n-channel device. In region labeled (a), the glass passivation insures against contamination, just as in p-channel fabrication. The silicon interconnects and the metal lines—regions (b) and (c)—are also well protected because of the thick oxide step surrounding the silicon gate and aluminum electrode.



4. Extra protection. Devices made with n-channel technology have better gate protection than p-channel structures made with conventional fabricating techniques. The low n-channel breakdown voltage curve means that these n-channel structures operate at voltages substantially lower than those causing gate breakdown. This extra gate protection, compared to p-channel devices, adds to device reliability.

identified: the thin field segment (a), the intermediate field with the silicon line interconnects (b), and the thick field segment with metal line interconnects (c).

In (a) the MOS transistor is well protected from the external environment by a glass passivation barrier impervious to contamination. The resistance of this barrier to contamination (Na+) has been well established in p-channel technology. The interconnects of (b) and (c) are also fabricated as in the p-channel technology process, and so are also well protected from external contamination.

Included in Fig. 3 are the results obtained after 800,000 unit-hours of stress on test devices. It shows that virtually no shifts in any of the threshold voltages were observed. The stress condition on these units was 5.5 volts (maximum value for the TTL circuits) at 125 C. The junction leakages of these devices were also monitored, and no increases observed.

An additional reliability feature of the n-channel technology is improved gate protection of the input devices—resulting in the lower breakdown voltage of the diode. Figure 4 compares the dc behavior of the same gate protection device for both n-channel and p-channel processes as a function of the static charge applied. If the same dynamic impedance is assumed for the two diodes, the breakdown voltage in the n-channel version is consistently lower than in the p-channel device, requiring a large static charge to break down the gate dielectric.

The real thing

The n-channel 2,048- and 1,024-bit dynamic recirculating shift registers, the Intel 2401 and 2405, are examples of products using this new technology. Both are directly TTL-compatible in all respects: inputs, outputs, clock line, and power supply. Table 2 compares a typical p-channel silicon-gate 1,024-bit shift register (1404A) with the n-channel silicon-gate 2,048-bit recirculating shift register (2401). A photomicrograph of the latter die is shown in Fig. 5.

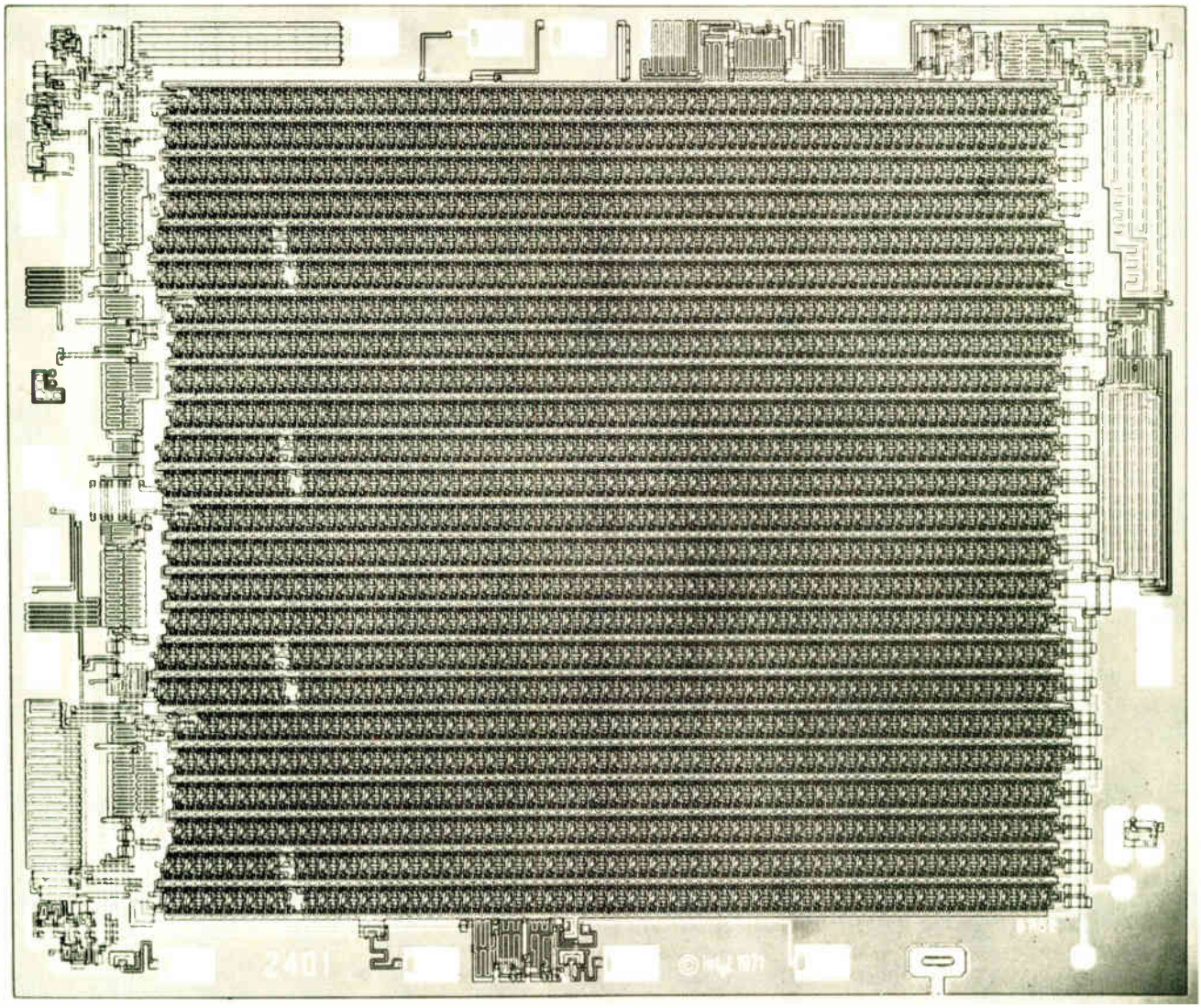
Even though the n-channel device has twice as many bits as the p-channel version, it is only 20% larger in area. This is because the cell size of the 2401 is also nearly half the cell size of the 1404A, thanks primarily to the closer spacing allowed by the low voltage. Doubling the bit capacity in each package results in considerable savings for the user in printed-circuit board area, of course. The increase in bits per chip on 2401 will far outweigh the loss in yield on the slightly larger chip and result in a much lower cost per bit.

Additionally the input levels are all referenced to ground, unlike the p-channel MOS levels that are referenced to the positive power supply voltage V_{CC}. Nearly 50% of the user problems with p-channel MOS shift registers are related to the clock levels. Incidentally, these are 16-V clock swings, and require either a voltage multiplying stage between the 5-V TTL supply or a separate negative voltage supply. Since the 2401 has a TTL level clock and the clock capacitance is only 7 picofarads (worst case) over the full temperature range, as compared to over 100 pF for p-channel MOS clock inputs, system design is greatly simplified.

The maximum power dissipation of the 2401 is less than the 1404A in system configurations. The 400-milliwatt worst-case power dissipation over the temperature range at maximum frequency of operation includes the clock generator power of the 2401, which is about 40% of the total.

Since ease of use and TTL compatibility were emphasized for this n-channel silicon gate design, the maximum data rate of the 2401 is actually slower than that of the 1404A. This is due to the large load presented to the internal drivers. But even under these circumstances the device is capable of operating at 2 MHz.

Finally, the 2401 saves the user some expense in external parts. Many p-MOS shift registers must have separate circuits to recirculate the data and to address the bit lines. With the 2401, on the other hand, recirculation, and two chip selects for X-Y matrix selection are supplied on chip. Also included is an internal load resistor, removing the user's need for external matching. □



5. Close fit. Unlike most p-channel memory devices, this 2,048-bit dynamic shift register made with n-channel technology is directly compatible with TTL interface circuits in input, output, and clock lines; most significantly, it can operate from a single 5-V supply.

Coplamos keeps n-channels in line

Oxide-isolated MOS structure controls parasitic currents that plagued past n-channel devices

by Paul Richman and James A. Hayes,
Standard Microsystems Corp., Hauppauge, N.Y.

☐ Although inherently faster than p-channel MOS integrated circuits, the n-channel configuration has made no significant impact on the semiconductor scene so far. What has held it back from fulfilling its promise for high-speed random-access memories is a fundamental problem that is only now being solved: parasitic conduction.

Parasitic currents, a major contributor to failures in n-channel circuit operation, can arise in two ways. The first occurs wherever a metal interconnection in an n-channel IC passes over a thick layer of silicon dioxide and crosses two non-related, heavily diffused n^+ regions. At a high enough positive voltage level, inversion of the silicon surface can occur directly under the metal, and undesired current flows between the two diffused regions.

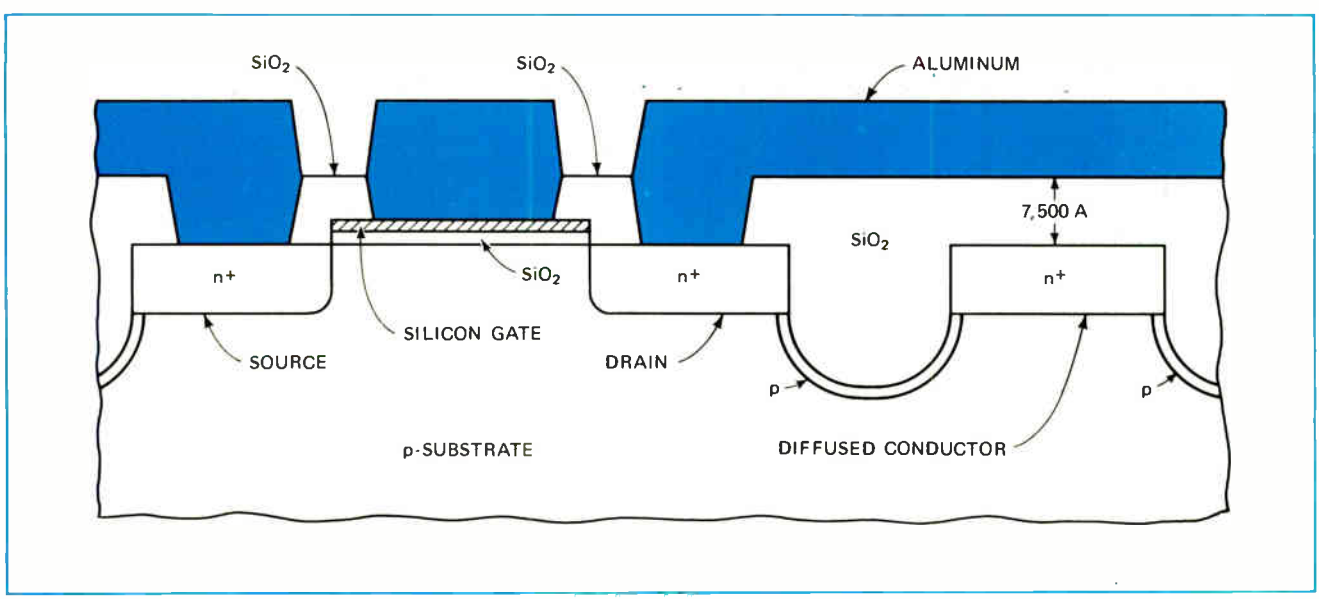
The second arises when so-called "punch-through" occurs between two closely spaced, unrelated diffused regions. This can happen when the doping concentration near the surface of the p-type silicon substrate is low enough, and the distance between the two n^+ regions is small enough, for space-charge-limited current to flow when a potential difference exists between the n^+ regions and a positive voltage is applied to the overlying metal. This kind of parasitic current can occur at even lower voltages than the silicon inversion level.

In general, these parasitic conduction mechanisms occur at much lower voltage levels in conventional n-channel structures than in p-channel configurations. But both are virtually eliminated by new n-channel process, called Coplamos. Additionally, Coplamos makes it possible to attain much greater packing densities than p-channel devices achieve.

The solution

The new process solves the parasitic problem with an oxide-isolated monolithic structure that takes advantage of the fact that silicon nitride can mask against both oxidation and diffusion. It is fundamentally an extension of the Planox process developed by Morandi at SGS, Milan, Italy [*Electronics*, Dec. 20, 1971, p. 44] and of the work on the local oxidation of silicon reported by Appels, Kooi, and others at Philips in the Netherlands. The new technology is equally applicable to n-channel aluminum-gate and n-channel silicon-gate structures.

A cross section of an active n-channel silicon-gate MOS transistor along with an n^+ diffused silicon interconnection, fabricated with the Coplamas process, is given in Fig. 1. As in the Planox process, all active silicon regions—drains, sources, channels, and diffused interconnections—are located on mesas which are surrounded by silicon dioxide and rise well above the recessed parasitic (nonactive) area. But in the Coplamos technique, a double dielectric layer, consisting of silicon nitride on top of silicon dioxide, covers the active mesa regions and protects them from the effects of the subsequent low-level p-type diffusion and localized thick-field oxidation. These thick-field p-doped regions are consequently self-aligned with respect to the active mesas. The mesa formation, the thermal oxidation, and the selective doping of the thick-field regions all require



1. Above all. Source, drain and diffused interconnections all are located on raised mesas, isolated from the surrounding silicon by SiO_2. The formation of the mesa, along with the thermal oxidation and selective thick-field doping, takes only one mask step. The process greatly reduces parasitic conduction, and results in closer memory-cell spacing, high circuit density and high speeds.

only the one photolithographic operation.

A key feature of the Coplamos process is the use of substrate bias to permit the desired active device threshold voltage to be achieved on a moderately doped substrate, while also maintaining high electron mobility and low junction capacitances to substrate. Typically, with a -5-V substrate bias, the threshold voltages of the active n-channel devices are on the order of +1.7 V. The selective doping of the silicon surface in the thick-field regions increases the surface depletion region charge density there, and hence increases the parasitic field-inversion voltage.

The source-body effect (change in threshold voltage with applied substrate bias) is directly proportional both to the thickness of the gate insulator of an MOS device and to the maximum value of the surface depletion region charge density. The latter quantity is much greater in the thick-field regions than in the active areas because of the selective doping, and the thickness of the silicon dioxide in the thick-field regions is approximately 18,000 angstroms as compared with an active gate insulator thickness on the order of 1,000 angstroms.

It follows that the source-body effect associated with parasitic devices is many times greater than for active devices. Consequently, while the selective doping of the parasitic regions results in typical field-inversion voltages of +10 to +20 V, the application of a small negative substrate bias further increases the field-inversion voltage to values in excess of +70 V.

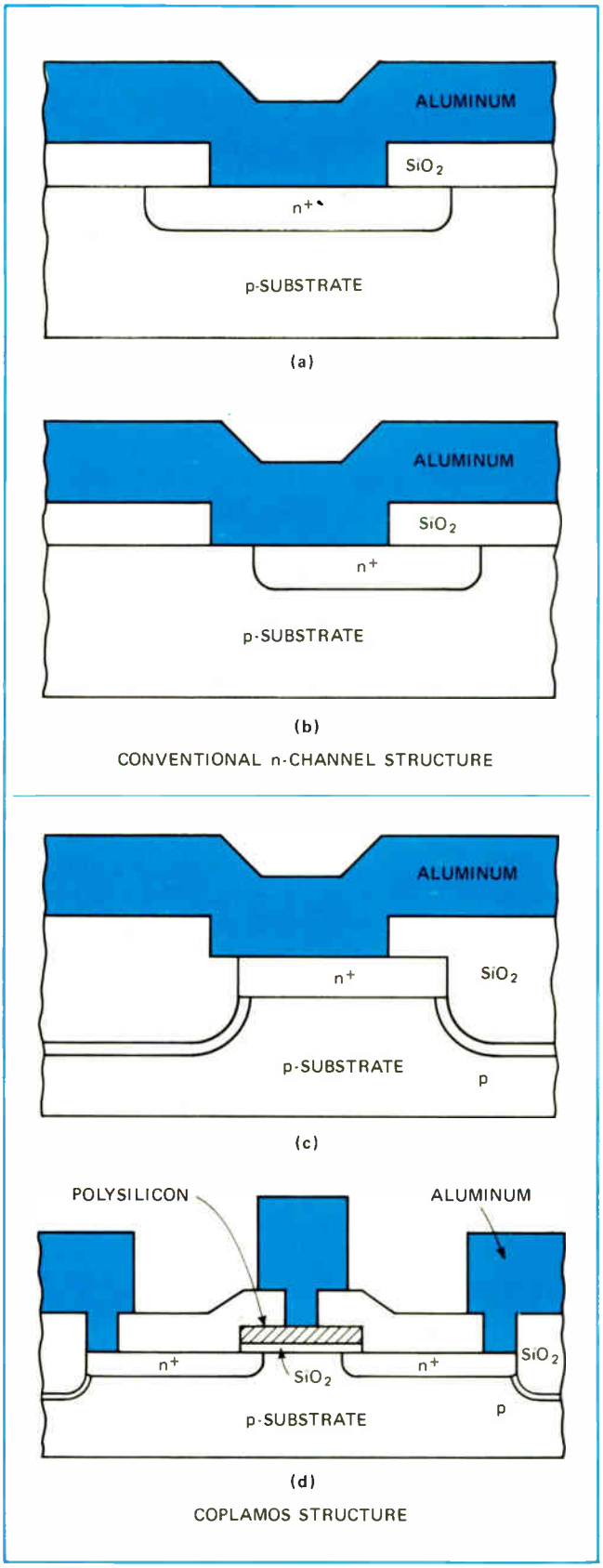
In addition, the selective doping of the silicon surface in the thick-field regions increases the acceptor doping concentration at the surface such that the punch-through voltage is much greater than typical operating supply voltages. This is the case even for drawn separations of nonrelated diffused regions as small as 0.2 mil.

On the level

As Fig. 1 shows, the surface of the Coplamos structure is relatively flat, since the thick oxide regions are recessed into the silicon. Indeed, when the polycrystalline silicon layer is deposited, the surface of the wafer is almost perfectly flat; thus, the polycrystalline silicon can be kept quite thin. In addition, any aluminum interconnection which crosses a polysilicon region will only encounter at most a 4,000-angstrom step. This virtually eliminates the step-coverage problems associated with double-metalization structures.

In practice, the largest step the metalization layer is required to climb is about 7,500 angstroms, and this occurs only at contact hole locations, where aluminum surrounds all four sides of the contact hole. All other steps in the structure are considerably lower. The result is very uniform deposition and etching of the metalization layer, so that it's easy to use 0.2-mil-wide aluminum interconnections spaced 0.2 mil apart.

Since all diffused interconnection mesas in this type of n-channel structure are surrounded by silicon dioxide, the area required to make contact to a diffused region can be greatly reduced. In a conventional planar silicon structure (Fig. 2a), a contact hole to a diffused



2. Better contacts. Comparison of standard planar structure (a) and (b) with the Coplamos structure (c) shows that in the former misalignment can cause contact between aluminum electrode and substrate—but that the p-diffusion in the Coplamos process eliminates this problem by resulting automatically in self-alignment. In (d) the complete structure is shown.

region has to be at some distance from the edge of the diffused region. Otherwise, any misalignment during the photolithographic process could cause the aluminum to contact the p-type substrate (Fig. 2b), and produce considerable metal-to-substrate current flow. In a Coplamos device, however, it's conceivable that a contact hole can actually extend beyond a diffusion region (Fig. 2c), and if misalignment occurs, the aluminum will still not make contact to the p-substrate, which lies well below the mesa.

A further advantage of this n-channel structure is that the p-diffusion surrounding the active area of the device forms a diode that can be used to protect thin oxide layers very effectively against static charge rupture. Since the acceptor doping concentration near the surface in the p-doped parasitic regions is high enough to achieve a sharp breakdown voltage in the +20- to +30-V range, this diode can function as a protection device without needing a grounded gate electrode to be placed over the periphery of a diffused junction, as is commonly done in conventional MOS integrated circuits.

Electrical parameters

Typical values for the more important electrical characteristics of the Coplamos process are listed in Table 1. The threshold voltage of the device is only 1.7 V, enabling Coplamos structures to interface easily with bipolar ICs. In addition, the high field-inversion voltage and drain-to-source-substrate breakdown voltages (+75 and +25 V respectively) insure reliable operation over a wide range of operating voltages.

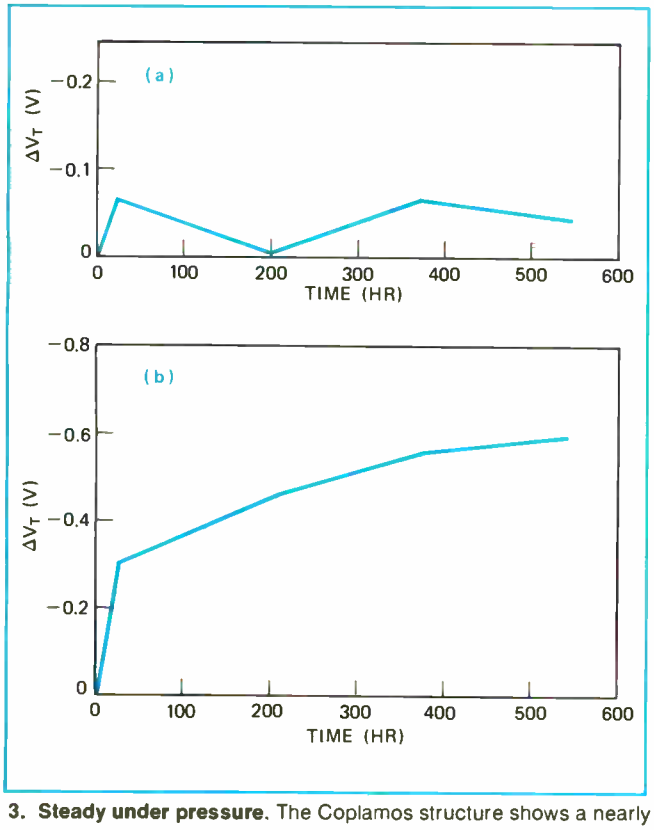
The high electron mobility, μ_e, is evident in the gain factor K′ (given in the table and derived from gain measurements made when the device was biased both in and out of current saturation). It indicates a surface electron mobility u_e of approximately 575 cm²/volt-second, typically more than twice the hole mobility associated with conventional p-channel MOS devices.

Another point is that the silicon gates in the Coplamos process reduce the overlap Miller capacitance, thus increasing the circuit operating speed. This high speed enables the designer to achieve a higher fanout limit for his logic, as well as increasing the frequency range over which the device can operate.

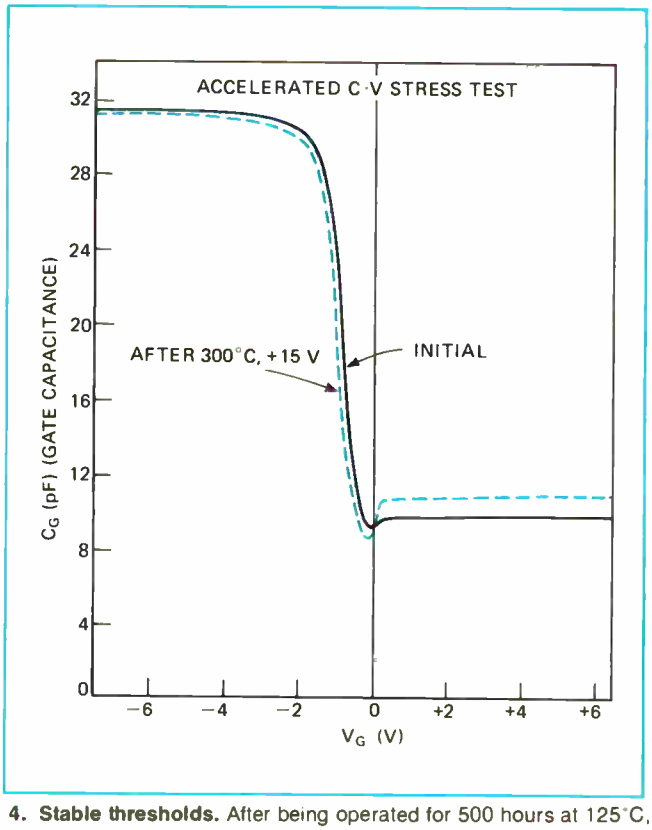
Figures 3 and 4 show the high degree of threshold voltage stability typically associated with the process. The capacitance-voltage curve of Fig. 3 shows almost no degradation after stressing at 300°C, with 15 V. The threshold voltage, V_T, and field-inversion voltage of Fig. 4 had similar high marks in stability after 500 hours of high-temperature operation at 125°C.

Figure 5 compares the active device areas of Coplamos and conventional p-channel aluminum and silicon-gate processes. Because of the reduced spacing between active devices, the narrower aluminum linewidths and spacing, the smaller area required for contact hole location, and the reduction of device area, a better-than-twofold density advantage over p-channel silicon-gate processes results, and about a fivefold advantage over the more widespread aluminum-gate p-channel technology can be realized.

The increased density provides a much lower cost per



3. Steady under pressure. The Coplamos structure shows a nearly perfect ability to hold its capacitance-voltage relationship. Consequently there is no degradation of logic levels when the device is operated at normal gate voltage (V_g = 2 volts).



4. Stable thresholds. After being operated for 500 hours at 125°C, the Coplamos device shows a high degree of both threshold voltage stability and field inversion voltage stability. Tests were also successfully run under a severe bias stress (−17 volts).

It's logical, too

By adding another dimension to MOS LSI standard logic cells, the n-channel process opens up a new vista for LSI. First, n-channel allows speeds comparable to TTL speeds (e.g., 20-ns pair delays). Second, the system voltage requirements and power requirements are identical with those already existing in most systems (+12 V, −12 V and +5 V). Third, the process allows direct TTL input/output compatibility (noise margin, levels, speed).

To take advantage of these characteristics, a set of standard logic cells could be developed that were identical in all respects to the present TTL. Then MOS LSI would no longer be an arduous re-engineering of a working TTL design, and the logic design could be implemented directly on the memory chip. This would reduce the custom MOS LSI circuit design to the level of laying out a single printed-circuit board, containing both logic and memory, and so would lessen considerably the cost of implementing equipment in MOS LSI.

Laurence Altman

logic function because logic requiring two, three and four chips can be reduced to one chip, thus lowering packaging costs. Now a designer can use the Coplamos process and put about 250 logic equations corresponding to a "bare bones" 8-digit calculator on a chip 100 mils square, or about 1,000 equations on a chip 160 mils square. Under development is a single calculator chip with 12 digits and memory, not considered feasible with the older p-channel process.

Long memory

One of Coplamos first entries into the random-access-memory market will be a 4,096-bit, fully decoded, dynamic memory. To fit into existing solid-state memory systems with a minimum of new peripheral design and testing development, the basic cell and memory cycle timing chosen are similar to the standard 1103. The cell area is 3.2 mils square, resulting in a chip size of only 167 by 167 mils.

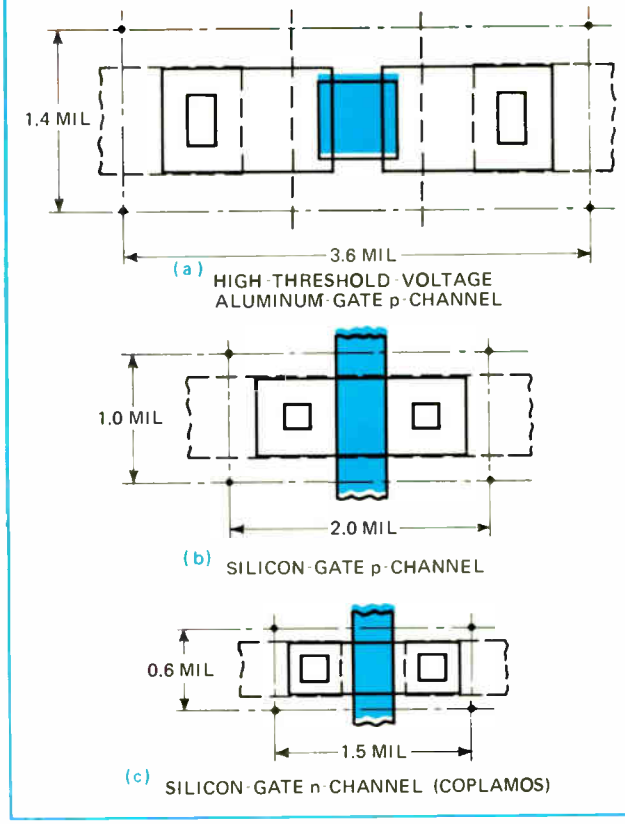
The memory is organized in a 64-by-64 array, requiring 64 read cycles every 2 milliseconds for refresh. Although containing four times the bits of a present-day 1-kilobit RAM, the access time and read cycle times are 250 ns and 400 ns (read/write cycle time 500 ns), compared to the standard 350 ns and 500 ns for the 1103.

