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5	9	512 x 5	MCS 2004
5	9	448 x 5 (64x7x5)	MCS 2000
6	9	384 x 6	MCS 2015
7	9	320 x 7 (64x5x7)	MCS 2001
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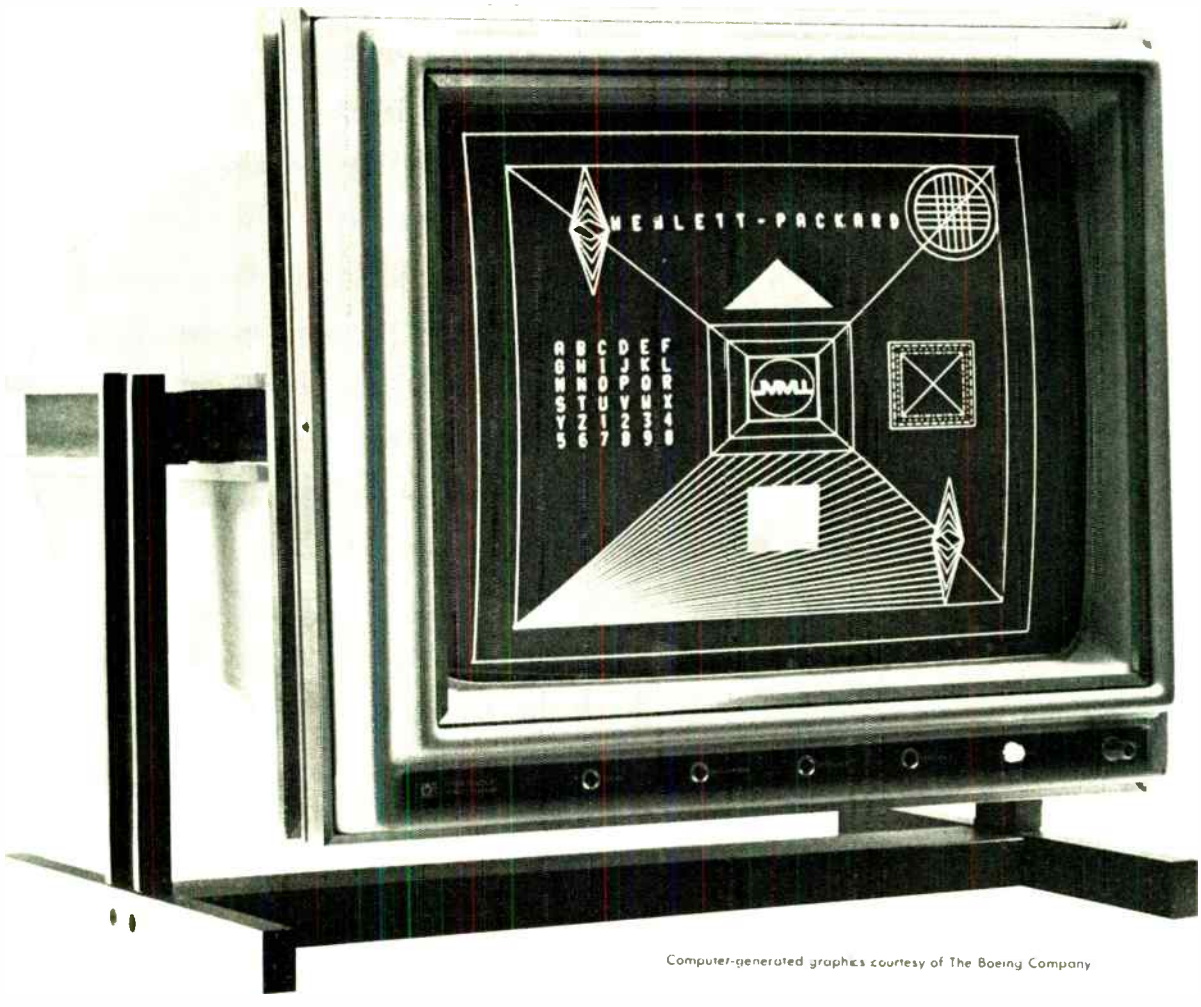

Computer-generated graphics courtesy of The Boeing Company

HP's new 1310A 19-inch-diagonal X-Y display is the answer to many an OEM's prayer... because it's the **first display ever that can keep up with the graphic information output of today's high-speed computers.**

The 1310A has a **writing speed of 10 inches per microsecond** – 10 times faster than any other display's. Its slew rate is 100 inches per microsecond. And its large-step jump and settle time is 1 microsecond. Thus, the 1310A gives you the ability to display information as fast as your computer puts it out – in any desired sequence of locations, without "smearing." No longer must you program outputs in a manner imposed by display limitations.