The 4,096-bit memory requires three high-level clocks—precharge, chip enable, and read/write. However, the input, output and all addresses are TTL-compatible, dramatically reducing system interface circuit complexity, cost, and power dissipation.

A more advanced 4,096-bit RAM being developed will have cells approximately 2 square mils in size, and allow a 200-ns access time and 250-ns cycle time. In addition, the device will have clock voltages generated on the chip, and will be fully TTL-compatible, reducing the user's peripheral circuitry.

Table 1
COPLAMOS ELECTRICAL PARAMETERS

PARAMETER	TYPICAL VALUE
Threshold voltage (with applied substrate bias)	+1.7 V
Field inversion voltage (with applied substrate bias)	+75 V
Gain factor, $K' = \mu_e \epsilon_{ox} / T_{ox}$	22×10^{-6} A/V
Drain to substrate breakdown voltage	+25 V
n^+ silicon sheet resistivity	17 Ω/square
n^+ polycrystalline silicon sheet resistivity	50 Ω/square



5. Sizing up. Coplamos memory cells are far smaller (0.9 mil²) when compared to aluminum p-channel cells (5 mil²), and the best silicon-gate p-channel cells (2.0 mil²). RAMs with 4,000 to 8,000 bits can fit on chips that measure only 180 by 180 mils.

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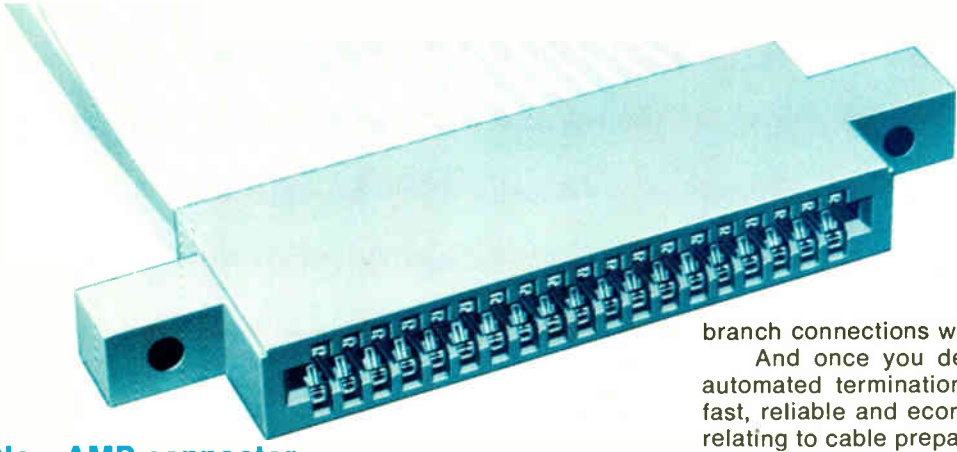

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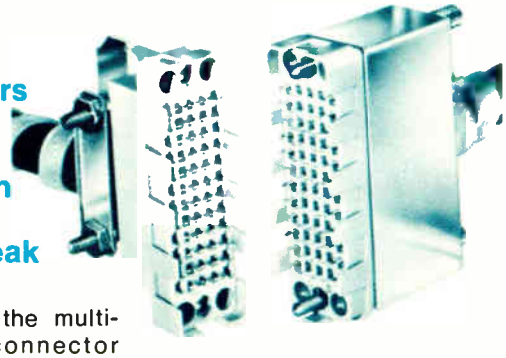

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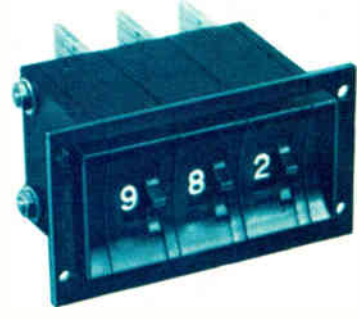

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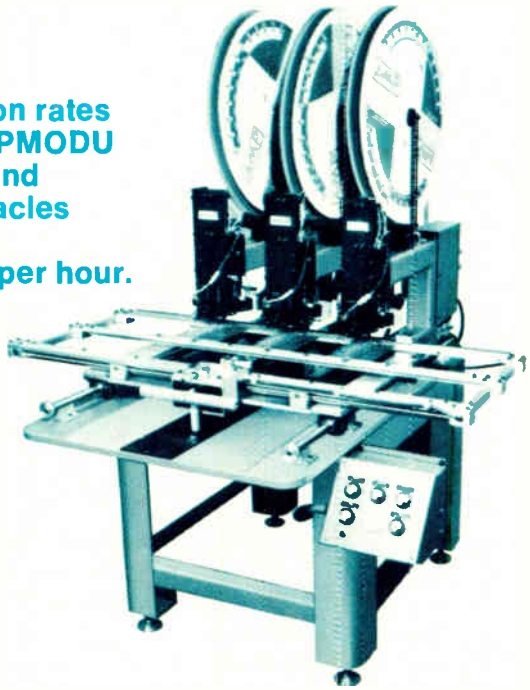

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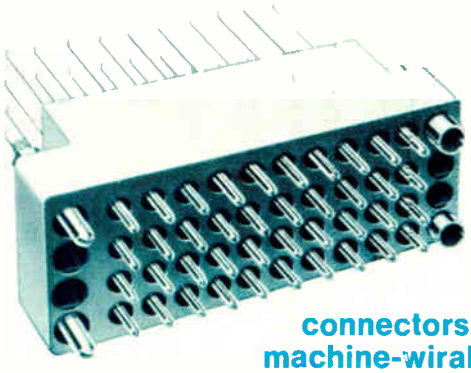

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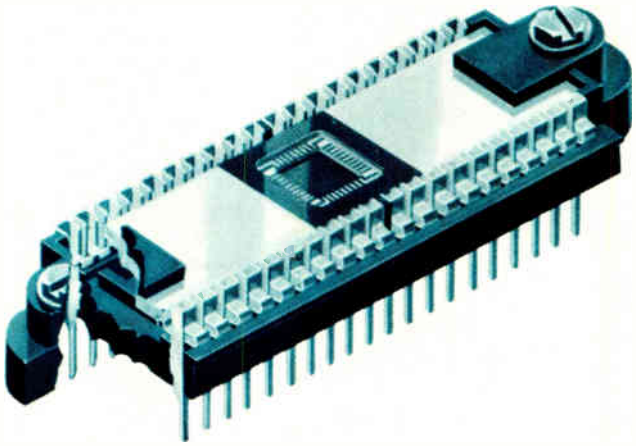

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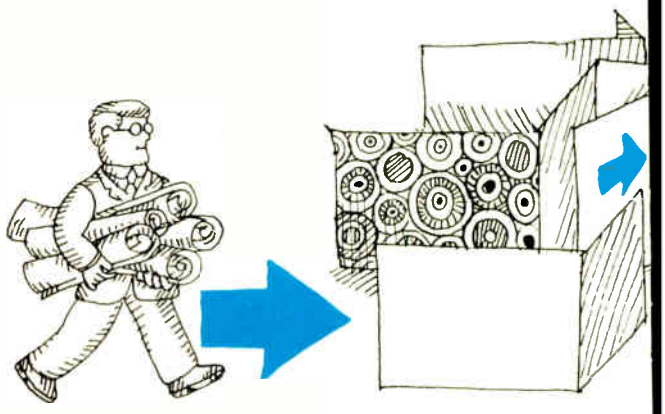
What EEs should know about patent law

The EE's specialized knowledge is vital to the patent attorney who has to define what is new in an invention

by Michael I. Rackman, *Gottlieb, Rackman & Reisman, N.Y., N.Y.*



☐ Of all the potential clients a patent lawyer encounters, electrical engineers are the most skeptical. They are the most prone to question how a valid patent can issue on anything electrical, except perhaps the pioneering inventions in radar, transistor technology, or xerography. Then, even if satisfied on that count, they tend to deprecate the whole process by saying, "But why apply for a patent, when I can design around anything?"

A glance at any issue of the Patent Office's Official Gazette, to which many companies and libraries subscribe, will settle many doubts on the first point. Each week this publication lists brief descriptions of over a thousand patents. Hundreds of these are electrical, some being directed towards new or improved circuits and devices, others towards new systems.

The companies that own these patents are not only in a position to protect themselves against the copying of their products—they can also horse-trade with their competitors for an exchange of rights.

What is a patent?

The effectiveness with which any patent protects its owner depends on its language. In theory, a patent bestows on its owner the exclusive right to make, use and sell an invention for 17 years. The problem is to define just what it is that has been invented. The engineer will want to claim proprietorship not only of a particular circuit or system, but of all circuits or systems based on the same principles of operation. He will also need the definition to be drawn broadly enough to cover any inventions that are made after his, and that are derived from his. At the same time, it has to be narrow enough to differentiate his invention from what has gone before.

Consequently, a U.S. patent includes, besides a patent drawing and a patent description, a set of numbered paragraphs, called claims, which are found at the end of the document. Each claim is a short definition of the invention, and infringement is established when an alleged infringer is shown to be making, using or selling something defined by at least one of the patent claims. Although some countries do not require the invention to be precisely defined in one or more claims, in the United States the claims determine the extent of protection.

Engineers frequently ask why so many claims use the word "means" to define a component in a circuit or a block of a system. The answer is that this is the way the lawyer generalizes the claim to equivalent circuits or systems. The patent statute specifically authorizes the use of a "means plus function" clause for the definition of an element in a claim for a combination of elements. (Almost every electrical invention is a combination of standard elements—resistors, capacitors, transistors, in circuits, or amplifiers, power supplies, converters, modulators, in systems.)

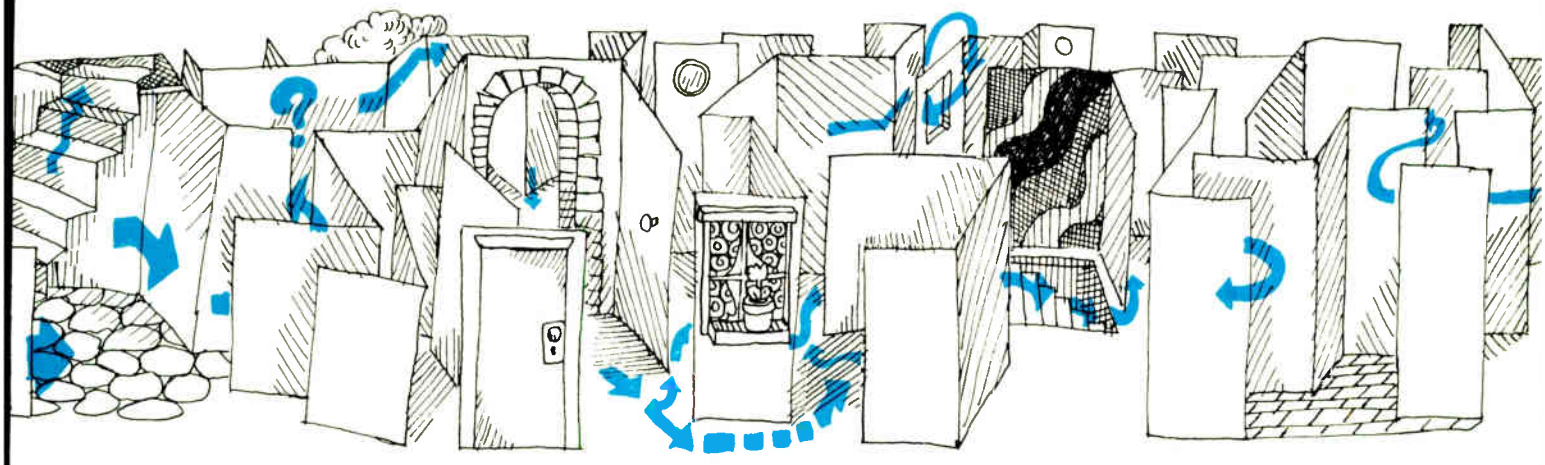
For example, consider any system—an optical character reader, integrated-circuit chip tester, patient monitor and so on—which includes a core memory. While the patent disclosure might describe a core memory as one block of the over-all system, the applicant will usually want to cover semiconductor, optical, and other newer types of memory, and even as yet uninvented types that could be used in the system. He can do this in the claims, by defining the memory block and its read/write circuits as "means for representing data, means for writing data in the representing means, and means for reading data represented in the representing means." If the system includes a read-only memory, the phrase "means for writing data in the representing means" would be omitted in claims referring to it.

Another question that often bothers the engineer is why there are several claims in a patent. Since each patent covers only one invention, why should it not be possible to define the invention in a single claim? By drafting several claims, the lawyer is essentially attempting to cope with the unknown. In the nature of things, he and his client cannot know what other inventors and their lawyers have recently done and are doing. And both are unavoidably ignorant of what is likely to happen in the next 17 years.

Scope of claims

A good hypothetical example to illustrate the need for several claims of differing scopes is frequency modulation. Assume that amplitude-modulated transmission and reception have already been invented but that most of the engineering profession is still unaware of it. This is not an unreasonable assumption, since a patent application is kept secret until a patent is issued, and since publication of the invention is often withheld pending its commercialization.

The patent application on fm might completely de-



scribe fm transmitters and detectors, without the inventor recognizing that amplitude modulation is possible. He may also be unaware that by modulating the phase of the carrier rather than its frequency, a nearly identical modulated carrier can be produced.

A patent application might include the following claim:

> "A system for communicating an information signal at frequencies higher than the frequencies which characterize the information signal, comprising: (a) means for generating a carrier signal at a frequency higher than the frequencies which characterize the information signal, (b) means for modulating the generated carrier signal in accordance with the information signal, and (c) means for transmitting the modulated carrier signal."

The patent application should also include claims about receivers and transmitter-receiver pairs, but the claim quoted is representative enough. (For a variety of reasons, the above claim and those to follow are less than ideal, but they make the point under consideration.)

A future shock

The patent attorney and his client who included only this claim in the application might be in for a rude awakening. The patent might be issued, and only years later might someone discover that a-m was actually invented before fm. For example, an application on a-m that was filed first might take longer to be issued as a patent than the fm application. When the a-m patent was issued, the world would suddenly learn that a-m had existed before fm. Alternatively, an a-m patent application might not have been filed at all; the technique might simply have been described in an obscure professional journal. Technically, either the a-m patent or the journal now counts as "prior art"—that is, a record of an earlier, pertinent discovery.

Unquestionably the above claim covers the prior art as embodied in the a-m patent or article—that is, it defines something that was old when the fm invention was made. Thus it is a broad claim in that it attempts to cover all modulation schemes—even those which are presently unknown. If the claim were valid, it would offer the broadest possible protection. Unfortunately, its breadth is its own undoing, because it covers many alternate schemes, one of which happens to be prior art. A claim, to be valid, must define only something new.

But instead of writing the claim in the application as above, substitute the following for clause (b):

> "(b) means for varying the instantaneous frequency of the generated carrier signal by an amount which is proportional to the amplitude of the information signal and at a rate equal to the frequency of the information signal to derive a modulated carrier, and"

Because this claim does not characterize a-m, it is much narrower than the first claim and is therefore valid (assuming that no other prior art is pertinent). But it is so narrow that when phase modulation is invented in the future, the inventor may have no control over it. That is because, even though the forms of the fm and pm transmitted signals are the same, the pm circuit varies the instantaneous phase of the carrier rather than its frequency, and the claim defines a circuit "means" whose function is different. Thus, while the revised claim quite fortuitously does not define amplitude modulation, neither does it cover the yet-to-be-invented phase modulation. (Actually, the claim could be interpreted to cover phase modulation, especially since it deals with a pioneering invention; nevertheless, a claim that leaves no doubt is better.)

But now consider a third claim—which substitutes a new clause (b) but otherwise is the same as the other two:

> "(b) means for deriving from the generated carrier signal a modulated carrier signal whose amplitude is constant and whose frequency varies in accordance with the information signal, and"

This claim clearly covers fm and pm, and yet because of its constant-amplitude limitation does not cover the prior art a-m. Therefore it is valid, and affords maximum protection because it covers both the new and the as yet uninvented forms of modulation.

The claim preferred

The choice of the third claim is predicated on the attorney's and the inventor's knowledge of the state of the art: a-m is old, fm has just been invented, and they suspect that some variations of fm are possible even though they are not quite sure what these variations might be. But usually neither the inventor nor his attorney knows the true state of the art, even though the at-

torney may make a patent search to determine it. If a patent search does not turn up a-m—which is likely if the a-m application is still pending—the attorney should include all three claims in the application. If he is aware of a-m, he would omit the first claim.

In general, even if the Patent Office rejects some of the broadest claims, and still others are invalidated in litigation, the remaining claims may still be broad enough to cover not only the specific embodiment of the invention disclosed in the application, but also the more important future variations of it.

Circuits and systems

The sorts of devices that can be patented are many. A typical recent issue of the Patent Office Gazette summarizes 309 electrical patents, ranging through memory array testers, adders, variable-gain circuits using field-effect transistors, error detectors, burglar alarm switches, electroluminescent displays, television deflection systems, insulated-gate field-effect transistors, time-interval-averaging circuits, electrical connectors, data processors, magnetic-domain propagation arrangements, optical mass memories and analog-to-digital converters.

Many of the patents that are issued each week describe new or improved circuits and devices for achieving standard functions, such as switching regulators, sample and hold circuits, and adders. Such patents are valuable not only in themselves, but especially when they are part of a larger group. A company with dozens of patents pertaining to analog-to-digital converters, for example, usually has a patent position strong enough to pose a threat to any competitor who tries to assert one of his own patents against it.

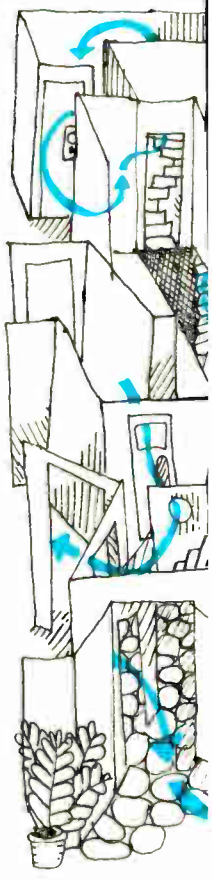
But more important, many basic patents are issued each week. Usually these cover systems rather than circuit improvements. Actually designing a system, especially if the design is only on paper, is often not too difficult after the system function has been decided. When a system is the first one to perform a new function, it can often be covered by very broad claims, for no really pertinent prior art can exist if the function is new. Simply producing prior art of blocks of equipment that could have been combined to build the system is not enough to invalidate the patent. What must be shown for invalidation is how the prior art suggested that the blocks be combined—it must include something that makes the new combination obvious.

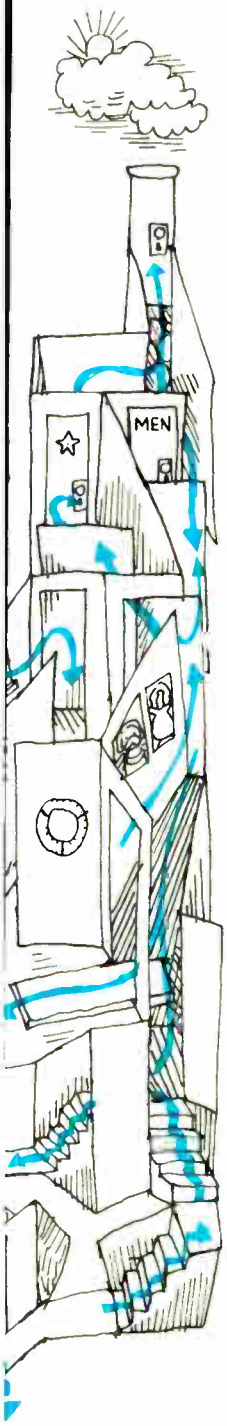
The first inventor to do a particular job often gets patent protection that covers subsequently invented and different ways of doing the same thing. For example, the inventor of the first version of each system listed in the table—even though his design may not have been particularly elegant or efficacious—could have been (and maybe was) granted a patent. Very broad claims in that patent would have covered much more sophisticated and better systems developed during succeeding 17 years.

An actual case

An example of broad claims in a non-esoteric area is a patent application made for a weighing machine for retail stores that would audibly announce weights. Several years ago, an engineer was grocery shopping for his wife. As he was straining to see the scale reading while some fruit was being weighed, it occurred to him that such an audio-output scale would have many advantages. He thought of providing a tape loop, with successive weight announcements, which would make one revolution after each weighing, and would announce only the correct weight. However, a scale with a 10-pound limit that announces weights in 1-ounce increments requires 160 announcements to be recorded on the tape.

To reduce the number of recordings, the en-





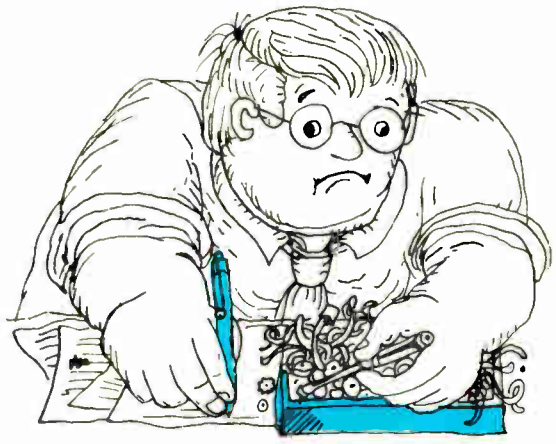
gineer decided to record only 10 successive pound announcements, from "no pounds" up to "nine pounds" inclusive, followed by 16 ounce announcements, beginning with "and no ounces," and continuing through "and 15 ounces." The proper pound and ounce announcements would be registered during each weighing, and the tape would begin moving at high speed. It would slow down only when the two registered announcements came beneath the read head, and only at these two times would the speaker amplifier turn on. After the weights had been announced, the tape loop would continue at high speed to its starting point.

The patent on this device includes two claims:

> "An announcement machine comprising recording means containing thereon a plurality of announcements, readout means for reading out said announcements, means for registering selected ones of said announcements, means for controlling the read-out of said registered announcements at a first speed, and means for controlling the read-out of the others of said announcements at a second speed.
>
> "An announcement machine comprising recording means containing thereon a plurality of announcements, read-out means for reading out all of said announcements during each operation of said announcement machine, means for selectively registering which of said announcements are to be audible, and means for rendering audible only the registered announcements."

Neither of these claims is limited to scales. The first claim broadly covers a two-speed machine that moves at one of these speeds while reading certain registered announcements from a recording, and at the other speed while reading the other announcements. It says nothing about the speaker system through which the announcements are read. The second claim covers a system that reads all announcements on a recording during each cycle, but that renders audible only registered announcements. It ignores the speeds of these readings.

The claims, on their face, certainly provide broad protection—especially since they are not limited either to tape loops or scales—despite the fact that the actual system built was in a particular field and was relatively simple.



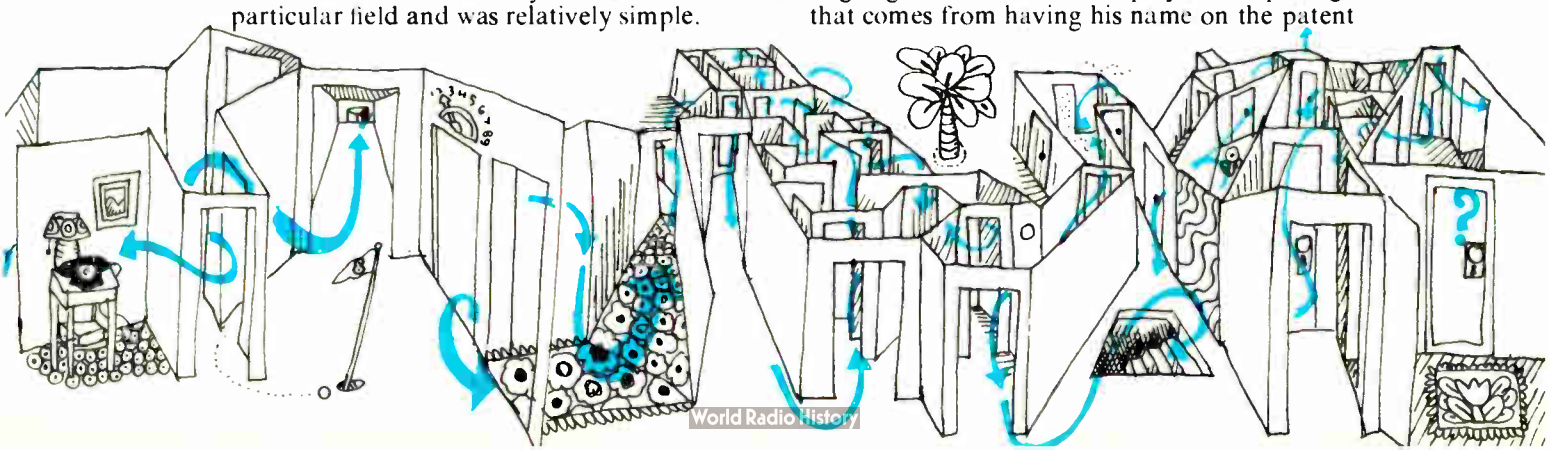
It isn't just the individual inventor who applies for a patent in the hopes of striking it rich. Nor is it just the newer and smaller company, for whom a strong patent may be the only way to protect a proprietary product and to establish its position in an emerging technology.

Why patents?

Many large companies, who do not generally assert patents against each other or against their smaller competitors, are often the most patent-conscious—they file dozens of patent applications each year. A company which is in a position to assert many patents against a competitor is often left alone when it uses a particular one of the competitor's inventions. Frequently, large companies exchange royalty-free cross-licenses so that each can utilize the inventions of the other. The stronger a company's patent portfolio, the stronger its bargaining position.

The classic example of the need for cross-licenses is that of Fleming and DeForest, inventors of the diode and triode respectively. DeForest could not manufacture triodes because each triode had a cathode and a plate, and necessarily infringed Fleming's diode patent. Fleming, while he could make diodes, could not add a grid to his diodes: that would make them triodes, which would have infringed DeForest's patent. By cross-licensing each other, they were both in the triode business.

Even if he's employed by a large company, however, the individual engineer plays an important part in securing a patent. (And even if he has assigned any direct pecuniary benefit he might get from it to his employer, the prestige that comes from having his name on the patent



Broad-claim systems

Integrated-circuit chip tester
Light pen
System which "learns" certain data patterns during a learning interval and thereafter monitors incoming data to detect deviations from the previously learned patterns
Optical character reader
System for ehectronically converting black-and-white films to color films
Time and/or frequency division multiplexer
Data processor with priority-interrupt structure
Data processor with microprograming features
Data processor with store and fetch protection
System for computing fast Fourier transforms
Data processor with cache or virtual memory
Vertical, longitudinal redundancy check characters

often earns salary raises and promotions.)

The engineer's role

In patent affairs, record-keeping is perhaps the engineer's most important contribution. A summary of each chronologically important development, experiment, theoretical analysis, and other landmarks of a project should be entered in a laboratory notebook—preferably a bound book with pre-numbered pages, successive pages of which are "witnessed and understood," and dated, by coworkers who are not co-inventors.

This industry standard practice is not arbitrary. Often, engineers of different companies make the same invention, and file patent applications, at about the same time. In such a case, the Patent Office sets up an interference proceeding by which a patent is awarded to the first inventor. Determining who was first depends on establishing the date the invention was first thought of, and the dates on which it was built and tested. Diligence in building and testing the invention following conception is also a factor in interference proceedings; because laboratory notebook entries can show diligence, the engineer should not limit them solely to the initial conception and final testing of the invention.

Laboratory notebook entries can also be important if the Patent Office rejects an application. When the Patent Office's rejection is based on the ground that the claimed invention is old or is at least obvious in view of the prior art, the inventor can overcome the rejection by demonstrating that the invention was actually made before the date of the prior art.

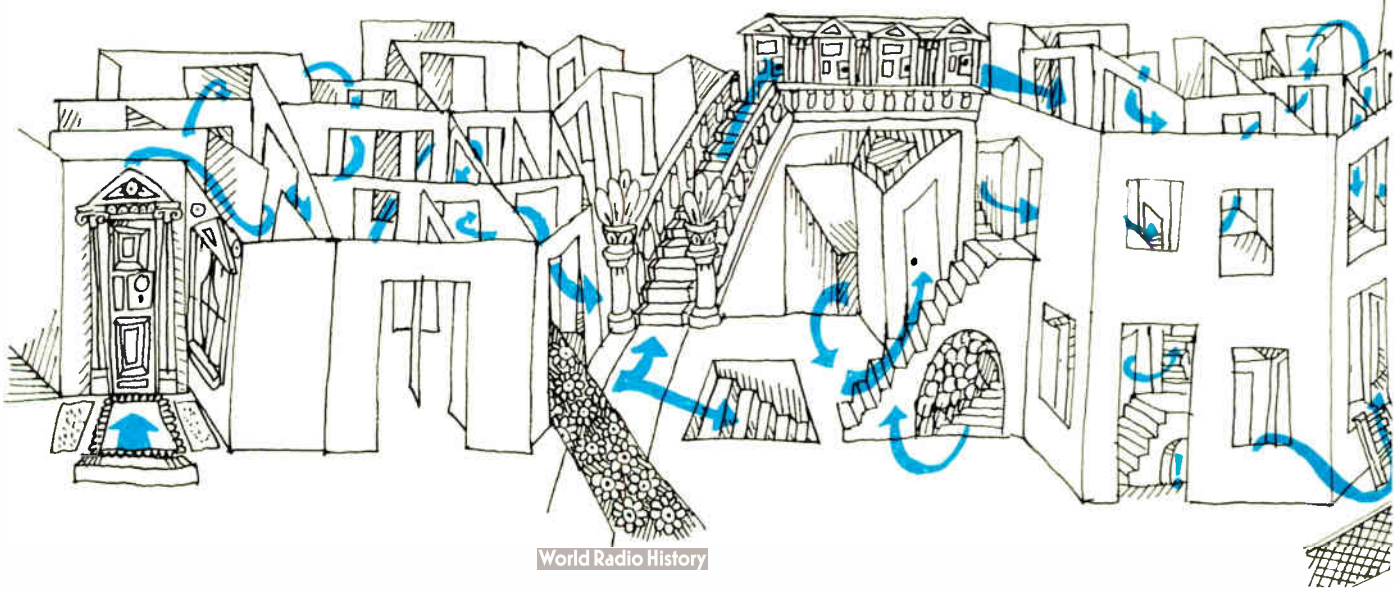
The engineer also is usually most aware of the first commercial use or publication of his invention, and he is responsible for preventing his attorney from making what could be a very expensive mistake. For if a patent application is not filed within one year of the first commercial use of the invention—including an offer for sale—or the first publication of the invention, any patent issued on the application will be invalid. Furthermore, if the patent was procured fraudulently by withholding use and publication information from the Patent Office, and is then asserted against an alleged infringer, not only will the court hold the patent invalid but in all likelihood it will also award attorney fees to the alleged infringer.

The need for precision

One of the engineer's primary roles vis-á-vis the patent attorney is to advise him of the nature of the invention. The attorney must fully understand what the invention really is, not only the details of a specific embodiment of it. This understanding, which is crucial, allows the attorney to characterize the invention properly, attributing to it the advantages that it has without any unnecessary exaggeration. When the Patent Office examiner rejects excessively broad claims, it is often difficult to argue that some specific arrangement or feature is patentable. As a matter of advocacy, accurately describing the prior art in the application is far better; then, in an offensive posture, the application can claim invention in the feature or features that are really new.

The engineer also must provide the patent attorney with the best embodiment of the invention, since the patent statute requires that this be disclosed in the application. Some patents contain a defect that may be fatal—the systems which are disclosed are not even operative. This is especially true in a block-diagram case—prepared expressly for the purposes of a patent application—in which one block or function is omitted. If this renders the disclosed system inoperative, the patent will often be held invalid.

For example, consider the disclosure of a priority interrupt structure in a data processor. Such a structure



typically requires a way to store a base address in a register when an interrupt occurs, to call in a new program. Yet in preparing the block diagram drawing, directed primarily to what the engineer feels are more important aspects of the invention, the "initialization" detail might be inadvertently omitted. The engineer is less likely than his attorney to omit such a detail; therefore, he should constantly bear operativeness in mind when working with his attorney.

While processing the application, the patent examiner cites prior art as the basis for rejecting some or all of the claims. Very often the attorney will ask the inventor to review the prior art and to distinguish his invention from it. The inventor should, of course, work with the attorney in amending the claims so they do not describe the prior art, while at the same time insuring that the broadest protection yet available is secured.

When a patent gets into litigation, an engineer may find himself devoting a considerable portion of his time to helping the lawyer. When aiding the plaintiff, the engineer may be called upon to analyze both the defendant's infringing product and the prior art cited as defense by the defendant. Or when aiding the defendant, the engineer may spend weeks reviewing old periodicals and texts, looking for prior art that invalidates the plaintiff's patent.

The important point is that both in litigation and in normal Patent Office proceedings, it does not matter whether the inventor actually knew of the prior art which is alleged to anticipate the invention. Knowledge of the prior art is irrebuttably presumed as long as it was publicly available somewhere. If prior art is uncovered showing that the claimed invention was used or published more than one year before the application was filed or making the invention obvious in view of it, then the patent is invalid even if the inventor was totally unaware of the earlier work.

Some bad luck just cannot be avoided. In general, however, engineers can do a lot to improve the chances of their patent applications, and the protection these afford to their companies, if they will take the trouble to understand the principles on which patent law is based. Patent matters cannot be left entirely to the attorney—the engineer's knowledge and experience are almost as vital to the protection of his design as they are to its conception in the first place. □

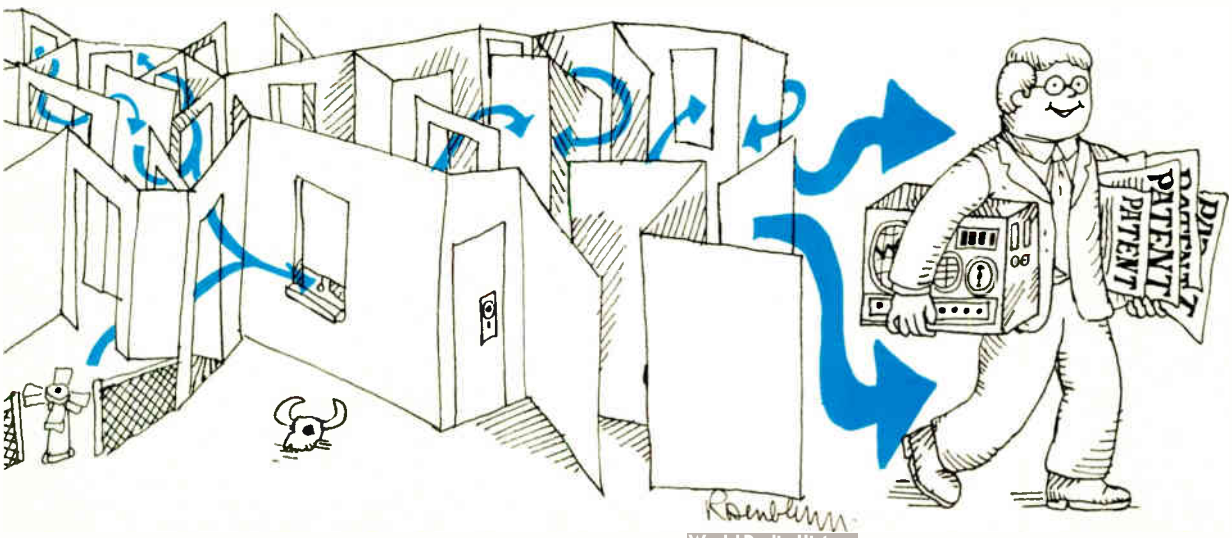
The position on software patents

The controversy over the patentability of software is now before the Supreme Court. Since the early 1960s, the Patent Office has been opposed to it, on the grounds that it would be improper to grant protection to the "mental steps" of a program, and that the search procedures for processing program applications would be too burdensome. But the Court of Customs and Patent Appeals has consistently overruled the office. In about a half-dozen cases, this court has held that methods or processes carried out by a computer can be patented provided that, as in other inventions, they are new and unobvious. The claims usually cover the steps of a method, rather than a combination of elements. Consequently, the Patent Office is now in the process of asking the Supreme Court to review and reverse one of the court's decisions.

What is most disturbing about the Patent Office's position is that it is not clear where to draw the line distinguishing hardware from software. In fact, before the present spate of CCPA decisions allowed them to be more forthright, patent attorneys often prepared block diagrams of special-purpose machines which executed the steps of a computer program. And they were quite successful, because the Patent Office could not determine whether the invention was made by an engineer or a programer—i.e. whether the disclosed machine was real or created just for that patent application.

But more important than the stratagems of lawyers is the fundamental question of how the Supreme Court can possibly differentiate between hardware and software.

The distinction in terms of function is difficult even for engineers to make. The term "firmware" was coined because microprograming fell between the two categories. Trade-offs between hardware and software are constantly made in the design process. A hardware design can be simulated by software. If the boundary between the two wavers even for those most familiar with them, the difficulties and dangers in having jurists draft an applicable legal definition are obviously great. The decisions of the Court of Customs and Patent Appeals thus far are logical and consistent; it is to be hoped that they will remain the law.



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Data General, the world's number 2 minicomputer company, is in the peripheral business.

We've just introduced a new line of compact, fixed-head discs – the Novadiscs.

They're the ruggedest, most reliable mini discs on the market.

When we designed the Novadiscs, we recognized that the critical requirement – beyond price, speed, size, and capacity – was reliability.

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We built reliability right into the guts of the Novadiscs.

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When they're not flying, the heads are secured, outside the disc pack cylinder. So you don't risk a crash every time you move the unit across the room – or across the country.

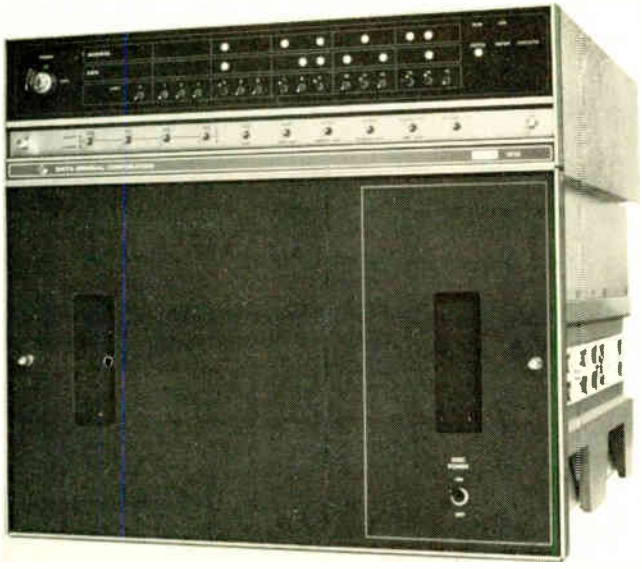
The Novadisc recording medium is an industry-standard, 10-surface disc pack. The motor, drive spindle, drive belt, and air filters are the same ones used on big, mass-produced disc drives.

Some of those parts are over-engineered for our requirements. They're also a lot less expensive and more reliable than anything else on the market.

Of course, the Novadiscs have all the other right specs, too.

Price. A Novadisc with storage capacity of 128K 16-bit words costs $5,200,

ROUND 1: A NEW DISC WITH GUTS.



256K is $6,750, 512K is $9,250, and the 768K Novadisc costs $12,560. Quantity discounts are available.

Size. Including power supply, the Novadiscs are only 12¼ inches high in a 19-inch rack.

Speed. Average latency time is 8.4 milliseconds, and data transfer rate is 2 million bits per second.

Software. Novadiscs are compatible with our device-independent Disc Operating System, which handles user I/O and provides interrupt-driven buffered service for peripherals.

DOS in turn supports a relocatable assembler, editor, linking loader, Extended ALGOL, Extended FORTRAN, and Extended Timesharing BASIC.

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In the last three years, we've shipped over 2,500 Nova-line minicomputers and systems.

We've made a reputation for making some pretty pushy claims – and for living up to them.

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Circle 125 on reader service card

No physical checkup required.

You might well assume that a very small (19.7 cubic inches) and very inexpensive ($95 in 100's) DPM would soon fall prey to some dread disease. Like heat prostration, or severe irregularity. Even cardiac arrest.

We worried about reliability beginning in the design phase. For example we reduced the number of components in this AN2532 self-powered meter, which cut down the power requirement and the heat dissipation and did wonders for MTBF. We isolated the analog return from the digital return with true differential inputs. We made the converter immune to line transients. We did a lot of other things to design reliability into it.

Then came vibration tests, 3-day burn-ins, baking, and computer-controlled testing of every performance specification. We did these things because we are pretty sure you care more about reliability than the latest development in the DPM size-price war.

Sample specifications of the AN2532 line-powered meter
Accuracy 0.05%
Stability 50ppm/°C
Bipolar, floating differential inputs
Input impedance 1000 megohms min.
Power requirement 3.5 watts
BCD output standard
Separate analog and digital grounds
Dimensions: 2"h x 3.5"w x 2.8"d (mounting surfaces)

There's a lot more to it, of course, and other meters to choose from. So send for complete specifications and our helpful 28-page booklet explaining the theory, operation, and applications of DPM's in general. Very little hard sell. Analogic Corp., Wakefield, Mass. 01880, (617) 246-0300, manufacturers of the largest line of DPM's in the world.

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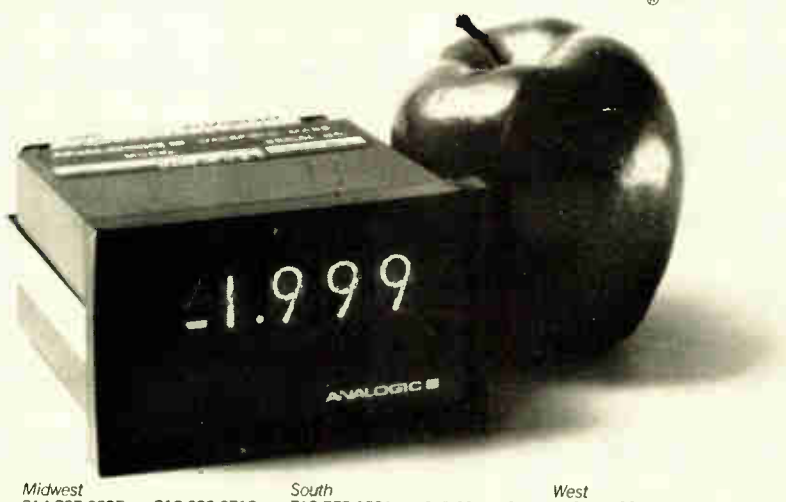

Northeast	Mid Atlantic	Midwest		South		West		Canada
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203-966-2580	212-947-0379	216-267-0445	913-648-4173	817-268-3505	404 351-3654	505-523-0601	408-374-5220	604-688-2619
315-446-0220	215 272-1444	513-434-7500	412-892-2953	305-647 3498	803-576-7462	602-946-4215	206 762-7664	416-444-9111
	301-587-3910	313-892-2500		305-622-8770		505-296-8303	503-646-6064	514-861-1375

Low-cost IC timer handles a lot of jobs

by Hans R. Camenzind
Interdesign Inc., Sunnyvale, Calif.

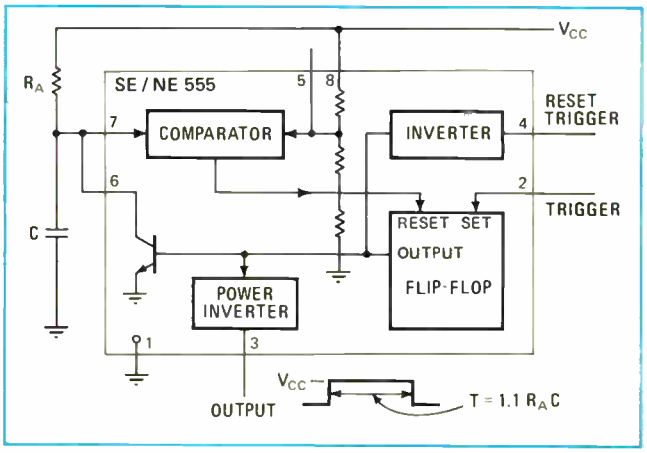
If you're in the market for a low-cost compact timer, try a new commercial integrated circuit—you may like it. This adaptable IC, internally compensated for component tolerances and temperature drifts, requires only an external resistor and capacitor for time delays ranging from a microsecond to an hour with maximum deviation of only 1%.

Designed by Interdesign Inc., the IC is available from Signetics Corp., in either an 8-pin plastic package (NE555) or an 8-pin metal package (SE555). The plastic version costs 75¢ in quantities of 100 and has a timing accuracy within 5%. The temperature coefficient of both circuits is typically only 25 ppm/°C.

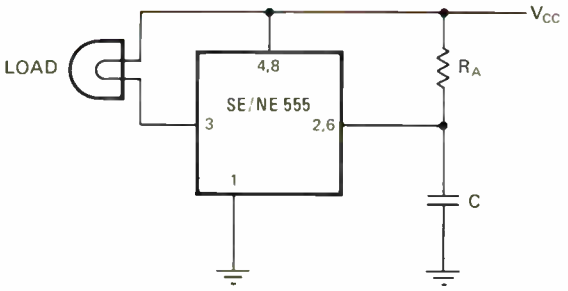
In addition to one-shot timing chores, the IC can be converted simply into a free-running pulse generator. The IC can be used for simple time delay, missing-pulse detection, frequency-division, pulse-width and pulse-position modulation, and test sequencing.

The output of the IC can supply about 200 milliamperes to a load, which can be connected either to V_{CC} or ground. This is achieved by using two high-current transistors in a inverting output stage, which allows the load to be connected for either normally on or normally off operations. At load currents less than 50 ma, the IC delivers a pulse with a maximum rise and fall time of 50 nanoseconds at any time setting, and the voltage levels are TTL-compatible.

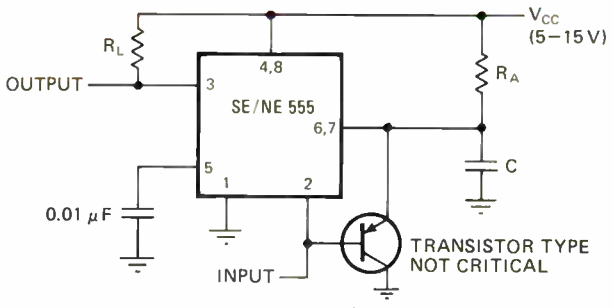
When connected as a one-shot the timing cycle of the IC starts when the trigger voltage drops below $1/3V_{CC}$



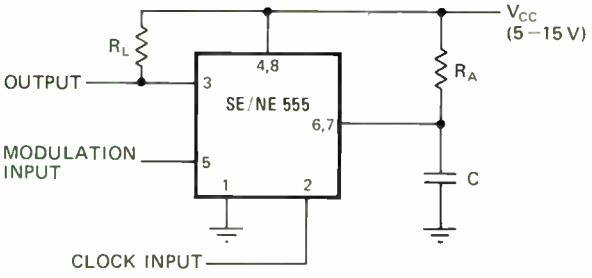
Functional diagram shows setup for one-shot operation; adding another resistor between pins 6 and 7 makes it astable.



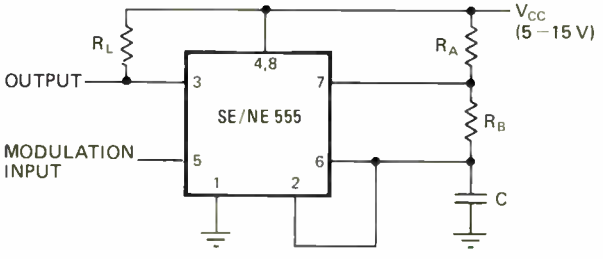
(a) BASIC TIMER. Circuit provides an initial time delay in which the lamp will turn on 1.1 $R_A C$ seconds after the supply voltage is applied. Circuit resets every time the power is turned off.



(b) MISSING PULSE DETECTOR. A change in frequency or a missing pulse shifts the output level. For proper operation, the time delay should be slightly longer than one expected pulse spacing.



(c) PULSE-WIDTH MODULATOR. Modulating the control voltage terminal (pin 5) and triggering the timer with a continuous pulse train produces an output of different pulse widths.



(d) PULSE-POSITION MODULATOR. With the modulating signal applied to the control voltage terminal and the timer free-running, the output pulse positions can be varied depending on the modulating signal.

and continues undisturbed, even if the circuit is triggered repeatedly. This eliminates contact bounce or can serve as a pulse stretcher.

Initially, the external capacitor is discharged by the transistor from pin 6 to ground. The negative trigger sets the flip-flop output to zero, which removes the short-circuit from across the capacitor and raises the IC output (pin 3) to V_{CC}. The capacitor then starts charging toward V_{CC} at a rate proportional to the time constant established by R_AC. The cycle ends when the capacitor is charged to $2/3V_{CC}$. The time that the IC remains in the high state is given by: $T = 1.1R_AC$.

The circuit incorporates a high-input impedance comparator so that large timing resistors (several megohms) can be used. The comparator is referenced to $2/3V_{CC}$ by three resistors of equal value. When the voltage across the external timing capacitor reaches this level, the flip-flop is reset, and the capacitor is discharged. The IC output level is then in the low state.

Both the charging current and the end-of-cycle voltage ($2/3V_{CC}$) are proportional to the supply voltage, which makes the timing accuracy independent of that voltage. The circuit operates from 4.5 V to 15 V, with less than 1% long-term drift in timing accuracy.

Timing can be adjusted in any of three different ways: resistor R_A provides a four-decade range; capacitor C offers more than an eight-decade coverage, and applying an external control voltage to terminal 5 produces a 3:1 timing variation. This terminal also provides an ideal point in which to add filtering to reduce noise on the supply-voltage line.

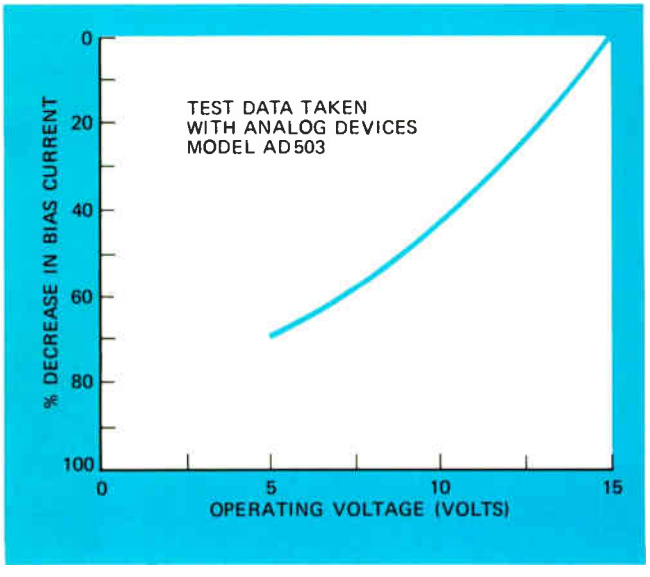
The basic one-shot circuit is easily triggered manually by a switch that connects the trigger input (pin 2) to ground to initiate the timing cycle. For example, using a 10-microfarad capacitor and a 91-kilohm fixed resistor in series with a 5-megohm variable resistor can provide preset timing from a second to an hour.

In addition to monostable operation, the IC timer can be made to trigger itself and free-run. An extra terminal (pin 6) is provided so that a second resistor (R_B) can be used to help set the duty cycle. The timing capacitor charges through both resistors, but discharges only through R_B. The total period, $T = 1.46/(R_A+2R_B)C$, is the sum of the charge time (output high), $0.685(R_A+R_B)C$, and discharge time (output low), $0.685R_BC$. The duty cycle, however depends only on the timing resistors: it is the ratio of either the charge or discharge time to the sum of both.

A quite different triggering mode is possible by connecting pin 4 and pin 2 (trigger input). In this arrangement, the timer is reset each time a trigger pulse is present, and the output will only go low if the circuit is not retriggered within the set time. Such a configuration could be used as a missing-pulse detector or a pulse-width discriminator. Other applications requiring any sort of a timing cycle can be easily accommodated by the IC timer. Frequency dividers, pulse-position modulators, and pulse generators with a frequency from 0.00001 hertz to 500 kHz and a duty cycle from 0.1% to 50% are possible. □

Reducing IC FET op amp input bias currents

by Richard G. Jewell
Nova Devices Inc., Wilmington, Mass.



Trading larger output-voltage swings for lower input bias currents

Adding a simple heat sink or operating at reduced voltage can significantly improve a field-effect transistor operational amplifier's input bias current over what the spec sheet says. Actually, both methods merely reduce the IC's junction temperature, but this is of great importance since FET input bias current doubles with every 10°C rise in temperature.

Either method of reducing the temperature requires the user to sacrifice very little. A heat sink isn't very expensive, if there's room for it; lowering the operating voltage has only a small effect on such parameters as input offset, slew rate, and gain. However, the maximum output-voltage swing will be limited to the operating voltage chosen.

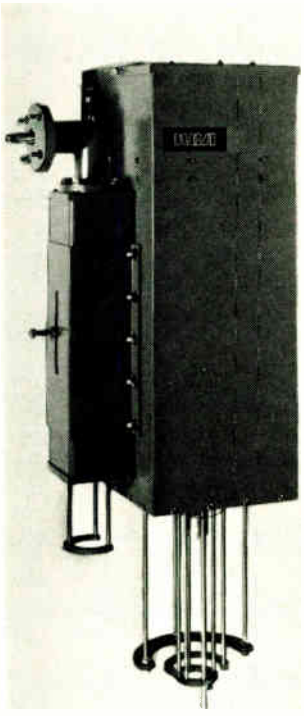
Using a Wakefield model 209 or an equivalent heat sink can reduce the warmed-up bias current of an AD503 by 60%, typically to 1 picoampere. The model 205 reduces the bias current by 40%, and the model 204 provides a 10% decrease. Or reducing the operating voltage to ±5 volts would drop the AD503's warmed-up bias current by as much as 70%—to about 0.75 pA.

Although both methods can be used simultaneously to obtain subpicoampere bias currents, there is a practical lower limit of about 0.5 pA because of the finite leakage inherent in the IC's glass header. □

Engineer's Notebook is a regular feature in Electronics. We invite readers to submit original and unpublished design, applications, and measurement ideas.

Off the Shelf

RCA RF Tubes/Cavities for VHF/UHF Translator/ Transposer Service world-wide.



Y1246

Y1222

Y1167

Y1257*

From 100 W to 1 kW. For VHF and UHF. That's RCA's range of RF tubes and cavities for translator/transposer service — world-wide!

From RCA the leading U.S. supplier of these combinations, you get as much as a 4-to-1 savings in plate dissipation. All the audio/visual RF circuitry is provided in each tube/cavity combination, and it can be tuned to any band now allocated to TV service anywhere in the world.

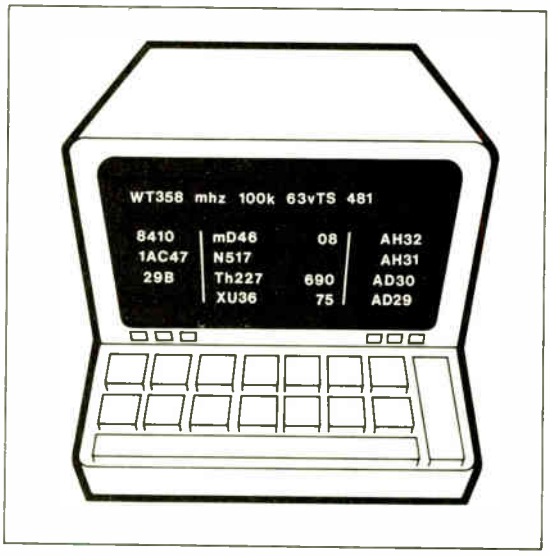
Ask your RCA Representative about the attractive costs and special advantages of RCA tube/cavity combinations. For more information, write: RCA, Power Tube Marketing, Section 70E8 /ZR7, Lancaster, Pa. 17064. International: RCA, 2-4 rue du Lièvre, 1227 Geneva, Switzerland, or Sunbury-on-Thames, U.K., or P.O. Box 112, Hong Kong. In Canada: RCA Limited, Ste. Anne de Bellevue 810, Quebec.