The key to the 1310A's outstanding performance is its **unique, advanced cathode ray tube** which uses electrostatic deflection to control its electron beam.

Also as a result of using electrostatic deflection, the 1310A is smaller, lighter, and **requires less power** than any competitive graphic display – only 100 watts. Because it uses the latest, highly rectangular CRT face glass, its display area is equal to that of many 21-inch units. And its **0.020-inch spot size** gives you a crisp, clear image over that entire area.

And performance is only the beginning! With the 1310A, you also get plug-in-board construction for fast, easy servicing. Replacement boards are available from any of HP's service centers around the world, on an exchange basis, within 48 hours. And it takes only minutes to remove or insert any board.

Yet, despite all these advantages, the **1310A costs only $3000** – far less than competitive displays (covers and stand, $100 extra). Or, for $2875, you can get all the features of the 1310A, in the new 14-inch-diagonal 1311A. **OEM price schedules are available on both the 1310A and 1311A.**

For further information on both of these new displays, contact your local HP field engineer. Or write Hewlett-Packard, Palo Alto, California, 94304. In Europe: 1217 Meyrin-Geneva, Switzerland.

081/14A

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Circle 1 on reader service card 1

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Price? 65¢ in 10 K quantities. And they're available in any quantity you want. Call your local HP office for the exact figures and specs on the 5082-4440. Or write Hewlett-Packard, Palo Alto, California 94304; Europe: 1217 Meyrin-Geneva, Switzerland.

HEWLETT hp PACKARD

SOLID STATE DEVICES

01105

Circle 2 on reader service card

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August 16, 1971

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Electronics

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Publisher's Letter

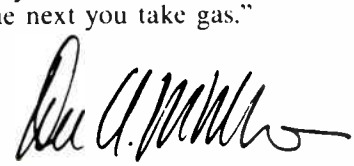
The task of looking behind the scenes at the problems of Wescon in the cover article (see p. 58) fell to Bob Henkel, managing editor, news, who spent most of July crisscrossing California talking to dozens of Wescon officials and to industry managers who were exhibitors or former exhibitors at the traditional annual industries event. Assigning Henkel was a logical choice, since he is a veteran Wescon watcher. He covered his first Wescon 15 shows ago, in 1957, and he's reported on the big meeting as it grew into the massive, 1,200-booth shows of the 1960s.

Back in those high-flying days, Henkel recalls, Wescon was limited in size only by the exhibit hall—there usually was a waiting list of anxious exhibitors ready to snatch up any booth space opened by a late cancellation. Then as now, Wescon has mirrored not only how good business was, but the style of the electronics industries and the way electronics people conducted business. Wescon was really "old home week" in the early days—an engineer had his choice of dozens of cocktail parties. It was a time when so many of the present Western industry giants were young, hustling firms using Wescon to show the more mature Eastern industry that they were very much "for real."

But today the Western industry has grown up, and Wescon's struggle to change the big meeting to make it more relevent to the industries' marketing needs again mirrors the problems of the companies it serves. As the electronics technology becomes ever more pervasive throughout all types of end-product applications, it becomes more and more difficult for the companies to identify, much less reach, prospective customers.

Completing our Wescon special coverage, San Francisco bureau chief, Stephen Wm. Fields, wore his "double E" hat to look over Wescon technical papers, and what he found interesting as an EE begins on page 70. Whenever the military/aerospace business in the West goes into eclipse, it's diversification time on the West Coast, and for the first time companies may truly be serious about getting into new markets. Lawrence Curran, Los Angeles Bureau Chief, made good use of his five years of covering Western industry for *Electronics* to take a look at what companies are up to in moving into new markets (see page 66).

We also have packed into this issue a midyear survey of the electronics markets (see page 97). Every one of our five domestic field bureaus and our New York staff of technical experts contributed to this interim report on just where the sales curve is heading. The verdict: almost straight east. The slide has bottomed out, but still up in the air is how long the flat spot will last. Al Rosenblatt, New York bureau chief, gathered up all the inputs, and provided a lot himself, to put together the story, which starts on page 97. Rosenblatt's favorite quote didn't make the story, though. He says one executive views the market this way: "One month the market is up, the next you take gas."



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Readers comment

Canada stands tall, too

To the Editor: If Switzerland stands tall in CATV [June 7, p. 101], Canada is a giant. Almost 25% of the 5.5 million TV households in Canada are on cable systems, compared to 10% in Switzerland and about 8% in the U.S. And the Canadian figure doesn't include hundreds of thousands of receivers on systems in apartment buildings and projects.