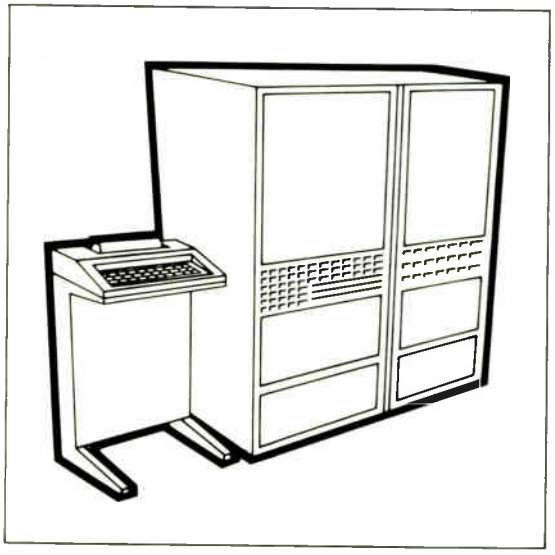
Tube/-Cavity	Peak of Sync	Gain (Typ.)	Linearity (Typ.)
8122/Y1222	100 W VHF	15 dB	-52 dB
8792/Y1167	1 kW VHF	12 dB	-50 dB
4628/Y1246	1 kW UHF	12 dB	-52 dB
8226/Y1257*	100 W UHF	12 dB	-52 dB

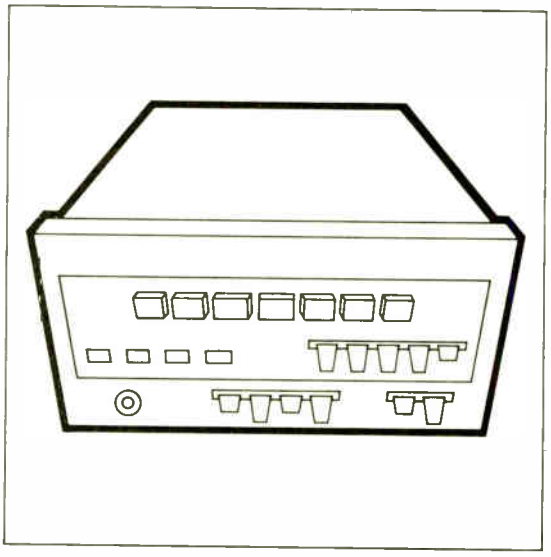
*Objective

RCA

MOS Memories







The FIRST source for standard RAM's is AMI. Production quantities of the following are available at prices that are hard to beat, try us.

Description	Model #	Replaces
1024 x 1, 500 nsec	S4008	MK4008
1024 x 1, 400 nsec	S4006	MK4006
1024 x 1, 300 nsec	S2103	1103
1024 x 1, 150 nsec	S3103	1103-1
1024 x 1, 100 nsec	S5103	

COMING — 512 x 4, 4096 x 1, and 1024 x 4

Whatever your memory requirements, from scratch pads to main frames, contact AMI. The company that shipped over 1 billion bits of memory in 1971.

Send today for current specifications, price list and memory application work sheet.

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Engineer's newsletter

CAD programs optimize designs

Don't toss out the soldering iron and lab oscilloscope just yet, but computer-aided-design programs are coming closer to validating the cliché about the computer's eliminating the circuit breadboard. **New programs, such as Optinet, Magic, and Recal II, all have optimization features.** You specify a certain characteristic to be maximized or minimized, give the computer weighting factors for the various circuit parameters, and you get the design that comes the closest to the desired performance. The operating cost is coming down because language has been simplified and computer time is used more efficiently.

Custom connectors come in 5 modules

Another do-it-yourself kit: Amphenol Industrial division of Bunker Ramo is ready to announce a set of connector insert modules for a 57-series shell size that will allow you to assemble your own customized rack-and-panel connectors. For lab use and small production runs, you could find it a lot cheaper and faster than entering into custom-design programs. **The shell holds five modules, and five different modules will be available from distributors:** a blank, a shielded coax or size 12 contact, four size 16 contacts, eight size 20 contacts, and 21 size 24 contacts.

What happened to the nanofarad?

We get letters: "Let's hear it for the nanofarad," writes Brock Dew of MIT's Charles Stark Draper Labs. He points out that nanosecond and nanoampere have come into common use, but not nanofarad. **Using nF would avoid keeping track of leading and trailing zeros such as in 0.001 μF and 2,700 pF.** About the only reason we can think of for the nF lag is that in most cases the numerical value itself suggests whether it's μF or pF and thus is more convenient. What's your opinion?

Effort was worth it, say IBM authors

Why don't engineers write more about their work? According to a survey of IBM professionals taken by IBM's Mason Southworth, about **two-thirds of the survey respondents who had never written an article or delivered a conference paper cited lack of time or motivation.** On the other hand, Southworth, reporting at the March IEEE show, pointed out that about **80% of the respondents who had written said it was indeed worth the effort.** They said it made them better known inside and outside the company, it opened up new lines of communication with other professionals working on similar projects, or forced them to analyze their projects closely in order to write about them.

Addenda

If you're planning to use batteries in portable equipment, **watch out for differences in physical size.** Designers at Keithley Instruments have found that D-cells of nickel-cadmium, alkaline, and zinc-carbon vary considerably. This could be critical, especially in large series stacks. For a new multimeter that will accommodate any of the types, Keithley engineers laid out six D-cells in three stacks of two each. . . . Motorola Semiconductor Products, 5005 E. McDowell Rd., Phoenix, Ariz. 85008, has put together a comprehensive book on beam leads. **It covers such aspects as thermal capabilities, reliability, and bonding.** You can get a copy by writing to Paul White, of beam-lead marketing.

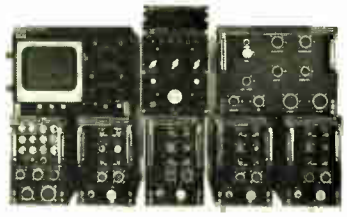
A Complete 40 MHz to 40 GHz DIRECTION-FINDING ANTENNA SYSTEM

ANTENNA AND PEDESTAL

All the equipment you'll need for fast threat analysis and identification is here: . . . antenna . . . pedestal . . . antenna control and amplifier . . . receiver . . . displays. Available in a versatile modular configuration, this multi-service D.F. system consists of rugged, field-proven equipment for air-borne, shipboard or ground usage.

The 40 MHz to 40 GHz frequency range is covered by three distinct antenna and receiver combinations:

Frequency	Antenna	Receiver
40 to 550 MHz	L4/A	RS-160
550 MHz to 12.4 GHz	L3/A	WJ-1140
12 GHz to 40 GHz	L5/A	WJ-1140



W-J 1140 RECEIVER

INDICATOR CONTROL ASSEMBLY

Frequency or spectrum coverage can be computer programmed by synchronizing the antenna spin rate and the receiver sweep rate.

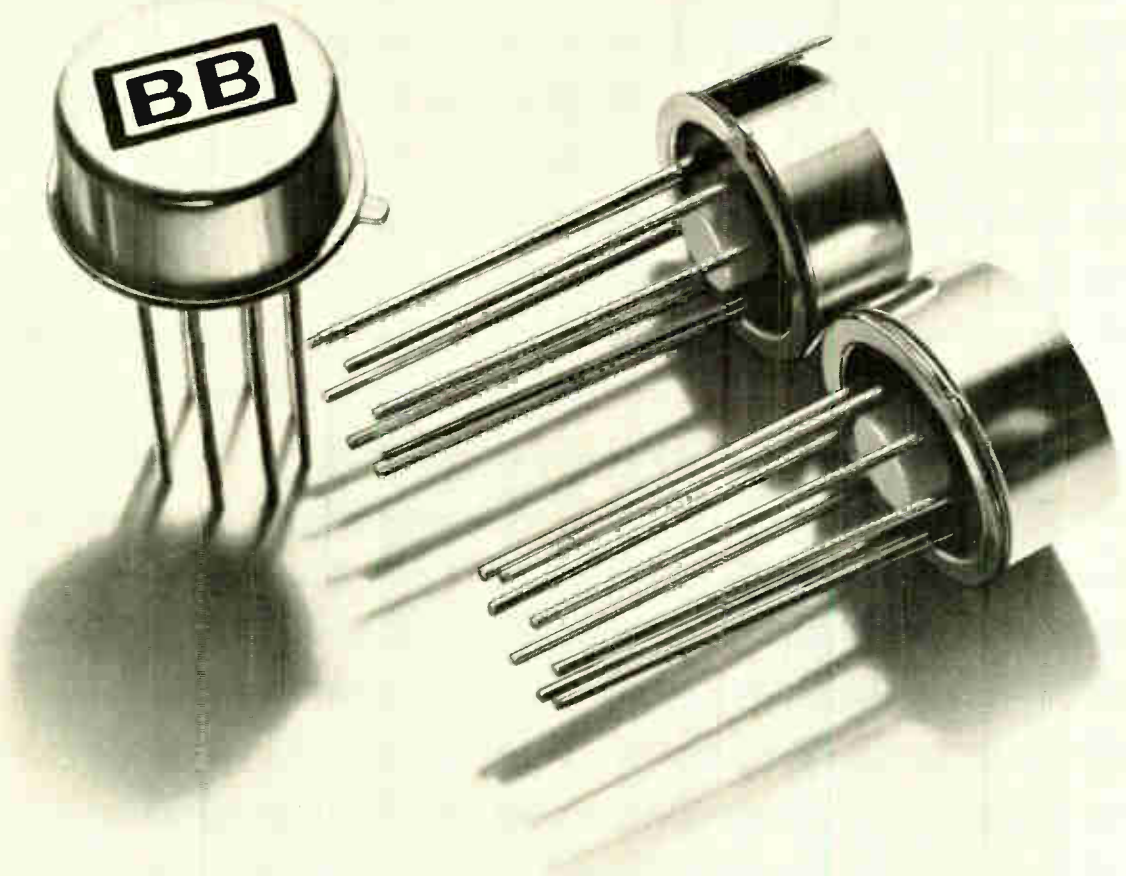
If desired, the antenna can be manually slewed in azimuth to any position, and the receiver can be manually tuned across the spectrum. System analysis capability may be expanded through the use of optional equipment, including RF spectrum displays, IF pan displays, and time base analysis displays. Computer interfacing and software programs are also available.

By merging the antenna system and the receiver into a single integrated package, Watkins-Johnson solves a critical interface problem. May we do the same for you?

WATKINS-JOHNSON

3333 HILLVIEW AVE., STANFORD INDUSTRIAL PARK, PALO ALTO, CALIF. 94304 (415) 493-4141

These new IC op amps have the lowest drift yet!



1μV/°C, in solo or duet!

Now you have a monolithic op amp that has a maximum voltage drift of just 1μV/°C **with no external compensation.** What's more, this performance is also available in drift-matched pairs, computer-matched to obtain 1μV/°C tracking.

As good as it is, low voltage drift isn't the only outstanding feature of these Burr-Brown units. Offset voltage is just 500μV, maximum (200μV for matched pair), without external trimming. In addition, they have extremely low noise, low bias current over temperature and common mode voltage ranges, high input impedance, and are internally current limited to provide short circuit protection.

Designed for low input current while maintaining a respectable slew rate (1.0V/μsec) and bandwidth (1.5MHz), the 3500E (single) and 3500MP (matched pair) are ideal for a wide variety of applications. Burr-Brown quality is assured since all units are 100% tested to all min/max specifications including voltage and current drift vs. temperature.

HIGHLIGHT SPECIFICATIONS

	3500E	3500MP (matched pair)
Voltage Drift	1.0μV/°C, max.	1.0μV/°C. max. (Tracking) 5.0μV/°C. max. (Each unit)
Input Offset Voltage	±500μV, max.	±200μV, max. (Match)
Open Loop Gain	100dB, min.	100dB, min.
Input Bias Current	±50nA, max.	±50nA, max.
Slew Rate	1.0V/μsec, min.	1.0V/μsec, min.
Price, 1-24	$30.00 each	$25.00 per pair

For complete technical information and applications suggestions, use this publication's reader service card or contact your Burr-Brown Representative.

NEW BURR-BROWN BOOK
"Operational Amplifiers — Design and Applications", over 470 pages, 300 illustrations. Written by Burr-Brown application-engineering staff, published by McGraw-Hill. U.S. price, 15.00 dollars. **Order from Burr-Brown.**

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Circle 133 on reader service card

How to stuff a lot of hot semiconductors into a small space and not get burned.

We've developed an ingenious new printed circuit board that conducts heat, radiates heat, and offers an effective area for convection of heat to the surrounding air, just like heat sinks and dissipators do.

So now you can mount concentrations of heat-producing devices directly on our new circuit board and save the space, weight, and cost of heat sinks, heat dissipators, blowers, and conduction planes while you operate your circuit at high power densities and let our circuit board keep junction and case temperatures at safe, comfortable levels.

Simple secret ingredient

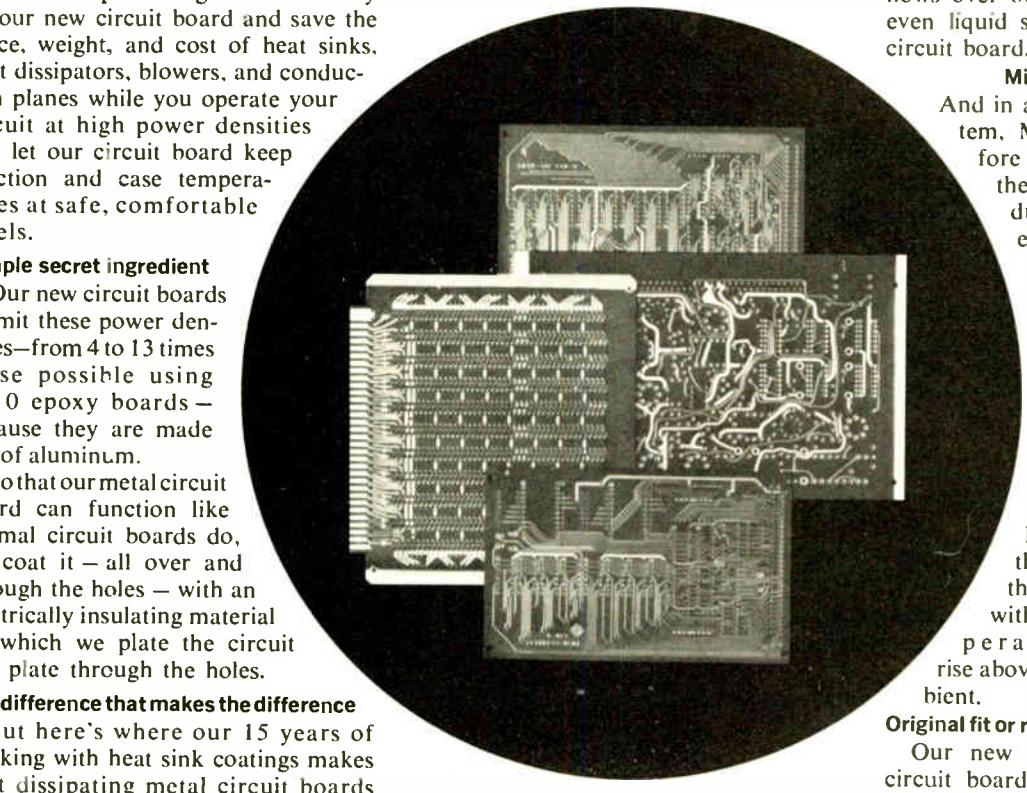
Our new circuit boards permit these power densities—from 4 to 13 times those possible using G-10 epoxy boards—because they are made out of aluminum.

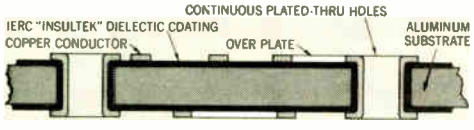
So that our metal circuit board can function like normal circuit boards do, we coat it—all over and through the holes—with an electrically insulating material on which we plate the circuit and plate through the holes.

The difference that makes the difference

But here's where our 15 years of working with heat sink coatings makes heat dissipating metal circuit boards possible. Our exclusive new coating—tough, hard, resistant to solder, solvents and thermal shock, and displaying high dielectric strength plus high surface and insulation resistance—has excellent thermal qualities.

That means you can take one of our circuit boards—called "MCCB" for Metal Core Circuit Board—and put circuitry on it developing four times the power that a circuit on a G-10 board of the same size and weight can handle while both hold case and junction temperatures to the same, safe levels.





CROSS SECTION

When you're hot, you're hot

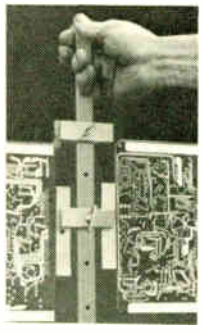
Looking at it the other way, if you're stuck with a hot circuit and you'd like to tuck it away in a nook somewhere, loading it on an MCCB will let you put it in about half the space you could get away with using an epoxy board plus the required heat dissipators and other thermal management devices. And it will weigh about half as much to boot.

But here's where our MCCB really gets unfair to the G-10 competition: You can thermally ground it. And when you do, it will dissipate up to *13 times* the power of a simple epoxy board while maintaining recommended temperatures.

That kind of ratio means you're replacing big blowers moving strong air flows over bulky heat sinks—maybe even liquid systems—with a printed circuit board.

Missing link found

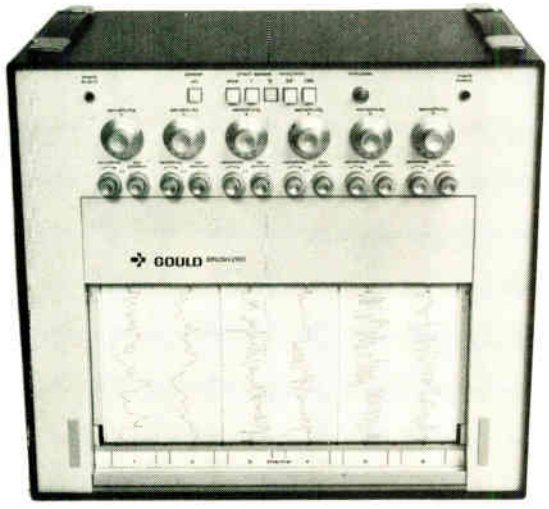
And in a thermally grounded system, MCCB supplies a heretofore nonexistent link between the heat generating semiconductor—or resistor or whatever—and the natural conduction path from metal board retainers through the chassis to the outside world. Another MCCB advantage you won't want to overlook is high conductor current carrying capacity. For instance, a .033" wide conductor printed on our MCCB will carry over three times the current as the same conductor on G-10 with the same conductor temperature rise above ambient.

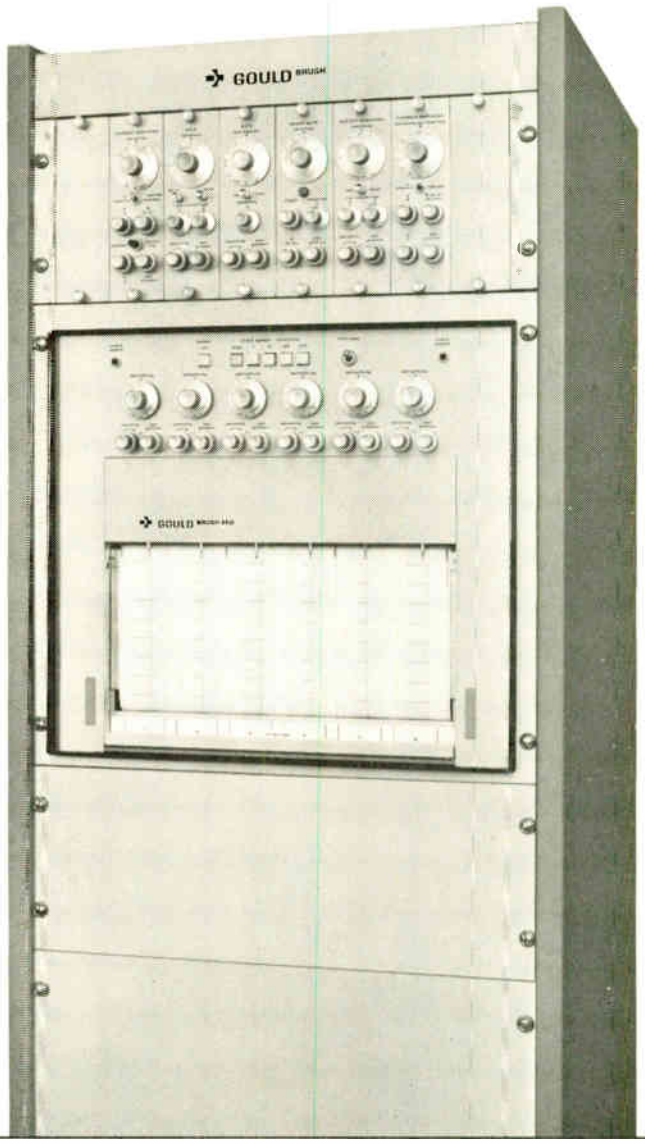


Original fit or retrofit

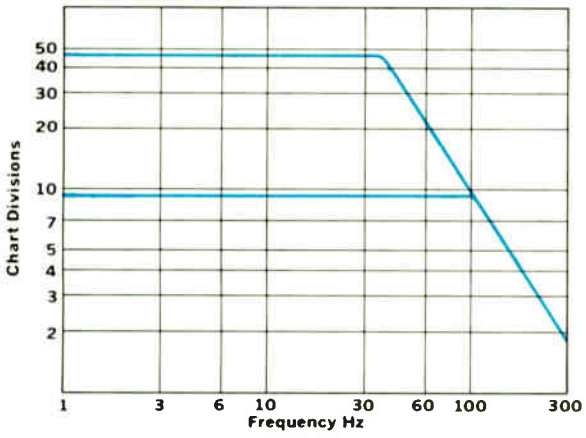
Our new metal circuit boards can revolutionize your next packaging design, and they can clear out hot spots in existing designs as well. Write, phone, or circle for all the details. Or send us your artwork for a quotation. International Electronic Research Corporation, a corporate division of Dynamics Corporation of America, 135 West Magnolia Blvd., Burbank, Calif. 91502. (213) 849-2481.

IERC





FREQUENCY RESPONSE AND AMPLITUDE



The Brush 260 is one of the few bargains left.

Because the Brush 260 6-channel recorder gives you the most accurate, reliable data at the lowest cost per channel.

The 260 also gives you all the important Brush exclusives. Like a pressurized ink system. Which eliminates smudging, puddling, and priming. So traces are always crisp, clear, and uniform. And a throw-away plastic cartridge which holds a year's supply of ink.

Another Brush exclusive is our Metrisite* non-contact servo-loop feedback device. The Metrisite makes the 260 so accurate we guarantee 99½% linearity.

And the 260 has built-in preamps which provide a measurement range from 1mV/div. to 500V full scale. Frequency response for the 260 at 50 divisions is flat within ± 2% of full scale from d-c to 40Hz.

Add in six 40mm analog channels and four event markers. Plus eight pushbutton chart speeds from 1.0 to 125mm/second and mm/min. And you can use the 260 as a portable unit, rack mount it or put it in a roll-around cart.

The Brush 260. It's a good way to get the most for your money. For more information, write: Gould Inc., Instrument Systems Division, 3631 Perkins Avenue, Cleveland, Ohio 44114. Or Rue Van Boeckel 38, Brussels 1140, Belgium.

BRUSH INSTRUMENTS

GOULD

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Call your AO Representative. Or write for our convincing 24-page brochure.

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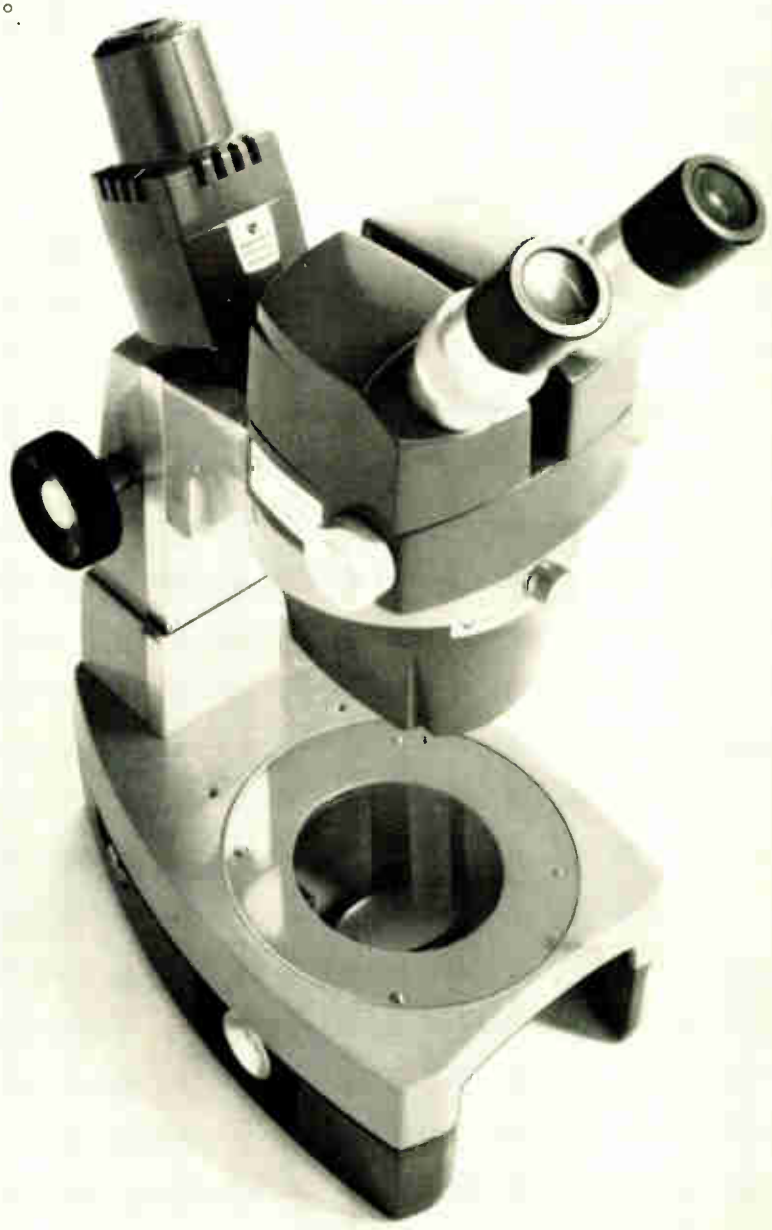
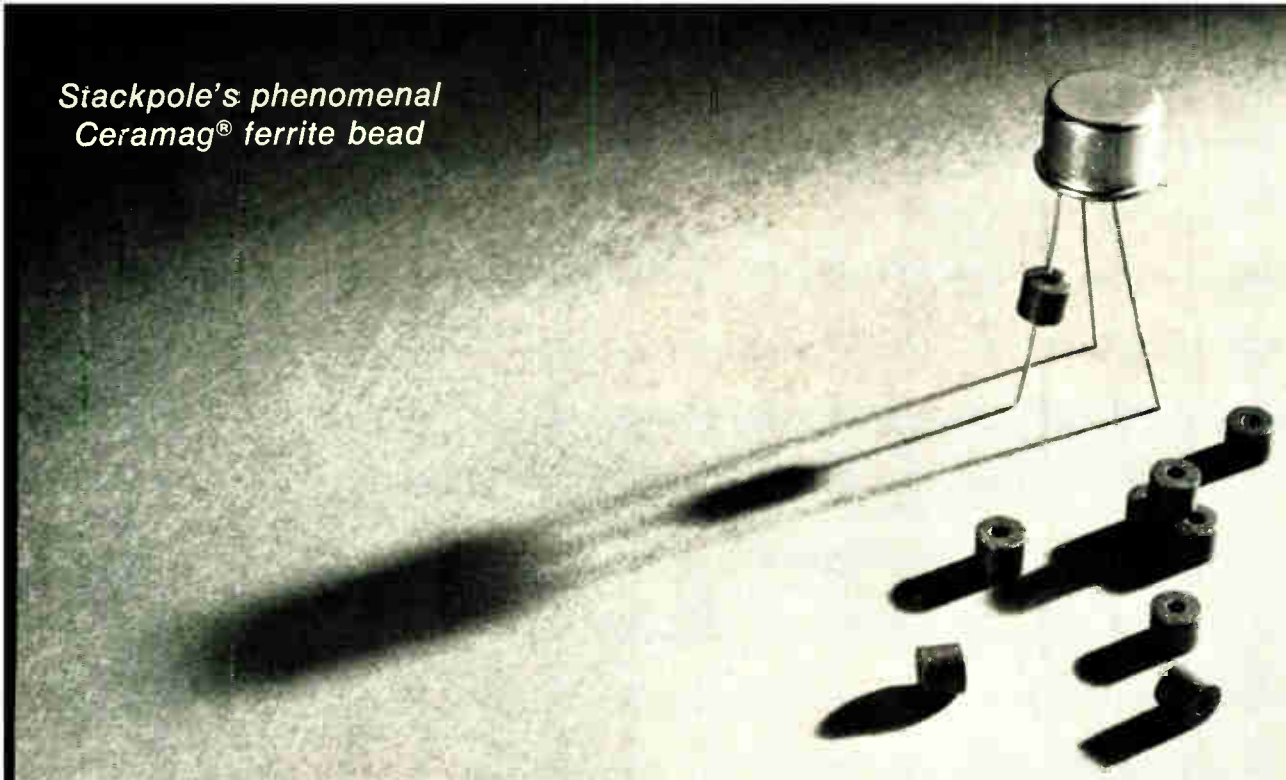


Stackpole's phenomenal Ceramag® ferrite bead

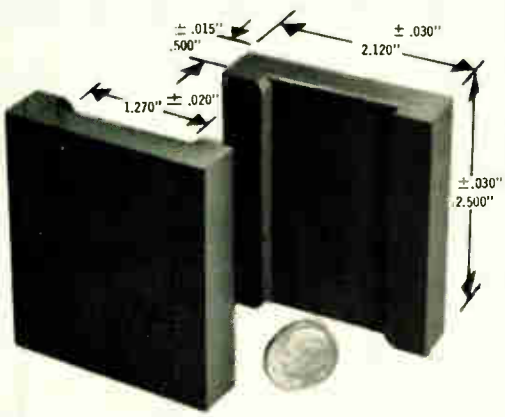


The Silencers

Ceramag® Beads Do Away with Noise

Stackpole ferrite beads offer a simple, yet effective means of suppressing spurious RF signals to prevent them from entering areas susceptible to such "noise." No other filtering method is as inexpensive as a ferrite bead.