Wood-pole antenna operating bases such as the one illustrated in the article are fairly common in mountainous areas of the U.S. and Canada, and have been in use for years. Hybrid systems as described are not common on this continent, but some examples can be found dating back several years—the cable system at Huntsville, Ala., uses a hybrid system. Gas-filled cables are not unknown in North America: the Altoona, Pa., system has operated gas-filled coaxial cables for years.

I. Switzer
Maclean-Hunter Cable TV Ltd.
Rexdale, Ontario.

The way it is

To the Editor: Your special report on EEs in the '70s [June 7, p.55] was extremely interesting, and has given me some grim amusement. Perhaps a comment from somebody outside the U.S. might be of interest . . .

Has it occurred to you that your advice to EEs to update their education is of no use to the professional group in this situation? Or did you write it only because of a lack of a better idea? There are less jobs than EEs, no matter how well they are educated. If some will really land a better job because of better education, others will become jobless.

You did not touch on the basic problem, which is that the progress-and-technology religion that has been pushed to hysterics has served its purpose and cannot be kept up. It has earned billions for some and now it has broken down . . .

The environmental hysteria is now in progress; it will not employ as many EEs as the progress-and-technology hysteria. It's possible that chemical engineers will now be bred like rabbits.

My advice for EEs, as long as they

When you're already on top in linear IC's, you might as well rub it in.

Herewith, the LM216.

Designed for use in high impedance applications, the new LM216 series uses supergain bipolar transistors in a Darlington input stage instead of FETs, which results in exceptionally low offset voltage and input current errors.

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Morever, the LM216 will operate on supply voltages from ±3V to ±20V, drawing a quiescent current of only 300μA. (If you'd like, the LM216 can even be run from a single power supply like the 5V used for digital circuits.)

That pretty much covers the outstanding features of the new LM216 series op amps.

Which leaves only prices and where to get more information.

Prices (100 up) are as follows: LM216, $19.50; LM216A (high performance version), $40.00; LM316, $9.95; LM316A, $20.00.

Where to get more information is National Semiconductor Corporation, 2900 Semiconductor Drive, Santa Clara, California 95051. Phone (408) 732-5000. TWX: (910) 339-9240. Cable: NATSEMICON.

National

Readers comment

are young, would be to look around for other jobs. The rest should indeed organize—not to fight for higher income, but to inform the public, especially students, about what's really going on in the profession, and how many EEs are needed.

W. Baumann
Schlossberg, West Germany

Circuitry

To the Editor: I'd like to suggest a minor improvement for the Designer's Casebook, "Any voltmeter reads electronic thermometer," by Robert J. Battes in your March 29 issue, p. 68. The improvement is really a useful addition for a number of measuring circuits.

Simply adding a transistor and a resistor to a meter (as shown in the

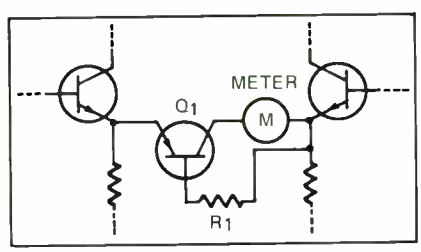

diagram) implements the change. The resulting circuit is usually inserted in the middle section of a difference amplifier. The meter indicates only when temperature (or whatever is being measured) passes a preset limit set by the amplifier's offset adjustment.

If the amplifier outputs are opposite in polarity, the meter does not deflect because transistor Q_1 is in cut-off. When the outputs have the same polarity, Q_1 conducts, drawing current through resistor R_1. By properly selecting R_1, it is possible to get 100% full-scale deflection regardless of how much the quantity measured exceeds the preset limit.

The circuit operates with the transistor on the verge of saturating. If too high a bias is applied, Q_1 quickly saturates. This means that meter output is quite linear over 80% of its travel. Moreover, the measuring circuit is protected from damage due to misadjustment or careless handling.

Klaus E. Engel
Frankfurt/Oder
East Germany

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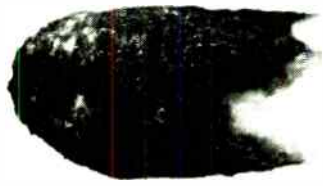