How can you use a bead? Consider it as a frequency-sensitive impedance (Z) element. Beads are available in a variety of Stackpole Ceramag® materials. Depending upon the material selected, beads can provide increasing impedances. From 1 MHz to over 200 MHz. Keep in mind, the higher the permeability, the lower the frequency at which the bead becomes effective.



Should a ferrite bead be small? Not necessarily. The unique, giant bead shown below is used by IBM to eliminate the effect of transient noise.

The impedance of Stackpole ferrite beads can be changed by simply varying the length or the O.D.-I.D. ratio.

Installation of Stackpole beads is easy. And inexpensive. Simply slip one (or several) over the appropriate conductor(s) for the desired noise suppression or high frequency isolation.

Additional savings in production time and labor costs are possible by utilizing automatic insertion equipment to install ferrite beads *with leads* in printed circuit boards.

CERAMAG® FERRITE BEAD CHARACTERISTICS

	24	7D	5N	11
Initial Permeability	2500	850	500	125
Volume Resistivity @ 25°C	$1.0x10^2$	$1.4x10^5$	$1.0x10^3$	$2.0x10^7$
Effective Suppression At:	1 MHz.	20 MHz.	50 MHz.	100 MHz.
Curie Temperature	205	140	200	385

Beads are available in sleeve form in a range of sizes starting at .020 I.D., .038 O.D., and .050 long. For special compact filtering applications, beads can be supplied to tight mechanical tolerances.

Sample quantities of beads and beads with leads are available upon request. Send your requirements to: Stackpole Carbon Company, Electronic Components Division, St. Marys, Pa. 15857. Phone: 814-781-8521. TWX: 510-693-4511.

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Free with every Model 132 Function Generator.*

We've always designed Wavetek generators to produce as clean an output as possible. The result is that we've neglected all you guys that need to check a system's capacity to handle noise. Our new Model 132 changes all that because it contains a pseudo-random noise generator. Now you can generate precise, calibrated outputs of digital or analog noise. And you can dial in calibrated signal-to-noise ratios. Naturally, the Model 132 still puts out super-pure sine, square and triangle waveforms–from 0.2Hz to 2MHz. And for just $795, you can also make all the noise you want.

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TELEPHONE (714) 279-2200, TWX 910-335-2007

*(While supply lasts.)

Circle 140 on reader service card

Computer show focuses on peripherals

There won't be as many mainframes on display at the 1972 Spring Joint Computer Conference as there were at previous shows. But visitors to the Convention Hall in Atlantic City May 16-18 will see plenty of peripheral equipment and witness demonstrations of computer applications in a variety of industrial and commercial environments.

"It's like what happened to the steam engine," says a marketing manager. "After the novelty wore off, people became concerned with how to use it." Visitors to the SJCC this year will find a broad range of equipment demonstrating applications and capabilities of computer power, as well as techniques for getting the most out of data processing systems through communications and for enhancing mainframe capabilities. The rapidly growing field of data communications will be one of the principal themes of the exhibition.

In the pages that follow, *Electronics* previews some of the more significant products from around the country that will be on display at 1972 SJCC.

Domain-tip propagation memory goes to market

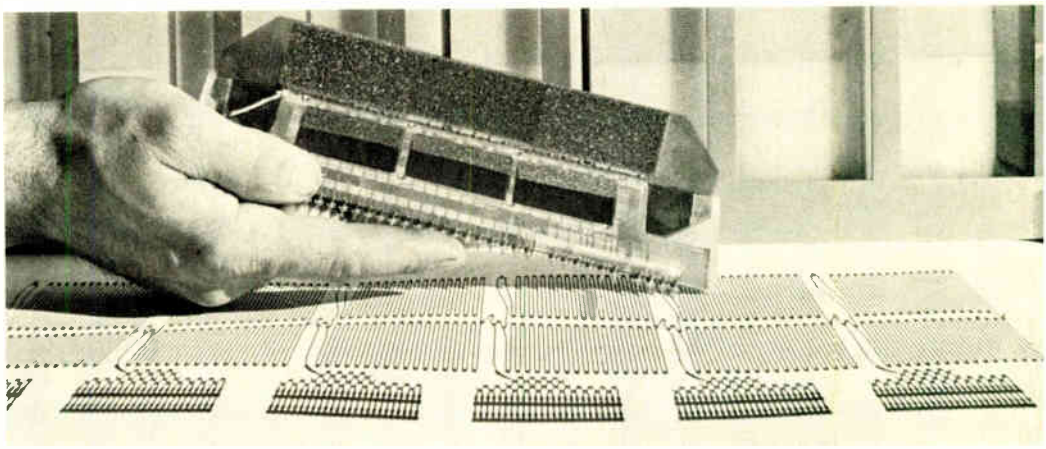
When a new electronic technology is dreamed up, it either makes its way into the commercial world within a year or two, or disappears. But a variation from this pattern is the domain-tip propagation memory, which was first developed some six years ago [*Electronics*, May 2, 1966, p.25, March 20, 1967, p.48], but is only now emerging as the technology behind two new products that will be introduced at SJCC.

The products are the DOTram-4 and the DOTram-16, both block-oriented random-access memories developed by Cambridge Memories Inc. The model 4, designed for terminals and peripheral equipment, can be thought of as a four-bit-by-16,384-word memory, although the word length can be as long as 36 bits, and the total storage capacity can range from 40,000 to 320,000 bits. The model 16 is intended to be a replacement for magnetic disk and drum storage units; basically it is a 16-bit-by-65,536-word memory, although again the word length can be eight to 36 bits and the total storage capacity can range from 65,000 to 16 million bits—and perhaps later it will be possible to increase capacity up to 128 million.

A block-oriented random-access memory (Boram) is one in which the beginning of any block of data can be addressed independently of every other block, but in which data in successive locations in the block can be obtained rapidly after the beginning has been located. In both DOTram models, any block is accessible in a maximum of 1 microsecond, and once started, words in a block come out at 1 μs intervals, but the average word access time is 1.75 milliseconds. Here, the DOTrams have an advantage over most Borams in that they suffer no time penalty in reaching the beginning of the block; the magnetic drum, another form of Boram, must wait until the drum rotates an average of half a revolution under the read/write head before data transfer can begin. Another advantage is that the DOTram can be stopped dead in its track for an indefinite time. A drum can't be stopped or even appreciably slowed down, and metal-oxide semiconductor dynamic shift registers, which can read data at a megahertz clock rate and stand by at a few kilohertz, can't quite come to a stop.

The DOTram consists of a narrow strip of magnetic film deposited in a serpentine pattern on a substrate

Memory path. In a domain-tip propagation memory, a strip of magnetic film is deposited in a serpentine pattern. Magnetic domains are set up in the film and moved along it.



over a pair of windings that carry a two-phase drive current. Magnetic domains are set up in the serpentine film and made to move along it, propelled by the field associated with the drive current. The phase relationship of these currents, together with the shape of the corners in the serpentine pattern, keep the domains from moving backward. They can move backward if the drive current phases are reversed; this is another advantage of DOTrams over drums and semiconductor shift registers, neither of which can be reversed.

DOTram-4 memories cost about 0.4 to 0.5 cent per bit, compared to the 1 cent per bit and up that ferrite core and MOS memories cost today. DOTram-16, because of its larger capacity, costs even less, and achieves storage densities of up to 10,000 bits per square inch—five times that of core memories.

Domain-tip propagation technology superficially resembles bubble technology. In the DOT memory, the domains are in the serpentine film and move along it under control of drive currents in windings close to the film. In the bubble memory, the domains are in the substrate and move freely through it, constrained by the magnetic properties of metal patterns deposited on the substrate; they are driven by a magnetic field perpendicular to the substrate and rotating in a plane parallel to the substrate.

Cambridge Memories, Inc., 285 Newtonville Ave., Newtonville, Mass. 02160 [371]

Modular design cuts cost of disk memory system

Designed for point-of-sale and other systems requiring mass storage of data for minicomputer processing, a disk memory developed by Data General Corp. is available in capacities from 128,000 16-bit words to 768,000. The Novadisc is the first peripheral designed and made in-house by the Southboro, Mass., minicomputer manufacturer. Prices range from $5,200 to $12,500.

DG uses the same modular concept it employs in its computers—electronic subsystems are plugged together, rather than soldered like the mechanical assemblies, thus reducing costs. The head retracts from the disk when not in use. If the disk drops 10% below its speed of 3,600 rpm during power brownouts, the head automatically swings away to avoid surface wear.

An air bearing exerts 2 pounds of force on the Novadisc head; since it can tolerate up to 4 pounds, the head will not hit the disk if it is jarred during operation. This feature should enable the disk to operate in moderately rugged environments, as on ships and planes.

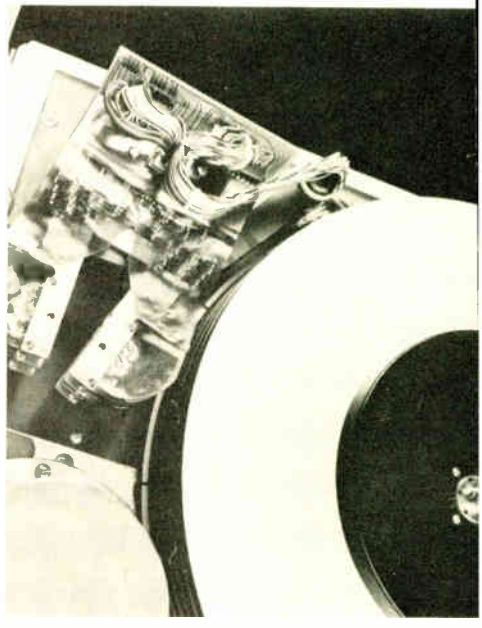
The head module is held by a single bolt to the loading and retracting post so that if it is damaged it can be replaced in about five minutes. Instead of using thin magnetic wires to connect the head to the electronics, DG uses Flexprint, which reduces to two 16-wire harnesses at the edge connector.

Three-frequency recording, such as that used on the IBM 3330 disk system, reduces the number of signal reversals required to enter data on the Novadisc. The operating speed of 3,600 rpm gives an average latency period of 8.4 milliseconds and a data transfer rate of 2 million bits per second. DG's 4019 disk control can handle as many as eight disks containing a total of 2.048 million words, has a track lock-out to protect disk tracks against overwriting by a program, and two buffer registers that give the data channel almost two words to respond to a request by the channel.

Along with the Novadisc, DG is offering a new real-time disk operating system that can handle single or multiple tasks and allows the user to access information randomly, continuously, or sequentially.

The Novadisc will be discounted at the same rate as Nova minicomputers—as much as 40% on quantities of 200.

Data General Corp., Route 9, Southboro, Mass. 01772 [372]



Graphics display stores, erases data selectively

A graphics display terminal developed for specialized scientific research at the Lawrence-Livermore Laboratory will now be marketed commercially. It is expected to have broad industrial applications as a designer's aid for products ranging from aircraft to integrated circuits.

The model 801, built by Princeton Electronic Products Inc., stores information on a silicon-target storage tube and can erase it selectively. The 801 interacts directly with a computer through a typewriter-like keyboard. On a 17-inch cathode-ray tube screen, it displays alphanumeric characters, vectors, or points at a writing speed as fast as 5,000

characters or 20,000 vectors per second. As many as 32 different shades of gray can be displayed.

Providing 50 foot-lamberts of brightness, it can be easily viewed in daylight, according to the company. And with an 8,192-character storage capability in the Lithocon storage tube—developed by Princeton about two years ago—the 801 is faster, 12 times brighter, and stores almost three times as much graphics information as other available units, asserts president Steven R. Hofstein.

The terminal is compatible with ordinary television systems—resolution is 550 line pairs—and one terminal will drive up to six TV monitors directly, or any number if a distribution amplifier is added. Altogether, the unit can address a matrix of 4,096 by 4,096 points, of which 1,024 by 1,024 are viewable. The model 801 character generator uses the ASCII 8-bit character set and can provide three character sizes. The unit will operate in full-or half-duplex mode.

Because of the Lithocon storage tube characteristics, the terminal can be equipped with an electronic "zoom-in" feature that allows a magnified portion of the generated image to be displayed. The zoom control consists of a joystick for manual positioning of the image center in the X and Y directions, and a size-control switch providing several different area magnifications. The terminal can also drive a Princeton electrostatic printer to produce hard copies of the display.

Hofstein says the terminal will appeal strongly to the scientific and engineering communities that use computer graphics displays to aid the design of aircraft, automotive parts, buildings, and integrated circuits. Price of the terminal is $7,200, plus $750 for the circuitry needed to provide an interface with a computer.

Princeton Electronic Products Inc., P.O. Box 101, North Brunswick, N.J. 08902 [373]

Plotter is accurate within 0.005% at 750 in./min

Two main types of plotters are available: small, low-priced units such as strip-chart recorders, used mainly in the laboratory, and high-speed closed-loop feedback units priced at $25,000 and up. But now Data Technology of Watertown, Mass., is marketing a plotter that combines the accuracy and speed of higher priced units for only $15,000.

Data Tech gains economies by supporting the pen from only one side of the drafting area instead of two—the more usual gantry approach. Experience in making coordinate digitizer systems also enables the company to cut manufacturing costs. And it uses state-of-the-art technology, such as transistor-transistor logic. The plotter is inexpensive enough to make it practical for the drafting room. Data Tech is aiming first at companies with in-house computer-assisted-design facilities.

The plotter has a flat bed measuring 22 in. by 34 in., a size that the company says will become more popular in the future and can fulfill 95% of most people's needs. Drafting paper is held down electrostatically, instead of with the usual vacuum method. Accuracy of the unit is guaranteed to within 0.005% and has reached 0.002%—equal to high-priced plotters—at a velocity of 750 in. per minute.

To attain this accuracy, Data Tech has developed an analog approach. Since there cannot be an instantaneous change in velocity, speed must come up on a ramp and then down. With digital plotters, the computer itself must speed and slow the pulse rate, an expensive procedure. Data Tech's plotter is able to accept pulses at a continuous speed of 5 kilohertz, which go into an up-down counter. Its output is converted to an analog signal, put through a low-pass linear filter, and then sent to a voltage-controlled oscillator (VCO) that subtracts counts from the up-down counter.

Thus, the analog input to the VCO is the velocity signal, and that can be used in an analog loop to control velocity with a tachometer feedback sensor. VCO pulses step the motor, and are behind the input pulses in time. Position of the pen is controlled by the VCO and velocity signal. Pulse resolution of 0.0025 enables the plotter to draw smooth curves and do lettering faster than usual, since there is no need to slow down at intersections.

At first, Data Tech will offer interfaces to PDP-8, PDP-11, and Nova minicomputers, and within a year it says it will have interfaces for most other minis, as well as Univacs and IBM 1130s. The first one will be a pulse-stream interface, which requires only a small amount of logic on the computer side. Later a word interface will be offered. Future plotters will be built to accept magnetic and paper-tape input. A readout, multiple pens, and a scribe for cutting rubylith will be offered as options.

Data Technology, 65 Grove St., Watertown, Mass. 02172 [374]

Cassette recorder challenges paper-tape equipment

A magnetic-tape cassette recorder that is aimed at the high-speed paper-tape market will read and write data at speeds from zero to 350 characters per second incrementally. This enables the operator to stop on a character to edit and correct data without duplication to a new cassette. In addition, in the continuous-tape read mode, fast tape access is available in any one of four digitally selected speeds up to 800 characters

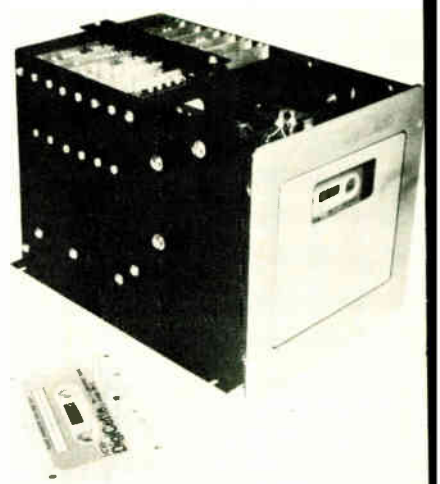
per second. The recorder, the PI-72, was developed by International Computer Products Inc.

Data organization in the Philips 0.15-inch tape cassette is adapted to paper tape. While bits are recorded serially on both channels, the deck reads and writes from a register to provide compatibility to the parallel-by-bit, serial-by-character paper-tape equipment. It also stops from full speed in four characters, which are stored in a short buffer to give the device the stop-on-character capability common to paper tape.

"The PI-72 was designed to do all the things magnetic tape does well—including correction and silent operation," says ICP vice president Robert N. Miller. Since the deck can be hooked up directly to paper devices, ICP hopes to capture its share of the market from the industries now relying on paper-tape punches and readers: communications, printing, minicomputers, business and accounting machines, and numerical machine-tool operations.

ICP uses a bit-mark-sequence recording format to get the deck's incremental capability in both read and write modes. Nine-bit bytes are bracketed by two-channel start and stop bits, and a nine-bit interbyte gap is inserted to allow the deck to increment in the read as well as the write mode without restricting data format or record length.

Bits are spaced at 0.002 inch, yielding 25 characters per inch, counting the interbyte gaps. Miller estimates that the PI-72 can write 55,000 characters on the standard Philips cassette. The recorder, using a spindle mechanism to drive both reels, can maintain some drive in both directions for fast braking and to maintain tape tension. The deck can reach its maximum read/write speed of 350 characters per second, or 14 inches per second, in 20 milliseconds. Specified error rate is one bit in 10^7 bytes.



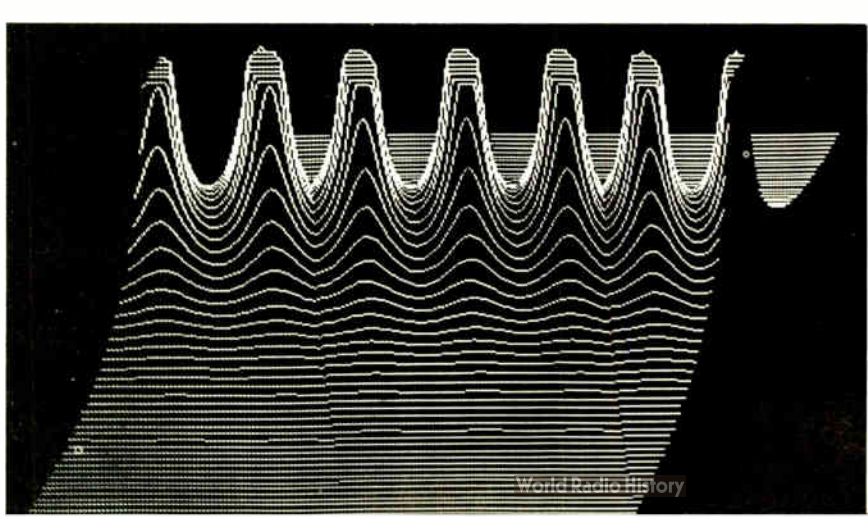
One of the few machines competing in the high-speed, expensive end of the cassette deck market, ICP's PI-72 offers size, price, and power requirement advantages over conventional high-speed paper tape devices. It is priced at $1,015 in quantities of one to 10.

International Computer Products Inc., P.O. Box 34484, Dallas, Texas 75234 [375]

Graphics display system eases load on processor

Using a minicomputer as a dedicated graphics processor has enabled Data Disc Inc. of Sunnyvale, Calif., to introduce Anagraph, its multichannel graphics display system for only $5,000 to $10,000 per terminal. The mini handles many tasks ordinarily assigned to the host processor, says Andrew O'Sullivan, president, adding that other graphics systems can run as high as $100,000 a terminal.

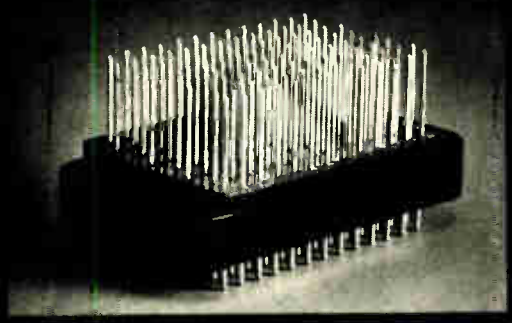
The Anagraph, said to be a plug-to-plug replacement for the IBM 2250 with most of the capability of the 2250, consists of a Data Disc 6600 cathode-ray tube display system, an Interdata 70 minicomputer, a Data Disc 7200 disk memory, and up to 16 Data Disc 6612/6611 display monitors and keyboards. Not only does Anagraph incorporate the minicomputer as a graphics processor, but because it is not necessary to communicate with the central processing unit to edit or format information, the system reduces the load on the CPU. The clustered system, similar to that of the IBM 2260, allows users to share the disk memory for the display, which further cuts costs. And the ease of graphic programing means more economies.



The Anagraph will drive as many as 16 display terminals. It can display 3,840 standard characters simultaneously in 300 milliseconds. Four character sizes are available. More than 300,000 points are possible in the graphic display with a 640 by 480 format. A complex graph of 1,000 random vectors can be generated in 2 seconds, the company says. Any rectangular area of the screen may be erased, and each graphic point is individually addressable. Channels may be combined for color or gray-scale displays. Seven colors plus black are available from three channels.

Process control and management information systems are probably Anagraph's chief applications. The first Anagraph management information system is already operating at the First National Bank of Chicago. But Anagraph can also be used in financial and securities analysis, and scientific/engineering ap-

38% OFF



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Circle 145 on reader service card

Circle 147 on reader service card

models of Complot digital plotters having DTL/TTL compatible inputs, at the control system market.

Software for driving the plotter can be as small as 30 locations of memory for specialized applications, says the company; the complete package, including alphanumeric symbol generation, array plotting and axis generation for graphs, requires about 1,000 locations. Delivery time is 60 days.

Houston Instrument Div., Bausch & Lomb Inc., 4950 Terminal Ave., Bellaire, Texas 77410 [378]

Tiny disk drive

What's the smallest disk cartridge support drive ever offered? Caelus Memories Inc. of San Jose, Calif., says that its new model 103, which stands 5.25 inches high and weighs in at 35 pounds, takes the prize. Compared with previous models, which Caelus says are at least 8.75 in. high and weigh 75 lbs, the 103 represents quite a saving in rack space—its length is 25.75 in., and it occupies 26.75 in. of rack.

Capable of being mounted in a standard RETMA rack, the unit consists of the enclosure, head-positioning servo system, spindle, disk, spindle motor, read/write electronics, option/interface board, and power supply. It interfaces with and provides on-line peripheral storage capabilities for small general-purpose digital computers and intelligent terminals. With a fixed disk drive, it is especially applicable to process control, where it must be completely sealed.

Available in a single-disk configuration, the model 103 has a 24-megabit capacity. There are 204 tracks per surface, divided into 24 sectors. The recording medium is a double-sided, magnetic-oxide-coated disk that is fixed within the drive. Density is 2,200 bits per inch. Transfer rate is 1.38 megahertz at 1,500 rpm.

The model 103 is priced below $2,000.

Caelus Memories Inc., 967 Mabury Rd. San Jose, Calif. 95133 [379]

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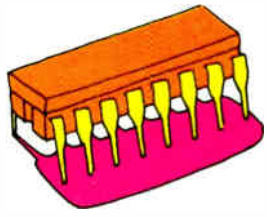

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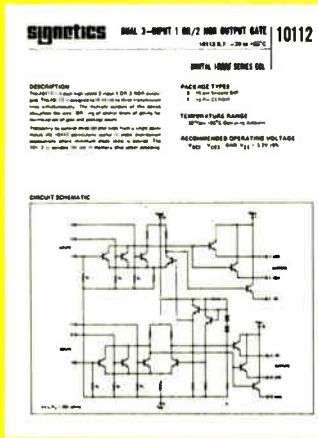
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10111 Dual 3-Input 3-Output NOR Gate	10121* 4-wide 3,3,3,3-Input OR-AND/OA Invert Gate	*Coming soon.

signetics

A subsidiary of Corning Glass Works

Instruments

Analyzer price tailored to job

Modular design of pulse and transient tester handles variety of waveforms

Carefully analyzing transient waveforms such as laser pulses and shock-test results can be a very expensive proposition. Typically, a high-speed a-d converter is used in this application. And since the cost of a converter goes up with both speed and accuracy, a precision tester can be a pretty expensive piece of gear.

If, however, the time between transient events is long, compared with the events themselves, there is a cheaper way out. A bank of sample-and-hold modules can sample the signal very rapidly, and then feed the samples into a relatively slow a-d converter during the inter-pulse interval.

By using this approach where it is appropriate, Inter-Computer Electronics Inc., is able to offer its pulse and transient analyzer at prices that go as low as $2,500. When the inter-pulse interval is short, it becomes necessary to use either a faster converter or even one converter per channel, driving the price up considerably.

A more representative price for the pulse and transient analyzer is about $8,000, according to Inter-Computer President James J. Connolly. Such a system would have 16 channels of sample-and-hold circuitry, a 16-channel multiplexer, a 10-bit/1-megahertz a-d converter, 2,048 words of 10-bit digital memory storage, and the necessary power supplies, interfacing circuits, control circuitry, etc. If a particular application really needs a high-speed converter, the system can be provided with a 10-MHz/8-bit unit, but the price then goes up to $12,000. Clearly the analyzer's chief attraction is its flexibility: It can be considered a customized off-the-shelf instrument.

The analyzer can accommodate up to 16 channels of sample-and-hold input, each of which has an aperture time of less than 100 picoseconds. The maximum sampling rate is 200 MHz, corresponding to a sampling interval of 5 nanoseconds. Over-all system accuracy can be within ±0.15% of full scale (when a 10-bit converter is used). Analog input range is 10 mV to 10 V.

A key feature of the pulse and transient analyzer is its packaging in standard nuclear instrumentation modules. These modules can be arranged, with all required power supplies, in a single 19-inch rack measuring 17 in. deep and 8 ¾ in high.

Delivery time of the pulse and transient analyzer, designated the ISA-1310/1024, is 90 days after receipt of order.

Inter-Computer Electronics Inc., a subsidiary of American Electronic Laboratories Inc., P.O. Box 507, Lansdale, Pa. 19446 [351]

'Goof-proof' multimeter is portable, priced at $700

Portability, protection from incorrect use, and low price are the key features of the model 4300 digital multimeter. The four-digit unit, with one digit for over-range, has a carrying strap built into the instrument's case, and provides eight hours of continuous battery operation for use at remote sites. A digital readout of the battery voltage is featured; with this readout and the conversion chart supplied, users can compute how many hours of operation to full specifications the unit will provide.

The model 4300's light-emitting diode display is blanked if battery power is too low to operate to full specifications. Further protection against erroneous readings or instrument damage is provided by means of interlocking cams that prevent the user from setting improper combinations of ranges and functions and by having the readout go blank when the instrument is overloaded.

Five dc ranges can be measured, from 100 millivolts to 1,000 volts. In ac, four ranges from 1 to 1,000 volts are offered. The kilohm function provides five ranges, from 1,000 ohms to 10 megohms. Price is less than $700, not including the nickel-cadmium battery pack; delivery time is 30 days.

Dana Laboratories Inc., 2401 Campus Dr., Irvine, Calif. 92664 [352]

Line of digital clocks uses diode readouts

A family of digital clocks, designated the series 2400, has light-emitting diode displays and includes remote-control features. Standard models are available with three methods of time reference: power line, internal crystal oscillator, or external input. Price of model 2411, with 60-Hz time base, 24-hour display, is $353.

Electronic Research Co., 10,000 W. 75th St., Overland Park, Kansas 66204 [359]

Low-cost prescaler extends counter's frequency range

Frequency prescaler model 6300 can extend the frequency range of any counter of 5 megahertz or higher to 512 megahertz. The 6300

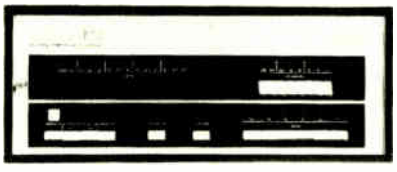
New products

is a system component, in addition to being an instrument accessory. For example, it may be used as a countdown for high-frequency phase-lock loops. Sensitivity is adjustable from 5 volts peak-to-peak to 100 millivolts peak-to-peak. Output is 1 v into a 50-ohm load, and the price is $485.

Newport Laboratories Inc., 630 E. Young St., Santa Ana, Calif. 92705 [353]

Analog signal processor has one amplifier per channel

An analog signal processor, designated the model 620, provides individual amplifiers and filters for up to 64 input channels. The chassis also contains a high-level multiplexer, gain-programable amplifier, high-speed analog-to-digital converter with sample and hold, and DTL/TTL-compatible levels. The system can be expanded to 256 chan-



nels by plugging additional 64-channel units into the basic 620. The high-level multiplexer reduces cross talk to less than 0.005%, and there is no degradation from common-mode voltage channel-to-channel. Price is $12,000, and additional 64-channel expansion units are $8,500.

Neff Instruments Corp., 1088 East Hamilton Rd., Duarte, Calif. 91010 [354]

Voltmeter's input impedance is greater than 10^{14} ohms

An electrostatic voltmeter that offers input impedance greater than 10^{14} ohms measures up to 100,000 volts ac or dc. Many models are available, with a choice of frequency range, single or multirange scales, and accuracy to within 0.5% or 1%. Highest operating frequency

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Aurora (Cleveland) (216) 247-4488
Pennsylvania: G. C. M., Ampler (215) 646-7517
Texas: Semiconductor Sales, Richardson (214) 231-6181
Virgina: Burgin Kreh Assoc., Lynchburg (703) 845-5600
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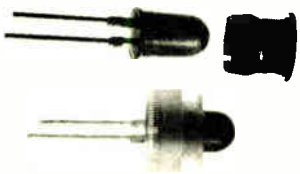
BRIGHTEST RED LIGHTS IN THE DISTRICT

The Litronix' line of LED panel and indicator lites sport some of the brightest, most economical and efficient solid state lamps around. Select from a broad line of devices with red diffused, clear, water clear or white diffused lens. Our LEDs have wide angle viewing, high brightness, low power, sturdy construction **and** a competitive price tag. We repeat, "competitive price tag." We have a lamp to fit your application. Here are just a few of our most popular:

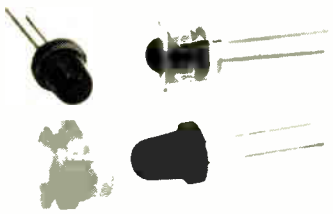


GREAT FROM ANY ANGLE

RL-21. 180° of full, bright viewing. Great for panel mounting, with lovable, wire wrappable leads. Available with black or clear mounting clip. Replaces HP 5082-4403, 65¢ in 1,000 quantities.

EASY MOUNTING

RL-2. Maximum brightness and spot size, comes with panel mounting clip and four lens options. 65¢ in 1,000 quantities.



BIG RED

RL-20. Extra bright, big boomin' 200 mil spot. Ideal for head-on viewing. Has panel mounting clip and two lens options. 65¢ in 1,000 quantities.

LITTLE ANTE

RL-50. Economy model with high brightness at low current. Its small size and low price make it ideal for general purpose applications. Comes in four lens options. The new diffused types provide a large 80 mil spot with full 140° viewing. Only 39¢ in 1,000 quantities.

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the bright guys

litronix

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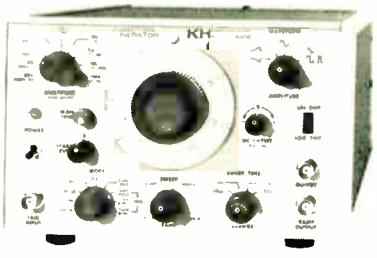
New products

offered is 450 kilohertz. The models ESH and ESD have extremely low loading features and thus have many special applications, such as low-charge measurements associated with ionization chambers. The instrument can measure extremely high voltages used in cathode-ray-tube power supplies.

Singer Instrumentation, Los Angeles Operation, 3211 South LaCienega Blvd., Los Angeles, Calif. 90016 [355]

Function generator can make semilog plots

Nine modes of operation are offered in the model 5300 function generator. The instrument features an exponential ramp function for logarithmic sweeping, in addition to separate waveforms and ramp outputs, pulse, sweep, and burst modes, and external voltage control of main

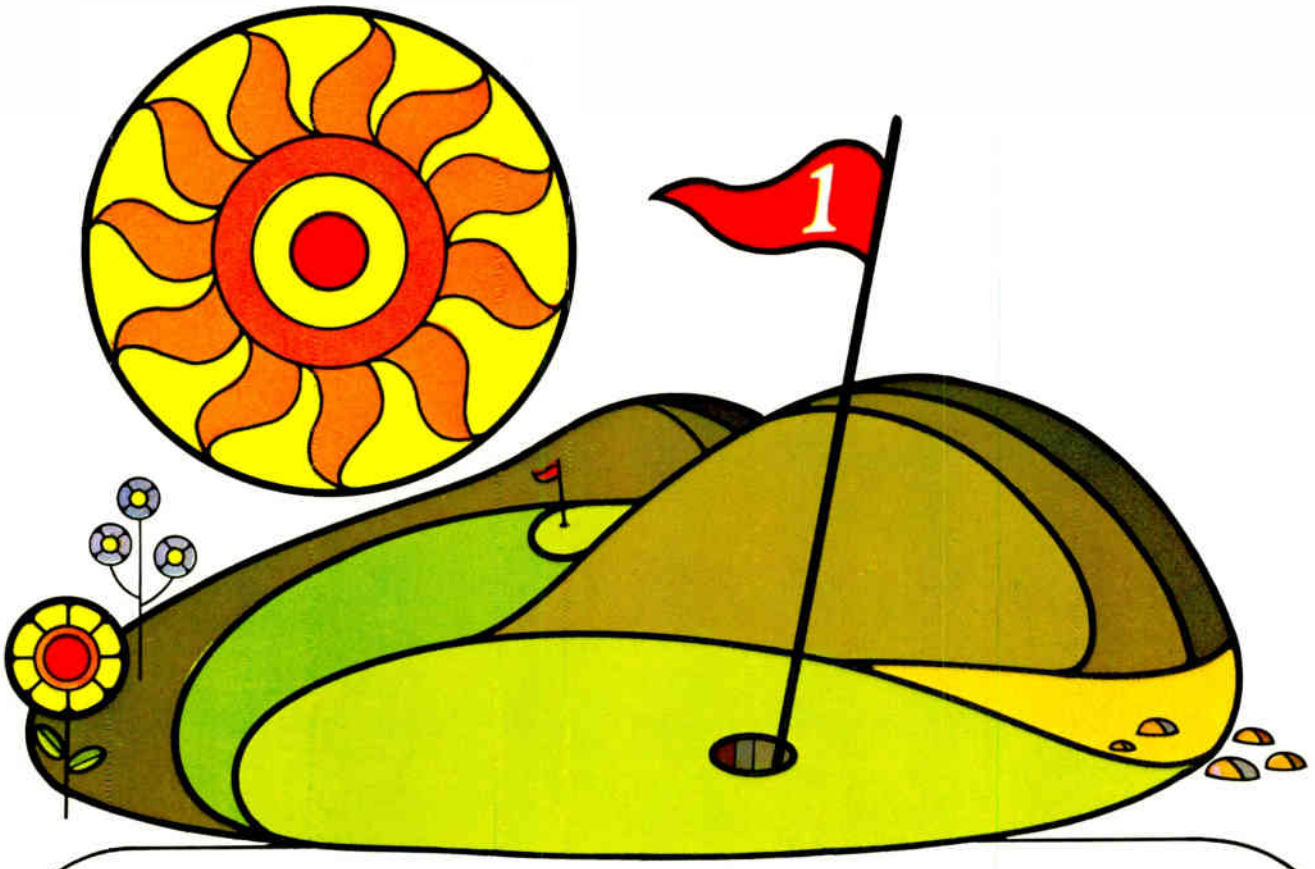


output frequency. The exponential sweep in conjunction with the linear sawtooth output enables the generator to do semilog plotting. In external and sweep modes, the frequency range of the versatile generator extends from 0.00003 hertz to 3 megahertz. Price is from $695.

Krohn-Hite Corp., 580 Massachusetts Ave., Cambridge, Mass. 02139 [356]

Versatile signal generators cover L and S bands

A line of signal generators, 7100 series, has a six-digit frequency counter readout for L band, upper L band, and S band. The frequency thus is determined within 10 kilohertz. Wideband frequency modulation is greater than 6



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Let SAE solve your packaging problems.

Are the problems of component selection, packaging, and systems assembly interfering with your golf game? Then delegate all that to us. You can concentrate on grooving your swing.

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Prefer planer? We'll provide the logic panels, mounting hardware, sockets, and all peripheral items.

Or investigate our unique Dipstik. It gives twice the IC density as PC methods, and eliminates lots of hardware.

Whichever method you choose, we can supply the components for you to assemble yourself. Or, we'll pick the parts, do the assembly, and let you do the wiring. Or, we'll provide everything: components, assembly, and Wire-Wrap®. So, just call us in . . . and you go out golfing!

Free bumper sticker for your desk. Flaunt your favorite sport. Or, if something else turns you on, tell us. Maybe we can send you a bumper sticker for that, too.We'll also include a brief brochure describing how we can relieve you of systems packaging hang-ups. Write us:

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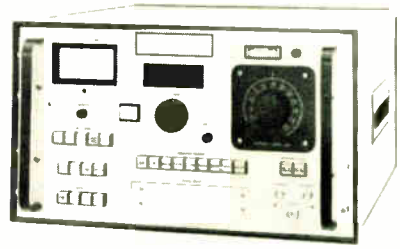
New products

megahertz peak at a 4-MHz rate. Continuous-phase PCM/fm with deviations to 6 MHz peak up to 15



megabits per second, non-return to zero, is also provided. The unit offers continuous-wave, fm, and phase-modulation capability for output signals within the individual frequency ranges.

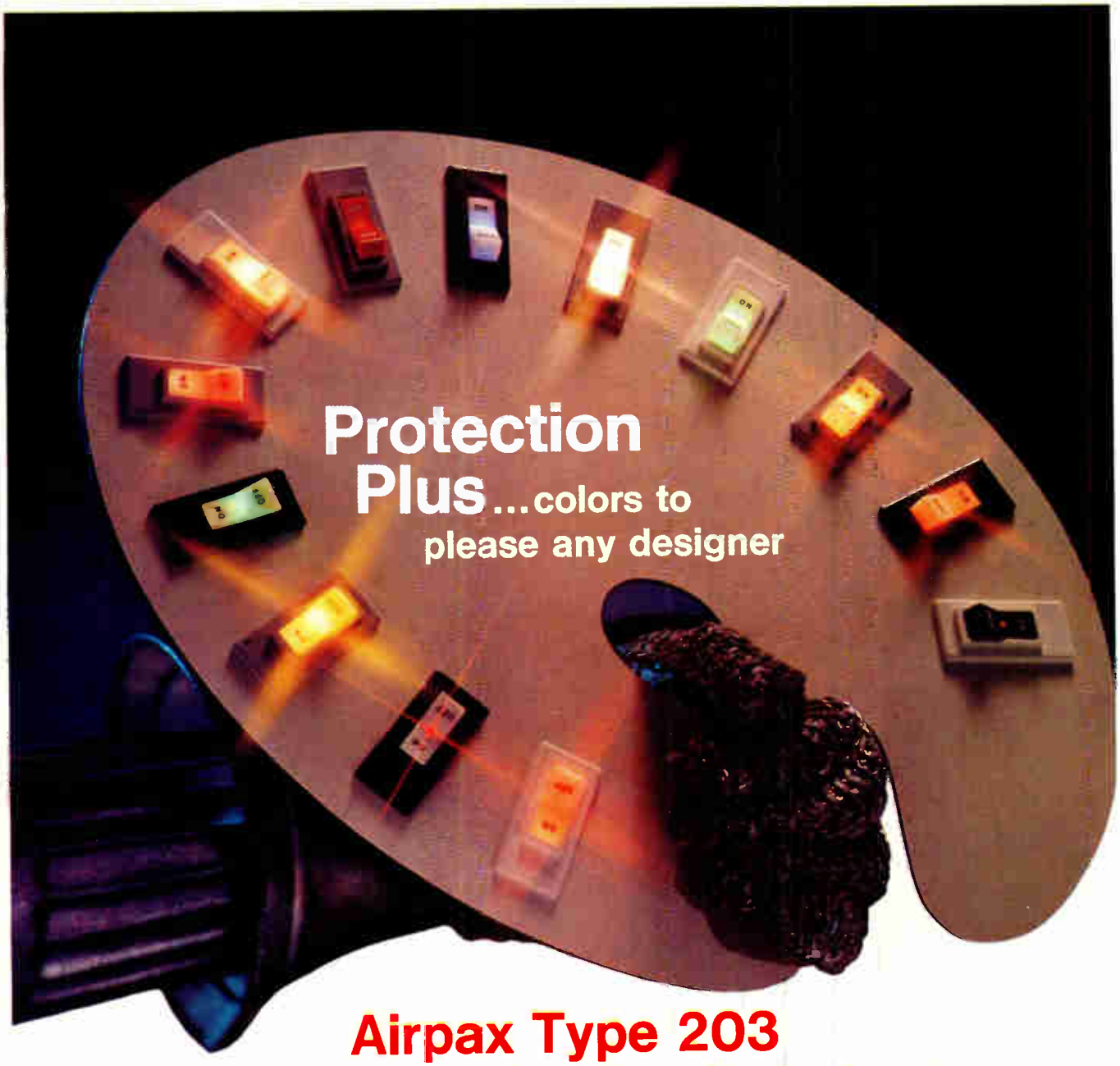
Microdyne Corp., P.O. Box 1527, Rockville, Md. 20850 [357]

Solid-state sweeper covers 2-18 GHz in one range

A new broadband sweeper, designated model 9530, extends the upper limit of the Narda 9500 series from 12.4 to 18 gigahertz. The 9530 covers 2 to 18 GHz with a leveled output power of 1 milliwatt minimum over the entire range, and up to 20 mW of leveled power can be obtained over narrower ranges at the low end of the spectrum. The

unit can be programed by an external analog signal; its calibration factor in this mode is 1 GHz per volt. Maximum frequency error in the continuous-wave mode is ±0.5%. Sweep-end points and markers keep maximum error within 1%. Price of the 9530 is $17,000.

The Narda Microwave Corp., Plainview, N.Y. 11803 [358]



Airpax Type 203 Electromagnetic Circuit Protector with Illuminated Rocker Arm

Airpax circuit protectors have always offered protection, plus. But now there's an added Plus — Type 203 protectors with illuminated rocker handles in a variety of colors that will enhance the appearance (and sales appeal) of any product or panel.

Combining over-current protection with ON-OFF switch and pilot light functions, the 203 is ideal for use in high quality consumer, commercial, and industrial equipment where accurate, reliable protection and attractive appearance are demanded.

A choice of many mechanical and electrical configurations provide maximum versatility for the designer. Series, shunt, and relay trip internal circuits are available and can be combined in single, two, and three-pole versions. Current ratings from 0.02 to 20 amperes at 120V AC and 0.02 to 10 amperes at 250V AC. Inverse time delay or instant trip.

Interested? Write for Bulletin 2009. Airpax Electronics, Cambridge Division, Cambridge, Maryland 21613.

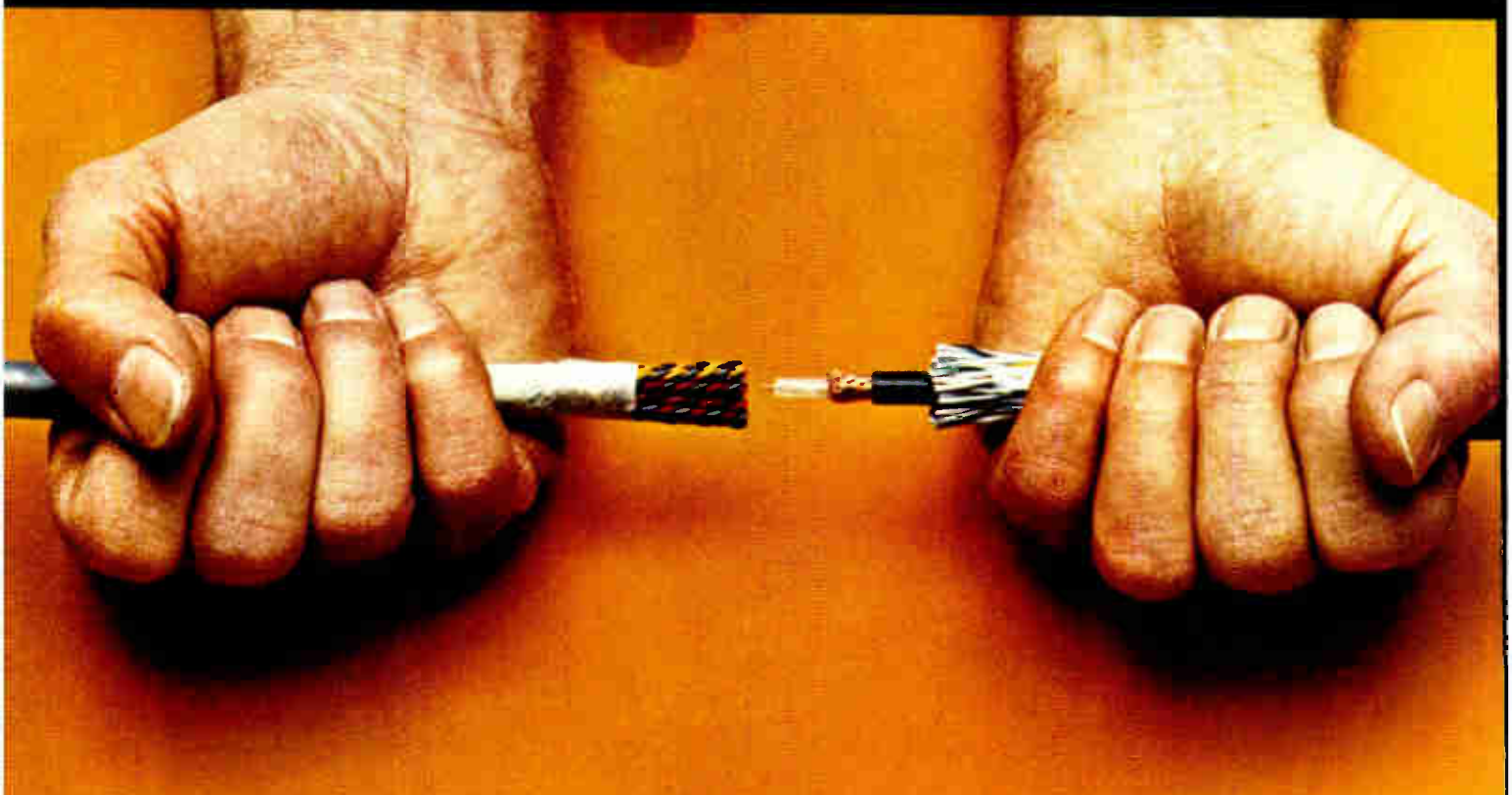
AIRPAX™

Protection comes in many colors

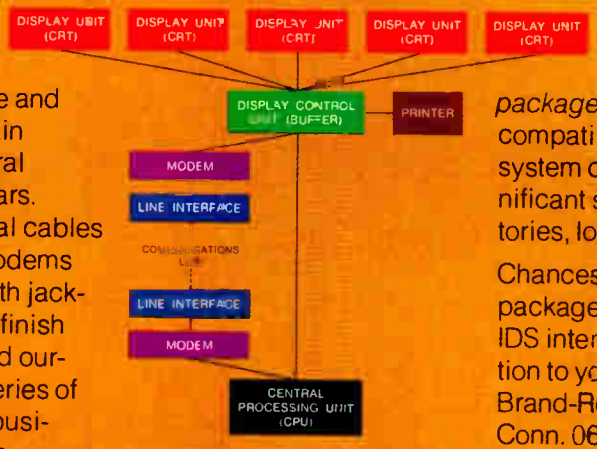
Airpax also manufactures many other types of circuit protectors in current ratings up to 100 amperes.

Circle 157 on reader service card

PROBLEM:
establishing plug-to-plug compatibility within a multi-company Information Display System.



SOLUTION:
the most complete series of "standard" interconnecting cable constructions available.



Brand-Rex has been solving wire and cable problems for the major main frame and independent peripheral equipment manufacturers for years. Designing and producing special cables for CRT displays, buffer units, modems and teleprinters. All UL listed, with jackets color-matched to equipment finish where required. Suddenly we find ourselves with the most complete series of "standard constructions" in the business. Information Display System *packages* that provide plug-to-plug compatibility between multi-company system components. You realize significant savings through reduced inventories, longer lengths, faster deliveries.

Chances are Brand-Rex has the cable package you need for fully integrated IDS interconnections. Ask us for a solution to your particular problem. Write Brand-Rex Company, Willimantic, Conn. 06226. Or call 203/423-7771.

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4,000 solutions in search of a problem.

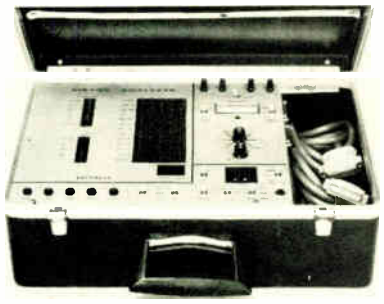
Circle 158 on reader service card

Data handling

Monitor traps 30 data link codes

By analyzing sequential line-control characters, user can pinpoint faults

When a data communications user installs his own system, particularly one that interacts on-line with a host computer, he usually deals with many different vendors for terminals, modems, printers, interfaces,



and the like. And when a fault shuts down communications or causes message errors, the user is often frustrated in finding the fault location and determining which vendor, including the telephone company, to hold responsible.

Some faults result from such electrical parameters as line distortion and phase jitter that are out of specification. But another type of serious failure arises from incompatibility in line-control protocols between terminal and computer, terminal and modem, modem and modem, modem and phone-line interface, and software programs.

Paradyne's model 810 Bisync Line Control Monitor aids in rapid diagnosis of faults resulting from inconsistencies in the control dialog for data communications equipment. Compatible with equipment using standard EIA RS-232 connectors, the monitor analyzes the line-control dialog of any single device or devices in tandem, based on the popular IBM binary synchronous communications protocol.

The protocol defines the code, the control characters and their meaning, the message formats, the reply formats, and the rules for responding to different messages. The 810, though, ignores message characters to simplify diagnosis and recognizes the occurrence of 13 different line-control characters, plus any one thumbwheel-switch-selectable message or control character, and it also displays whether or not a character occurred during transmission or reception.

The analyzer stores up to 30 sequential transmitted and received control characters and displays five of them on a 5-by-15 matrix of light-emitting diodes. A switch permits the operator to shift the other 25 characters into the display window, one at a time, for analysis of the control dialog. The 30 control characters can be trapped in several ways, including stopping the unit on the occurrence of a preselected control character.

In addition to this control character trap, the analyzer also includes functions to test the RS-232 interface, a meter to indicate line dBm and voltage levels, and an audio amplifier and speaker to permit the operator to listen to the line signal. Price is $2,750. Delivery time is 45 days after receipt of order.

Paradyne Corp., P.O. Box 5144, 2040 Calumet Street, Clearwater, Fla. 33518 [361]

Circuit analysis software eases designer's task

Added versatility and ease of use are built into the revised computer program called Recal II (Rapidata's electronic circuit analysis language). Since all inputs and outputs are specified in engineering terms, Rapidata points out, a user can run the powerful software system after 30 minutes of instruction. A circuit must be described just once, then Recal will add or delete component descriptions as the user analyzes his design for dc, ac, or transient conditions. Because Recal does not have a library of device models, the user is not limited in his design by the program's data base.

Recal's new features include optimization, arriving at the best possible design to maximize or minimize any single output parameter; frequency functions, representing multiport networks or complex components as a series of parameters that are a function of frequency; modulated sources, ac sources with built-in modulation and dc offset capabilities; and function files, the ability to load nonlinear and frequency functions into the program directly from a file.

Semiautomatic circuit partitioning can be accomplished by breaking a design down into areas or "black boxes." Then, Recal will generate the network terminal characteristics for the areas, and these characteristics can be re-entered into the program to replace the specified circuit area or areas. Also, impedance, admittance, and gain can be specified as functions of frequency in the design or circuit area.

The program's output can assume several forms—tables, graphs, and files. And the complete Recal II package can be called as a sub-routine in any Fortran program when network analysis is required. This allows such sophisticated analysis as multidimensional circuit optimization. Moreover, ac and dc worst-case analysis and sensitivity analysis can be performed on part or all of a circuit for any output parameter.

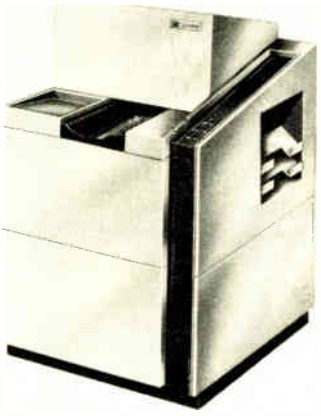
Recal II is available on a time-shared basis; there is no program fee. Typically, a dc analysis for a 10-node circuit costs less than $1.

Rapidata Inc., 20 New Dutch Lane, Fairfield, N.J. 07006 [362]

Optical page reader scans 2,000 characters a second

The Laser Vision series 2000 optical page reader incorporates a laser beam, fiber optics, and a typewritten font in its design. It reads at speeds above 2,000 characters per second, and a vacuum transport accepts pages up to 9 by 11½ inches in size in a range of thicknesses and weights. A so-called Logic Font, a self-checking code, is typed below

New products



normal alphanumeric upper- and lower-case characters. The reading head of the unit dissects only the Logic Font code and analyzes it for specific recognition features. Price is less than $20,000; slower units are available for about $10,000.

Creative Logic Corp., 80 E. Ridgewood Ave., Paramus, N.J. 07652 [369]

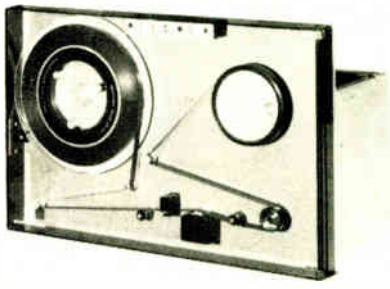
Controller operates with most central processors

The model 844 universal controller can interface with any major manufacturer's central processing unit, and operates with a single- or double-track disk, double-track double-density, a mix of the two track densities, or other peripheral units such as tape drives, printers, and readers. When used as part of the company's model 844 disk storage system, the controller makes it possible to double or quadruple existing storage. The system, consisting of eight spindles (four racks) and one spindle mounted in the controller rack, provides a storage capacity of 233 megabytes when using single track and 466 megabytes, using double track. The controller will be displayed at the Spring Joint Computer Conference.

Peripherals General Inc., Cherry Hill Industrial Park, Cherry Hill, N.J. 08003 [366]

Tape transports offer speeds of up to 25 inches/second

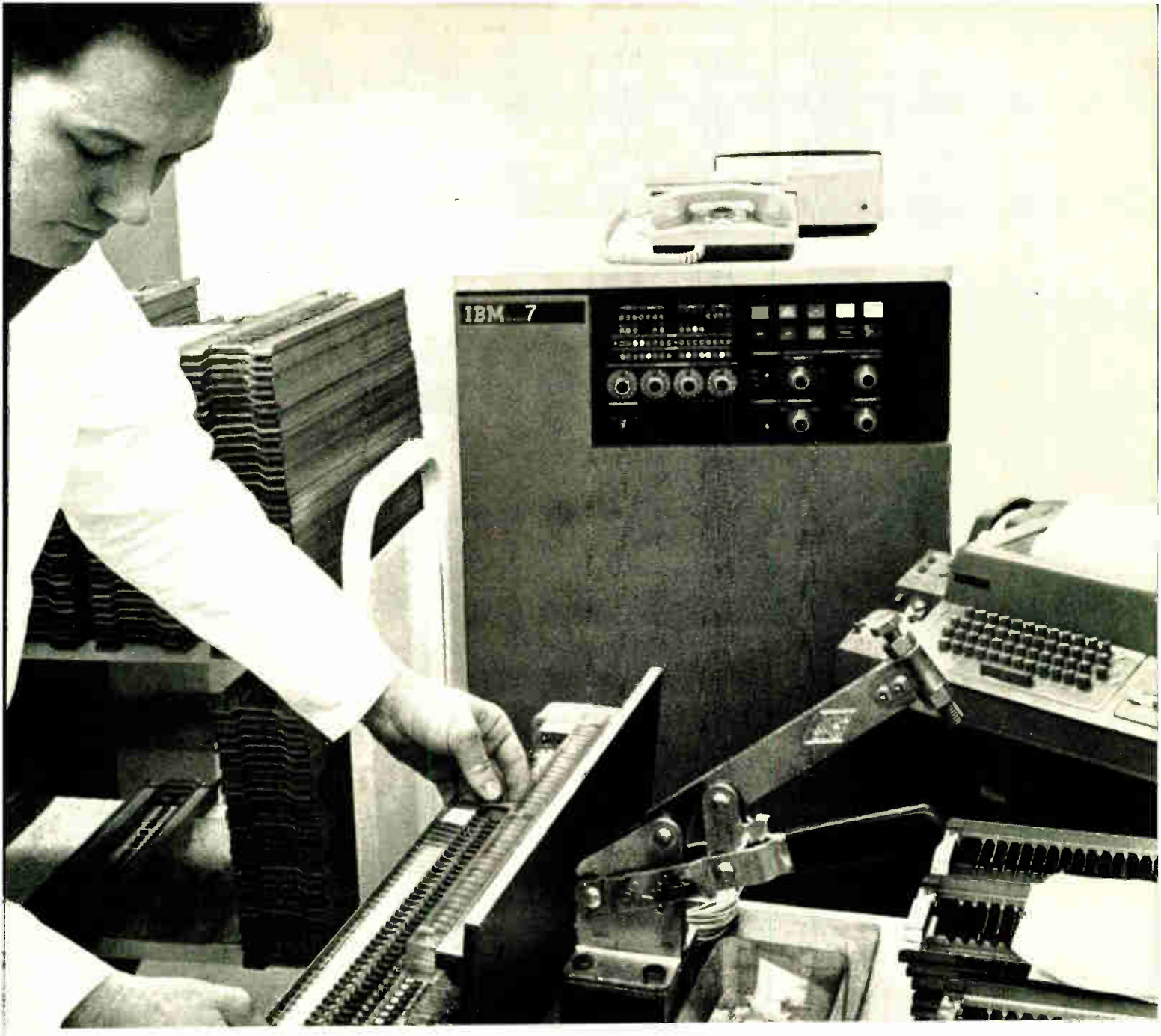
Tape transports in the model 1600 Mididek series operate at speeds of 12.5, 18.75, and 25 inches per second. Optional speeds are 6.25 and 37.5 in./s. The single-capstan units have densities of 200, 556, 800, or 1,600 cycles per inch, and accommodate 8½-inch reels. They are IBM-compatible, and configurations include read-only, write-only, and read/write with single- or dual-gap heads. Prices in OEM quantities start at $1,927. The transports will be demonstrated at the Spring Joint Computer Conference.



Digi-Data Corp., 4315 Baltimore Ave., Bladensburg, Md. 20710 [365]

Printer terminals are compact, virtually silent

Three new models in the Silent 700 series of data terminals are compact, virtually silent printers aimed at hard-copy requirements in video terminal display systems, hospital monitors, newswire services, and similar systems. The model 722S, with bit-parallel data interface, is for computer applications supplying



IBM System/7 installed at Dale Electronics to speed production.

A sensor-based IBM System/7 computer has gone into operation at the Norfolk, Nebraska, plant of Dale Electronics, a subsidiary of The Lionel Corporation. Dale expects that use of the System/7 will double its output of high-reliability film resistors.

All such resistors must undergo repeated tests to insure that actual resistances do not deviate more than 1% from rated values. Formerly, differences between pre-test and post-test values were calculated by hand, creating a production bottleneck.

Now, test instrument readings are entered directly into the System/7, which singles out for removal resistors failing to meet specifications. All readings for resistors which meet specifications are then transmitted directly to an IBM system at Dale headquarters in Columbus, Nebraska.

Upon completion of endurance testing, the resistors are again measured. The system at headquarters computes the differences between readings and transmits a list of resistors which failed to qualify back to the System/7 in Norfolk.

In addition to speeding resistor throughput, Dale plans to use the System/7 for order tracking and monitoring and control of testing and production machinery.

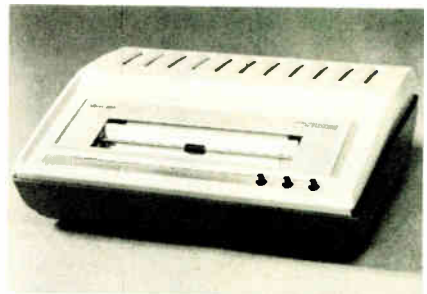
Full information on the System/7 is available through your IBM representative or local office. Or write IBM Data Processing Division, Department 807-E, 1133 Westchester Avenue, White Plains, N.Y. 10604.

IBM

Circle 161 on reader service card

New products

transistor-transistor-logic levels; the model 721S, with serial dataset interface, and the 731S, with serial dc signal interface, are compatible with systems requiring EIA, modem, or teletypewriter interfacing. Options

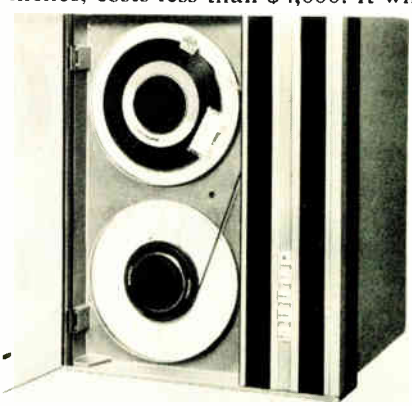


include upper- and lower-case alphabet and a built-in copy lighting kit. Prices are $2,490 for the 721S, $2,175 for the 722S, and $2,415 for the 731S. The terminals will be displayed at the Spring Joint Computer Conference.

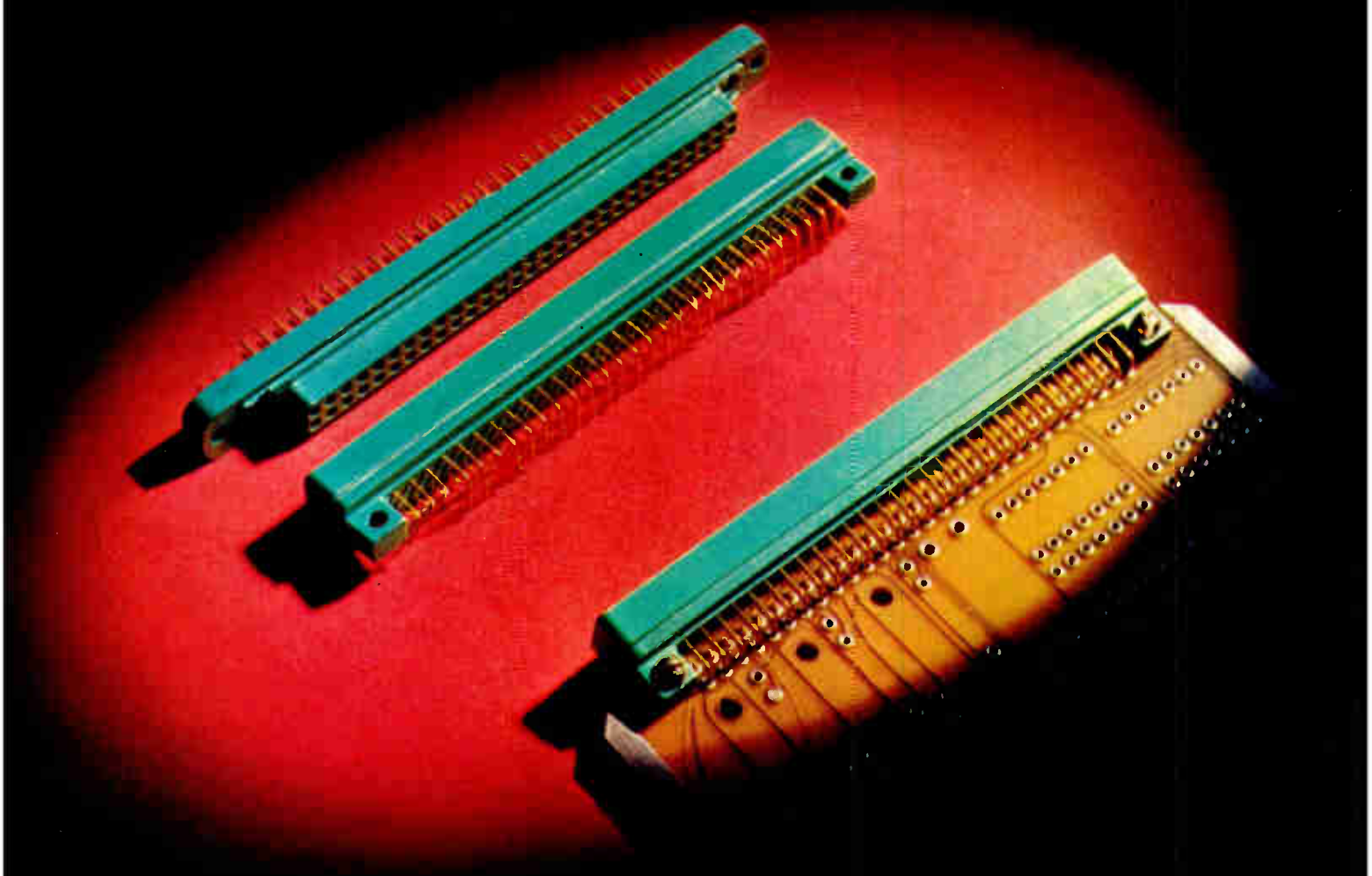
Texas Instruments Incorporated, Digital Systems Div., P.O. Box 1444, Houston, Texas 77001, Att. Marketing Services [363]

Digital tape transport loads, unloads automatically

A digital tape transport offers automatic loading and unloading, vacuum buffering, and a modular capstan assembly that pulls out of the front of the unit and can be replaced without realignment. The model TD 1000 is IBM-compatible, and has bidirectional tape speeds from 25 to 90 inches per second. Bidirectional search speed is 150 inches per second. The unit, housed in a frame measuring 19 by 24 inches, costs less than $4,000. It will



Bendix printed circuit board connectors put an end to close order drilling.



You know close order drilling. It's what's called for to produce ultraprecise hole locations in printed circuit boards. Eliminate this need and you'll cut costs for sure. Bendix P.C.B. connectors help you do precisely that. Their optional floating pin terminations "give" enough to make it easier to align pins with the printed circuit board holes.

Bendix boasts other features, too. Options like wire wrap or solder terminations. Straight or right angle. Insertable crimp contacts.

Applications? Wherever printed circuit boards are used, such as switching circuits, computers, business machines, process controls, etc.

Chances are, Bendix Printed Circuit Board connectors can help you. Why not find out. The Bendix Corporation, Electrical Components Division, Sidney, New York 13838.

Bendix

Circle 163 on reader service card

New products

be on display at the Spring Joint Computer Conference.

Wang Computer Products Inc., 2400 Broadway, Santa Monica, Calif. 90404 [367]

Teletype and magnetic tape serve as remote terminal

An automatic send-receive terminal, to be shown at the Spring Joint Computer Conference, includes a Teletype model 38 with a 15-inch-wide pin-feed platen and a model 4210 magnetic tape data terminal that can handle data distribution and collection at speeds as high as

2,400 words per minute. Matching the two terminals enables remote-batch computer processing applications. The model 38 accepts 14⅞-inch fan-fold paper and prints a 132-character line at 10 characters per inch in upper and lower case. Price is $1,400 to $1,450.

Teletype Corp., 5555 Touhy Ave., Skokie, Ill. 60076 [364]

Printer operates at 120 characters per second

An asynchronous serial impact-printing terminal called the Execuport 1200 operates at a speed of up to 120 characters per second. It prints a full 132-column line from a buffer, and can also print one character at a time. Settings are provided for speeds of 10, 15, 30, or 60 characters per second. Options are available to extend the capability of the terminal to include use as a communications printer, billing printer, computer output lister, and remote-batch terminal. Price for the basic unit is $4,500. It will be introduced at the Spring Joint Computer Conference.

Computer Transceiver Systems Inc., 317 Route 17, Paramus, N.J. 07652 [368]

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and how it saves you money on your mini.

Discover the all-new SPC-16 family of minicomputers. The first minis to save you substantial money in system implementation. They're from General Automation . . . the fast-growing, pace-setting mini maker.

For total value, SPC-16's put those other two highly-touted brands of minis to shame. With features like the most powerful instruction set of all. Features like exclusive OR. Compare and bit/byte word instructions. A unique one-word Load All Registers/Store All Registers capability. Eight true (16 optional) general purpose registers that can save you up to 4K (about $2500) worth of core. Plus programs that let you code your problem in half the time. And a lot more.

Including the right price, the best quantity discounts in the industry and the easiest OEM buying policy of all.

SPC-16's are available as I/O and memory-integrated models for dedicated in-house applications. Or as unbundled versions for OEM users or large system applications requiring up to 65K of memory. Six models in all, in three speeds.

No other minis come close to SPC-16's in giving you so much performance for your money. Give us a benchmark, we'll prove it. Meantime, send today for a detailed brochure.

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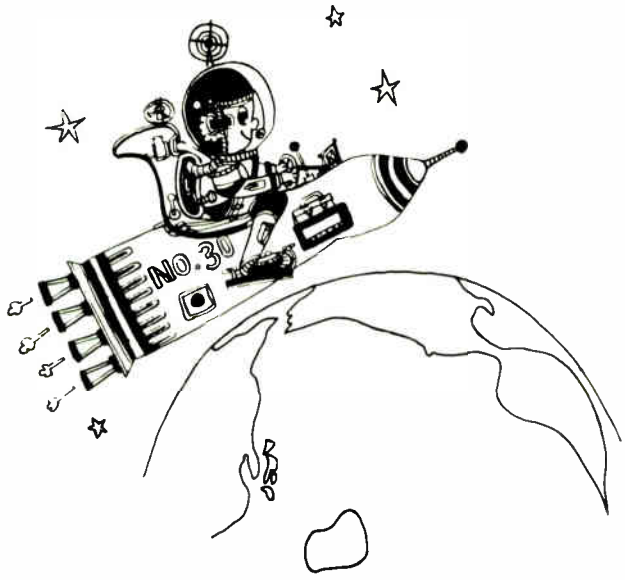
Circle 165 on reader service card

Go ahead, dream your impossible dream....



Stopped by the need for a permanent magnet better than any that now exists? Maybe Hitachi Metals can help. At our magnetic and electronic materials research center and other laboratories, our experts are hard at work making magnets do more things than anyone thought possible. Developing new magnetic materials such as rare-earth cobalt, and finding new uses for magnets. No one knows what they'll come up with next. But it just might be the answer to your impossible dream.

Devotion to improvement, added to integrated production backed by years of experience, is behind the quality of Hitachi magnets. Quality that means cast magnets designed and finished to close tolerances. Featuring high coercive force; big energy product; magnetic field uniformity and stability. And cast in any shape—no matter how intricate.

Here are some typical examples.

Type	Residual Induction (Br) gauss	Coercive Force (Hc) oersteds	Energy Product (B×H) max.×10⁻⁶
HI-MAG (ALNICO-5-7)	13,000-14,500	700- 800	6.8- 8.2
YCM-8B (ALNICO-8)	8,800- 9,600	1,380-1,550	4.8- 5.5
YCM-8D (ALNICO-8)	7,500- 8,300	1,700-1,850	5.5- 6.5
YCM-8E (ALNICO-8)	7,500- 8,500	2,000-2,150	5.5- 7.0
YCM-9B (ALNICO-9)	10,000-11,000	1,350-1,500	9.0-11.0

For full details about Hitachi magnets, write.

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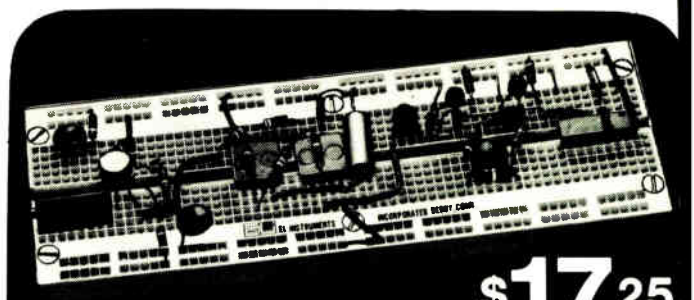
Los Angeles: Suite 870, 1901 Ave. of the Stars, Los Angeles, Calif., 90067 U.S.A. Tel. (213) 553-6649



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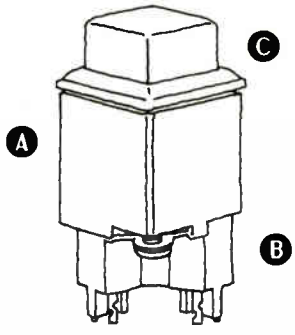
Circle 193 on reader service card

What do you want in a push button switch?



A Actuation—Momentary, alternate or snap action.

B Circuitry—From single pole, single throw to double pole, double throw; SPDT (2 circuit); make-before-break or break-before-make.

C Styling—Square, round, bezel, colors, lighted.

Just a few of the options possible in a wide range of push button switches available from Grayhill. If what you need isn't among them we can design one that is.

For our latest Engineering Catalog write or phone:
Grayhill, Inc., 523 Hillgrove Ave.,
La Grange, Illinois 60525.
(312) 354-1040.

Grayhill INC.

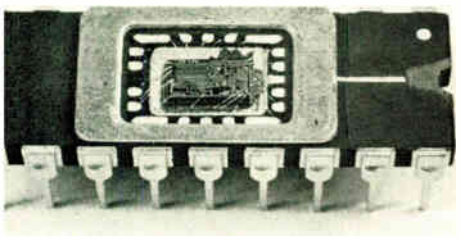
Circle 166 on reader service card
Circle 194 on reader service card

Semiconductors

Monolithic DAC resolves 10 bits

Converter chip includes voltage reference, op amp, and diffused resistors

When Precision Monolithics introduced a 6-bit monolithic digital-to-analog converter two years ago, a horse race of sorts developed among a half-dozen companies interested in developing a one-chip DAC with



8-, 10-, or 12-bit resolution.

The race has been won by Precision Monolithics with a full 10-bit-plus-sign DAC containing all the required elements on a single chip. These include the voltage reference, an internally compensated operational amplifier that slews at 40 volts per microsecond and requires only 1 μs to settle within 0.1% of the final value, and a diffused R-2R resistor ladder. In its own right, the op amp is a significant advance.

The converter, which is designated the monoDAC-02 and is described by Precision Monolithics as the industry's first true linear large-scale integrated circuit, is built on an 82-by-148-mil chip and housed in an 18-pin dual in-line package.

In operation, the signal from the internal voltage reference drives the bases of 10 constant-current-source transistors. These current sources, with emitters connected to the appropriate taps of the R-2R ladder, provide the required binary-scaled currents, which are switched by current-steering logic either to ground or to an output sum line. Finally, an inverting amplifier, driving the output op amp, converts the summed currents to a low-impedance output voltage.

Precision Monolithics Inc., 1500 Space Park Dr., Santa Clara, Calif. 95050 [411]

SPECIFICATIONS
Resolution: 10 bits and sign (11 bits)
Linearity options: 0.05%, 0.1%, 0.2% max (0 -70°C)
Tempco options: ±15, ±30, ±60 ppm/°C
Output voltage options: +10 v, ±5 v, 0 to +5 v, 0 to ± 10 v, 0 to -5 v, 0 to -10 v
Settling time: 1 μs to 0.1%
Zero offset: 10 mv max
Logic input current: 10 μA max
Bipolar symmetry: 10 mv
Output slew rate: 40 v/μs
Power supplies: +12 v to +18 v
Power supply rejection: 0.1% per %
Power consumption at +15 v: 260 mW max
Logic levels: V_{IH} = 2.0 min, V_{IL} = 0.8 max (can also operate with +15, -5 v MOS and C/MOS logic)

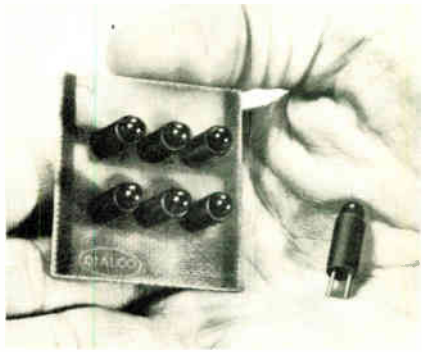
SOS static shift register stores up to 256 bits

A static shift register built into a silicon-on-sapphire chip is intended for use in high-performance computers, digital communications systems, and cathode-ray tube displays. The circuit, which is expected to compete with glass delay lines in some applications, stores up to 256 bits of digital data, and processes it at a rate of 20 million bits per second. It is said to be the most complex SOS circuit now commercially available. Operating range is from 0 to 75°C. Built-in control circuitry is also provided for writing in, reading out, and recirculating data, or for stopping. The unit is TTL-compatible, and it is packaged in a 14-pin, hermetically sealed, dual in-line package. Price is $50 for sample lots of 100 or more. Delivery is from stock.

Inselek Inc., University Park Plaza, 743 Alexander Rd., Princeton, N.J. [413]

LED is interchangeable with incandescent lamp

A light-emitting diode made from gallium arsenide phosphide is designed as a direct replacement for incandescent T-1¾ equivalents. The series, called the 549 Bi-Pin, is available in voltages from 1.4 to 14 v and currents up to 30 milliamperes. The LED, capped by a red diffused lens,

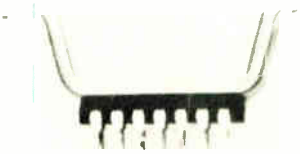


is combined with a built-in current-limiting resistor and pins molded in a plastic case. In quantities of 1,000, the LED is priced at 84 cents. Delivery is from stock.

Dialight Corp., 60 Stewart Ave., Brooklyn, N.Y. 11237 [414]

4-watt IC audio amplifier is designed for television

A 4-watt monolithic integrated circuit called the model LM354 is designed for use in television sets as an audio amplifier. The usable range of the supply voltage is from 6 to 24 v.



Other specifications include a self-centering bias for any operation in the voltage range, a direct-coupled input and high input impedance, high supply voltage rejection ratio, and a minimum number of external components. Price in 100-lots is $3.

European Electronic Products Corp., 10180 W. Jefferson Blvd., Culver City, Calif. 90230 [415]

7-segment display delivers 500 foot lamberts at 10 mA

A seven-segment alphanumeric display for high ambient light conditions is designated the MAN-10. The 0.27-inch-high display has a typical brightness characteristic of

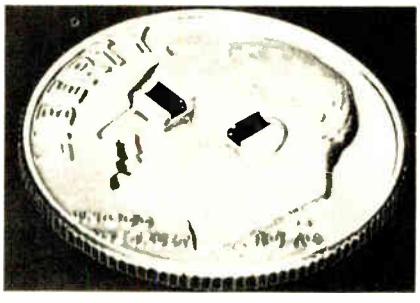
New products

500 foot lamberts at 10 milliamperes. At 20 mA, it produces 1,000 ft-L. The display, packaged in a 14-pin dual in-line housing, is capable of displaying all digits from 0 to 9, plus nine distinct alphabetic characters. Price for 1 to 9 displays is $13. In quantities of 10 to 99, it is $10.75, and for 100-lots, $9.

Monsanto Commercial Products Co., 10131 Bubb Rd., Cupertino, Calif. 95014 [416]

Reference diode chips are packaged as LIDs

Temperature-compensated reference diode chips, designated the CZ series, are channel-mounted devices. They feature an average long-term reference voltage drift of less than 10 parts per million per 1,000 hours.



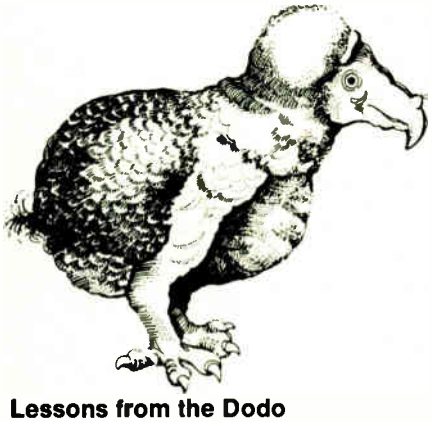
The units are packaged as leadless inverted devices, and they offer precise temperature compensation for reference voltage, with coefficients as low as 0.0005% per °C. Measurements are 0.080 inch maximum in length, 0.082 in. in width, and 0.040 in. in height.

Centralab Semiconductor 4501 N. Arden Dr., El Monte, Calif. 91713 [417]

MOS memory designed for PDP-8/E computers

A metal-oxide semiconductor plug-compatible memory is designed for the PDP-8/E computer. It plugs directly into the Omnibus chassis and is both electrically and physically compatible with the DEC memory. The unit can be used either as a complete substitute memory or as an add-on to the existing system. Design is modular,

Evolution and the function generator



Lessons from the Dodo

IEC, in building its high-quality, low-cost Series 30 Function Generator, learned from the mistakes of others. (Yes, the industry has had its Dodos.) We knew that only a strong, highly reliable unit would survive, so we developed our compact, hard-working 0.3Hz-3Mhz Series 30 accordingly.

Performance and quality are built into the unit right from the beginning. Interstate Electronics Corporation's independent QC lab puts every Series 30 semiconductor through a rigorous performance test before production acceptance. Then, after Unit Testing, Calibration, Burn-In, and Stress Cycling, each instrument ticketed for shipment has to pass QC's computerized Assurance Test before it goes to our customer.

Monkeying with Ontogeny

The Unit Test is the first evaluation to identify and correct operative problems in the working instrument. Each of Series 30's versatile outputs, including variable Width Pulse, Sweep Sawtooth, Adjustable D-C Level, and Sine, Square, and Triangle waveforms are scrutinized for pure, consistent performance up to 20V p-p. In addition, our direct-reading Sweep Limit, 40-db Calibrated Attenuator, and other controls are handled for "feel" as well as accuracy.

During Calibration, Trigger, Gate, Burst, and Sweep Modes are given full play. By such critical inspections, we learn more about the instruments we make, and the product species as a whole is improved.

IEC actually over-calibrates to reach an exceptional quality of performance. While we spec a respectable 0.3% sine distortion, our generators typically achieve 0.18%.

Loss of the Sixth Toe

As part of the stress Cycle, we developed a "Shake 'n Bake" test that jolted and jarred Series 30 prototypes, then operated them in a 70°C. heat chamber. We still burn-in each Series 30 generator, but after extensive Unit Tests without a vibration failure, the "shake" cycle was declared obsolete.

Mutation Elimination

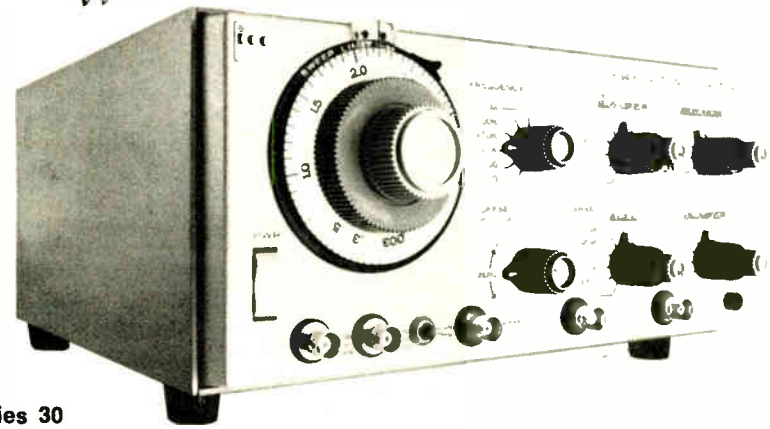
We don't produce to MIL-SPECS, but our procedures are amazingly close to it. During four in-process inspections, a QC team checks everything from each solder joint to screw mounts, rejecting the slightest imperfections. We expect each Series 30 unit to evolve exactly as specified, with absolutely no mutations.

Survival of the Fittest

After calibration, the Series 30 generator undergoes a minimum 120-hour "mileage" test. We turn each instrument on and off at irregular intervals during this stress cycling to simulate real-world strain, and our exclusive Output Limit Indicator glows to confirm that the Generator is operating under stress.

Following this, all instruments are processed by a final automated lab system. At this point the Function Generator *must* continue to perform precisely, with an exacting degree of conformity and predictability. Only by surpassing the highest standards of the species does the Series 30 survive in the field, and enjoy the lowest return in the industry.

We're ready to back up our claims. Go ahead . . . call John Norburg, collect, at (714) 772-2811, and ask for a demo!



F34 . . . $495

5 Other Models available in Series 30 From $295 to $695

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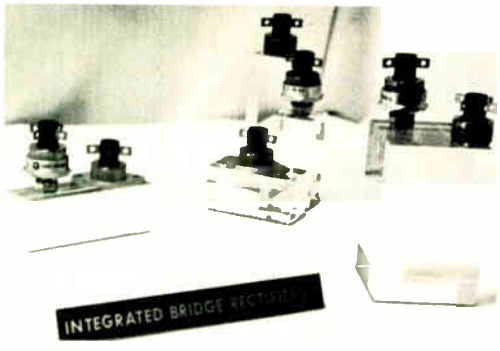
Circle 169 on reader service card

Culligan JOB REPORT

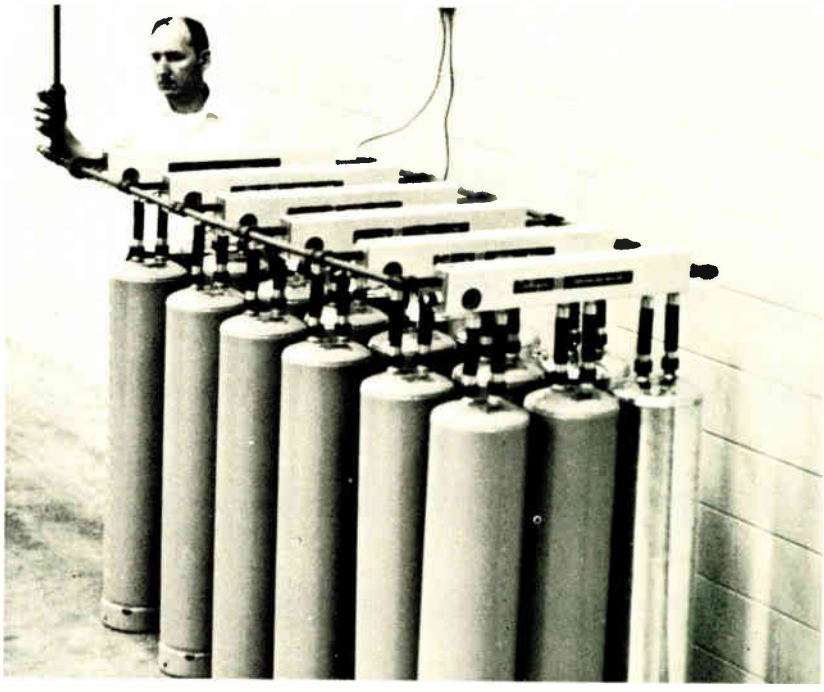
ELECTRONICS NO. 103

Deionized Water Essential To Texas Semiconductor Manufacturer



Typical silicon rectifiers made by Varo Incorporated.

Close-up view of cleaning booth, where assembly is being rinsed with deionized water.



Eighteen-tank Culligan system in use at Varo. System supplies deionized water for use in manufacture of semiconductors.

☐ If a manufacturer of semiconductor devices can't get high quality water, then it isn't a matter of product quality—it's a matter of product life or death. "And by very high quality," says Jan Collmer, General Manager of Varo, "we're talking far beyond one or two parts per million; we mean water quality in the 15 to 18 megohm range."

To meet Varo's exacting standards, the local Culligan Man supplied a deionizer system, utilizing 9-inch exchange service tanks. The decision to use portable exchange rather than automatic packaged deionizers was made for two reasons: economics and convenience.

The Culligan Man put the economics reason this way: "When the flow volume demand is low, you use portable exchange. Naturally, you reach a point in gallonage where you must balance the cost of purchase against the cost of leasing equipment. But you can't make a universal rule about it; each customer's demands are different."

As for convenience, Collmer adds, "We're not interested in becoming water experts. Our main concern is having high quality water available at all times, and we want to limit our involvement to paying the invoice each month.

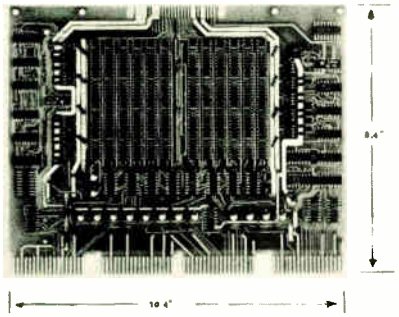
We pay only for the water we use. If we have a plant shutdown or if production drops for any reason, we can reduce or cut off the supply of deionized water immediately."

For detailed information and additional case histories, write to Will Sanders for our 4-page Job Reports 103, 119 and 120—or call your local Culligan Man for a consultation. ☐

Culligan USA, One Culligan Parkway, Northbrook, Illinois 60062.

CUSTOMER: Varo Incorporated
PROBLEM: Need for high quality water for manufacture of semiconductors
SOLUTION: 15-megohm water with exchangeable tanks
EQUIPMENT: Culligan deionizer tanks and carbon filters

and capacity can be expanded from 4,000 to 32,000 words in 4,000-word increments. The MOS device consists

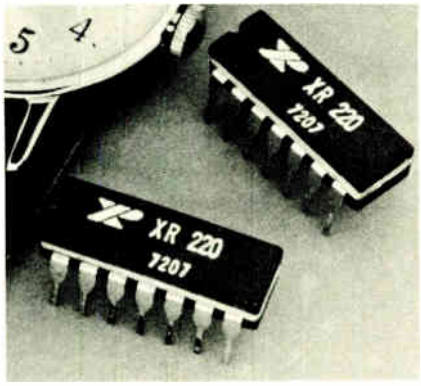


of one timing and control card plus up to eight 4,000-by-12 memory cards.

Signal Galaxies Inc., A subsidiary of The Signal Companies Inc., 6955 Hayvenhurst Ave., Van Nuys, Calif. [418]

Monolithic timer IC provides delays of 1 μs to 1 hour

A monolithic timing integrated circuit with delay output pulse ranging from 1 microsecond to 1 hour offers typical accuracy to within 0.5%. Temperature drift of the XR-220 is specified as 150 parts per million per °C. Only three external components are required: a timing resistor, a timing capacitor, and a simple load resistor, with delay determined



by the value of the timing resistor. Practical values of this resistor range from 3 kilohms to 1 megohm for a 5-volt supply. The XR-220 is available in two guaranteed timing-accuracy ranges. A military version is also available. Prices start at $4.

Exar Integrated Systems Inc., 733 North Pastoria Ave., Sunnyvale, Calif. 94086 [419]

New books

CRC Handbook of Lasers with Selected Data on Optical Technology, Robert J. Pressley, ed., The Chemical Rubber Co., pp. 631, $27.50
A comprehensive compilation of experimental data, this book consists mainly of charts, graphs, and tables—the text serves simply to explain them. The data is current as of late summer, 1970, the editor says, but he promises future editions.

In 21 chapters, with material from 28 contributors, the book covers such topics as safety, atmospheric transmission, incoherent sources, filters, detectors, laser types, modulator materials, optical storage media, and holographic parameters and materials. Each chapter is well referenced—a necessity, because there is little standardization in many measurements, and the user should have access to the original papers to determine the methods used in making any measurement.

One 20-page section lists more than 2,000 gas lasers by wavelength. Injection lasers are listed in a separate chart, backed up by some 89 references. The book's philosophy of compact treatment is epitomized in the section on injection lasers—in two pages, basic equations and definitions for injection lasers are given, while a third page lists the various materials, wavelengths, bandgaps, and modes of excitation.

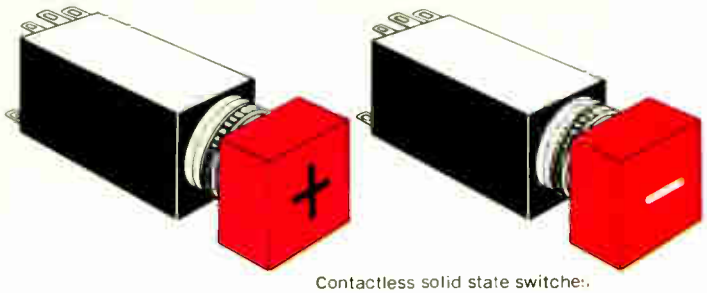
Some practical applications of lasers are given in the chapter on holography, but primary emphasis is on materials and properties.

Electronic Engineering Materials and Devices, John Allison, McGraw-Hill Book Co., pp. 303, $13.50

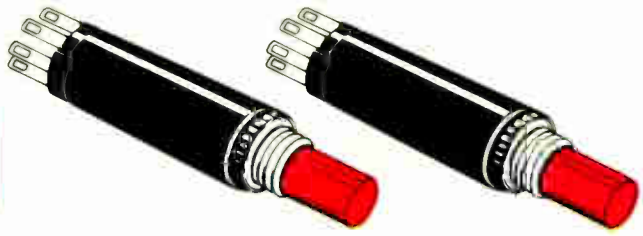
Calculus for Electronics, (second edition), A. E. Richmond, McGraw-Hill Book Co., pp. 544, $9.95

Parallelism in Hardware and Software: Real and Apparent Concurrency, Harold Lorin, Prentice-Hall Inc., pp. 508, $15.00

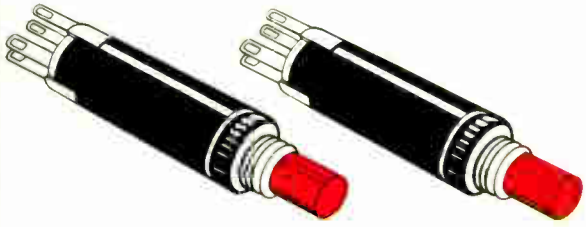
Instruments and Measurements for Electronics, Clyde N. Herrick, McGraw-Hill Book Co., pp. 560, $13.95



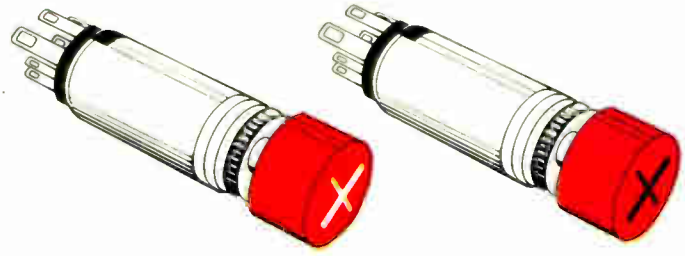
Contactless solid state switches



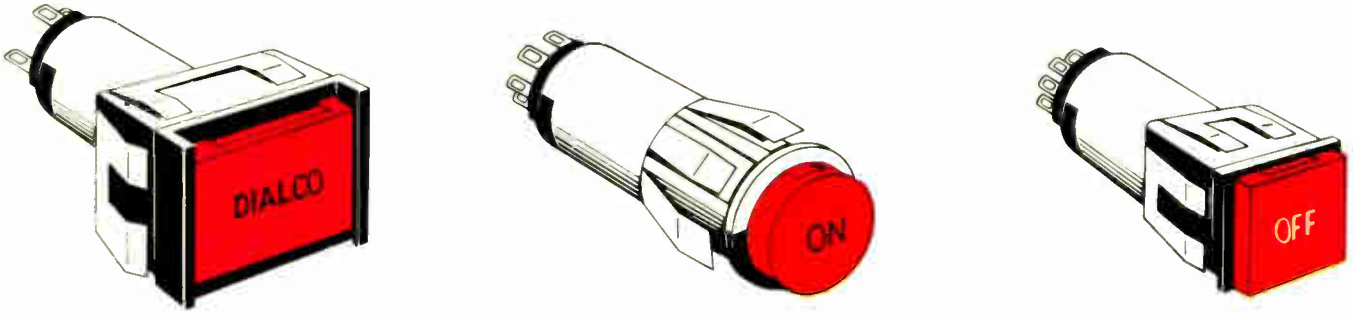
Incandescent or neon lighted switches



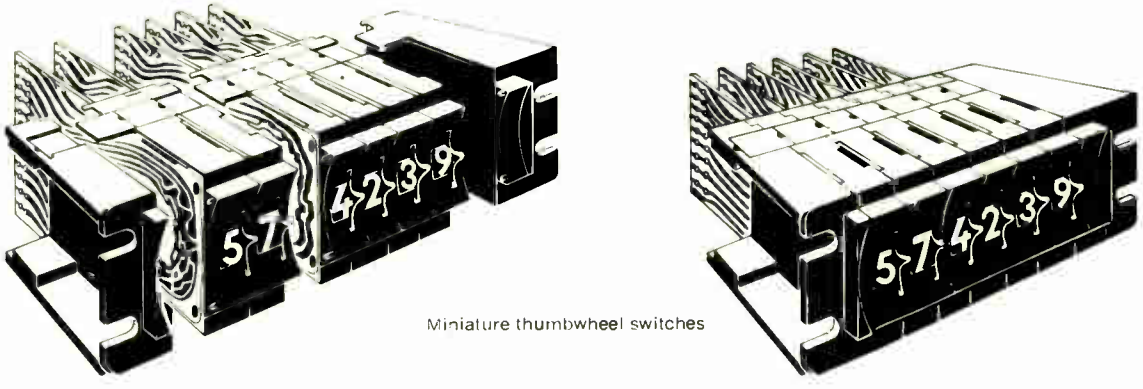
LED lighted switches... panel mounting



Incandescent lighted switches... panel mounting



Incandescent lighted switches... snap-in mounting



Miniature thumbwheel switches

Switches?

Talk to the specialists at Dialight first. You won't have to talk to anyone else.

Dialight has a switch for virtually any application. That means complete freedom to design for the job without compromising on physical or electrical parameters. Dialight can give you push button switches with unlimited cap and bezel options ...solid state switches that eliminate all mechanical switching problems... LED lighted switches... thumbwheel switches that snap together to provide any number of decades you require... switches with transistorized indicators. If you have a special problem, tell us about it. Chances are, the specialists at Dialight have seen it before. Meanwhile, ask for our switch catalog.

DIALIGHT DIALCO

DIALIGHT CORPORATION, A NORTH AMERICAN PHILIPS COMPANY · 60 STEWART AVENUE, BROOKLYN, N.Y. 11237 · (212) 497-7600

New literature

Tone-burst generator. Singer Instrumentation, Los Angeles Operation, 3211 S. LaCienega Blvd., Los Angeles, Calif. 90016. A four-page brochure describes the universal tone-burst generator, and lists proprietary call systems with which the instrument can be used. Circle 421 on reader service card.

Time code formats. A reference book of time code formats gives drawings and characteristics of about two dozen of the most commonly used codes, along with a glossary of terms. The manual is available from Datum, Timing Div., 170 E. Liberty Ave., Anaheim, Calif. 92801 [422]

Relays. A 28-page catalog is available from Struthers-Dunn Inc., Pitman, N.J. 08071, that gives condensed specifications, dimensions and prices for relays and motor controls. [423]

Coaxial components. A 36-page brochure from General Radio, 300 Baker Ave., Concord, Mass. 01742, describes components and accessories for high-frequency applications to 9 gigahertz. [424]

Fm tuner. Texas Instruments Incorporated, Components Group, P.O. Box 5012, Dallas, Texas 75222, has published an application report on designing a frequency-modulation tuner using metal-oxide-semiconductor field-effect transistors. Bulletin CA-164 is eight pages long, and provides test data and technical guidelines. [425]

Instrument transformers. An eight-page booklet on how to specify an instrument transformer is available from the Ritz Instrument Transformer Co., 2006 Manhattan Beach Blvd., Redondo Beach, Calif. [426]

Transistor chips. Teledyne Crystalonics, 147 Sherman St., Cambridge, Mass. 02140, has published a catalog of semiconductor chips for use in hybrid circuits. The catalog describes a series of standard components including FETs, pnp and npn switching transistors, integrated choppers, and monolithic interface circuits. [427]

Transformers. Essex International Inc., Controls Div., Stancor Products, 3501 W. Addison St., Chicago Ill. 60618. Catalog 207 lists more than 1,900 standard transformers for design engineers, and includes technical data and illustrations. [428]

Pc card test systems. A 16-page brochure has been released by Teradyne Inc., 183 Essex St., Boston, Mass. 02111, describing the company's L100 family of computer-oriented printed-circuit-board test systems. The brochure discusses both hardware and software aspects of the systems. [429]

Thyristors. A short-form catalog from Hutson Industries Inc., 2019 W. Valley View Rd., Dallas, Texas 75234, lists the line of triacs, SCRs, and diacs available, with data on principal voltage, current ratings and characteristics. [430]

Station coupler. Elgin Electronics Inc., Walnut St., Waterford, Pa. 16441, is offering a two-page data sheet of the ESC-20721 station coupler that connects various types of customer-provided equipment to the switched telecommunications network. [431]

Instruments catalog. Ballantine Laboratories Inc., P.O. Box 97, Boonton, N.J. 07005, has available a 15-page condensed catalog listing the company's line of test and measurement instruments, including automated and programable equipment. [432]

Photomultipliers. A catalog covering the line of photomultipliers, gas and vacuum photodiodes, electron multipliers, and integrated photodetection assemblies is available from RCA Commercial Engineering, Industrial Tube Div., Harrison, N.J. 07029. The 86-page catalog, PIT-700B, describes developments in photodetector design and manufacture. [434]

SEVENTY ACTIVE YEARS IN RADIO TELECOMMUNICATIONS

1901 . . . using kites and 500 feet of wire Guglielmo Marconi and his assistants, Kemp and Paget, receive the first transatlantic radio message. Faintly, but triumphantly, the three dots, 'S' in Morse Code, span three thousand miles breaking what was then the major communications barrier between continents.

1972 . . . seventy years later, Canadian Marconi Company has set the pace for breaking today's communications barriers using another form of code — pulse code modulation.

If you are in the business of communicating voice or data, find out how you can benefit from seventy years of telecommunications experience.

Write and ask us about our MCS 6900 digital microwave communications system . . . **the better way to communicate.**

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Circle 175 on reader service card

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Electronics Buyers' Guide

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We sell more magazines than most of our competition can give away free.

When you can sell something that everyone else gives away free, you must have something special.

And that's how it is with Electronics.

Our readers find Electronics so valuable, they'd rather pay for it than take a chance on something for nothing.

With every other electronics magazine giving subscriptions away, Electronics, at $8.00 to $25.00 a year, has a higher circulation than all but one. And that one doesn't beat us by much.

Ours is the most controlled circulation in the field. Controlled first, because subscribers must qualify to receive Electronics. Controlled again, because our readers have to be willing to pay the price.

Not only is our audience select, it's loyal. In fact, 25,000 of our subscribers never read any of the next six electronics journals.

And that's the kind of audience you have to reach.

58,000 (67%) have management responsibility.

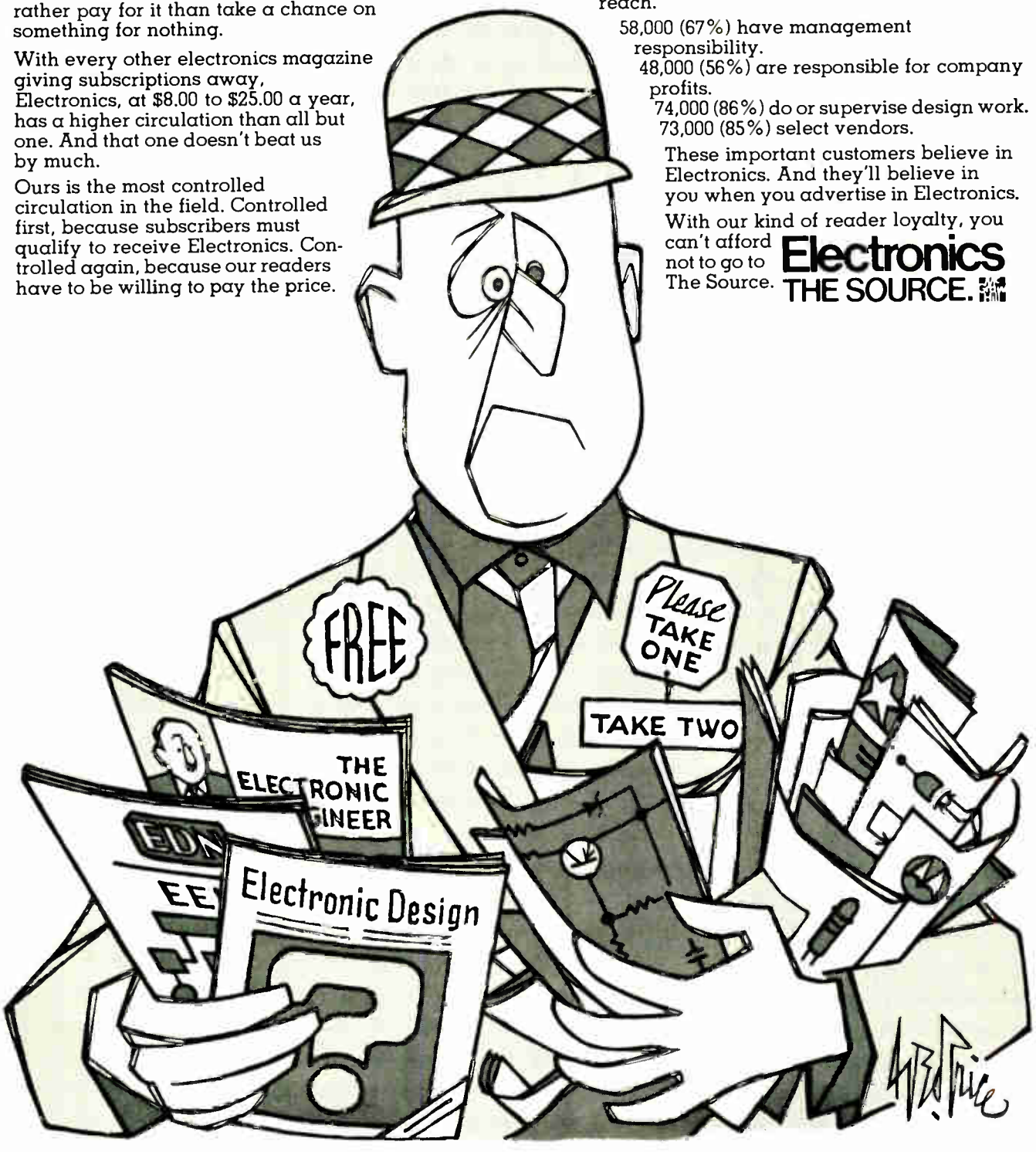
48,000 (56%) are responsible for company profits.

74,000 (86%) do or supervise design work.

73,000 (85%) select vendors.

These important customers believe in Electronics. And they'll believe in you when you advertise in Electronics.

With our kind of reader loyalty, you can't afford not to go to The Source. **Electronics** THE SOURCE.



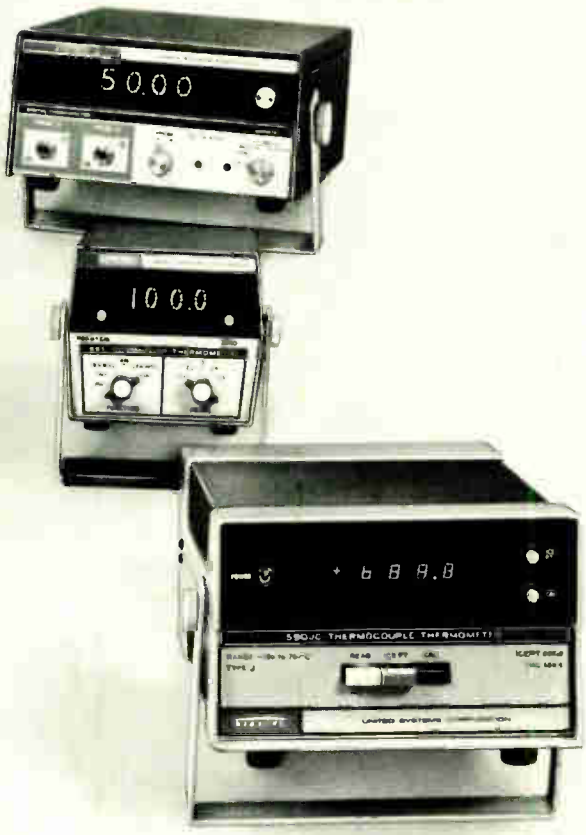
Electronics advertisers

May 8, 1972

Classified & Employment Advertising

F. J. Eberle, Manager 212-971-2557

■ For more information on complete product line see advertisement in the latest Electronics Buyer's Guide
Advertisers in Electronics International



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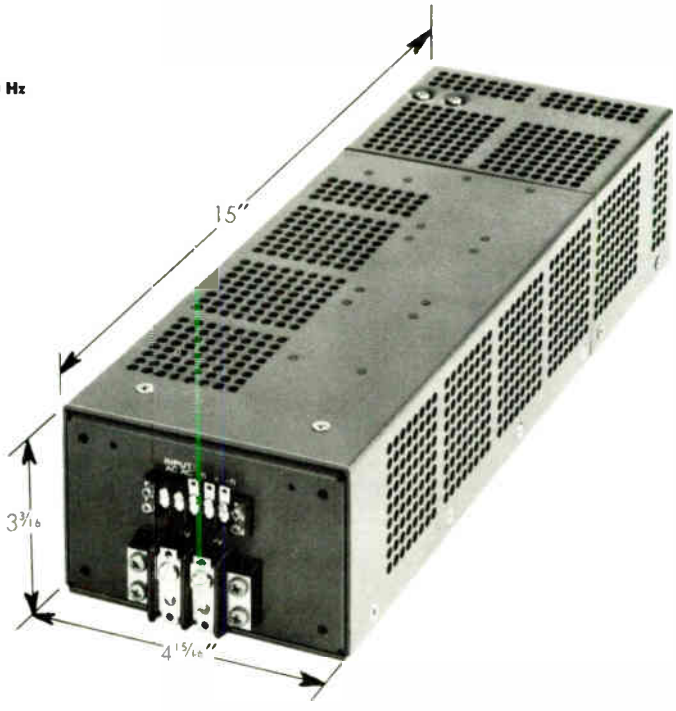

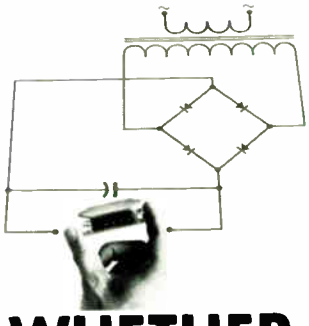

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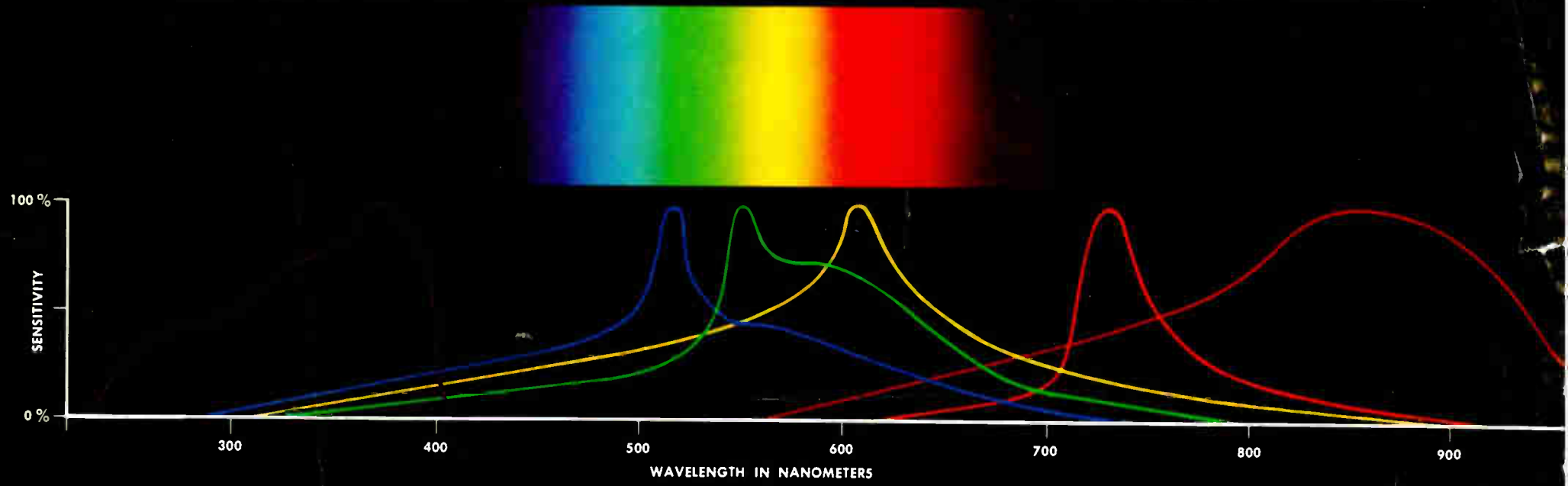

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