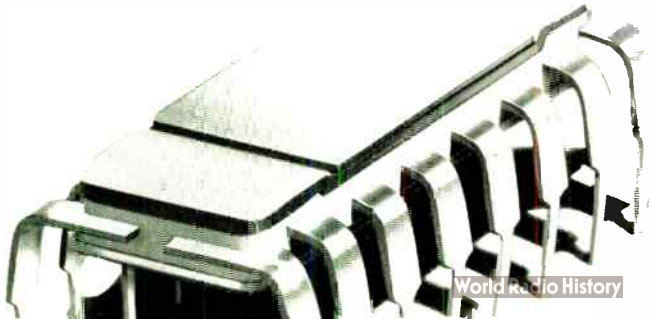

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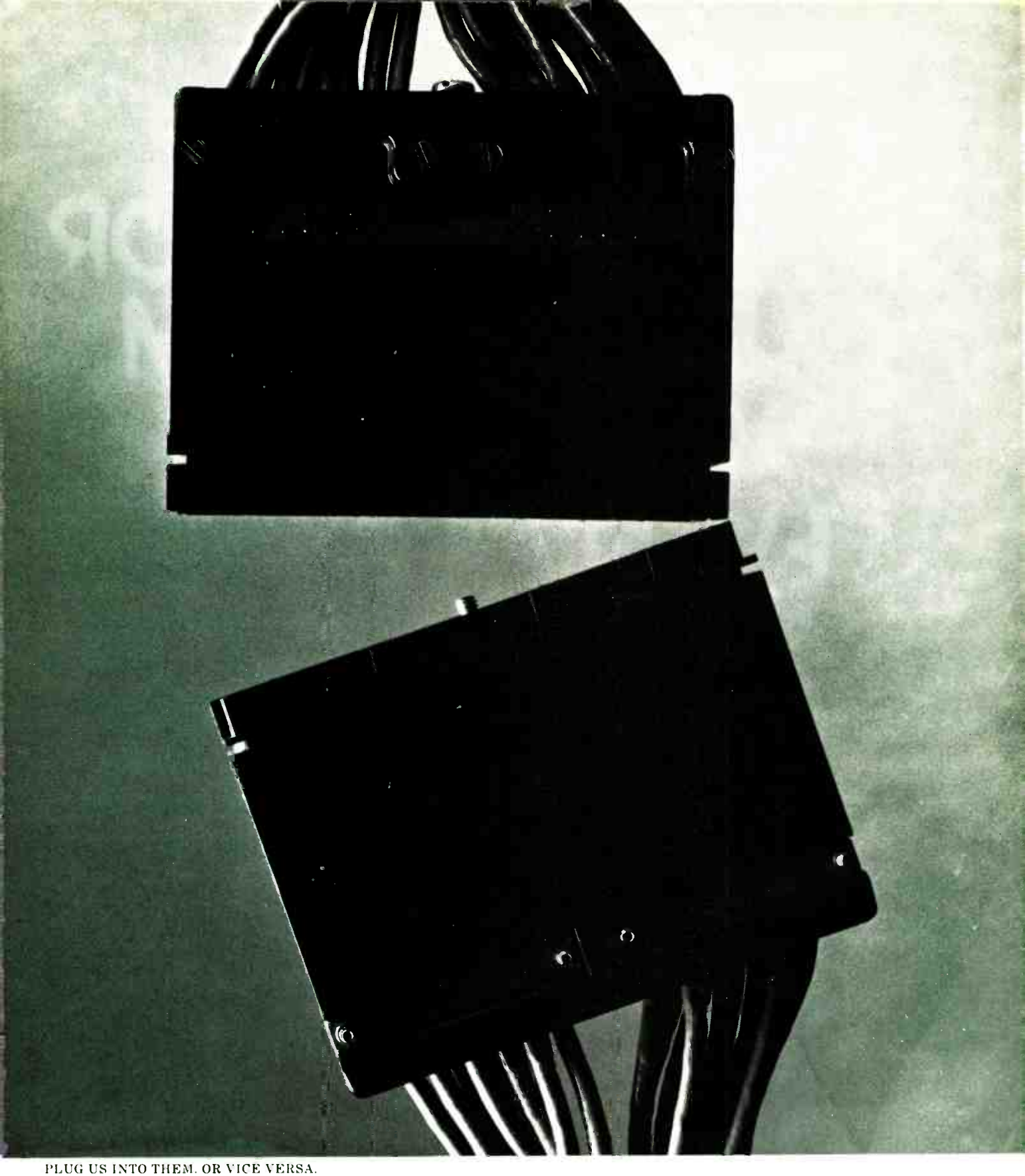

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MEASUREMENT IS OUR BUSINESS

People

The new president of North American Rockwell Information Systems Co., in Anaheim, Calif., has worn many hats in his career, but his latest challenge will probably mean that he'll start out as a fixer. A. Zettler Greely is taking over Narisco at a time when sales are strong but profits haven't been as good as North American Rockwell management would like.

Greely moved to his new post from the position of vice president for financial management at Autonetics. "I don't bring anything in technology to the new job," he says, "but I want to bring something crisper to Narisco's focus on business development." Narisco is primarily a systems and software house, tying computers, software and peripheral equipment together to provide, for example, monitoring and control of electric utility systems. It's under contract to deliver one such system to the Philadelphia Electric Company.

Greely: Sharpening up Narisco's focus

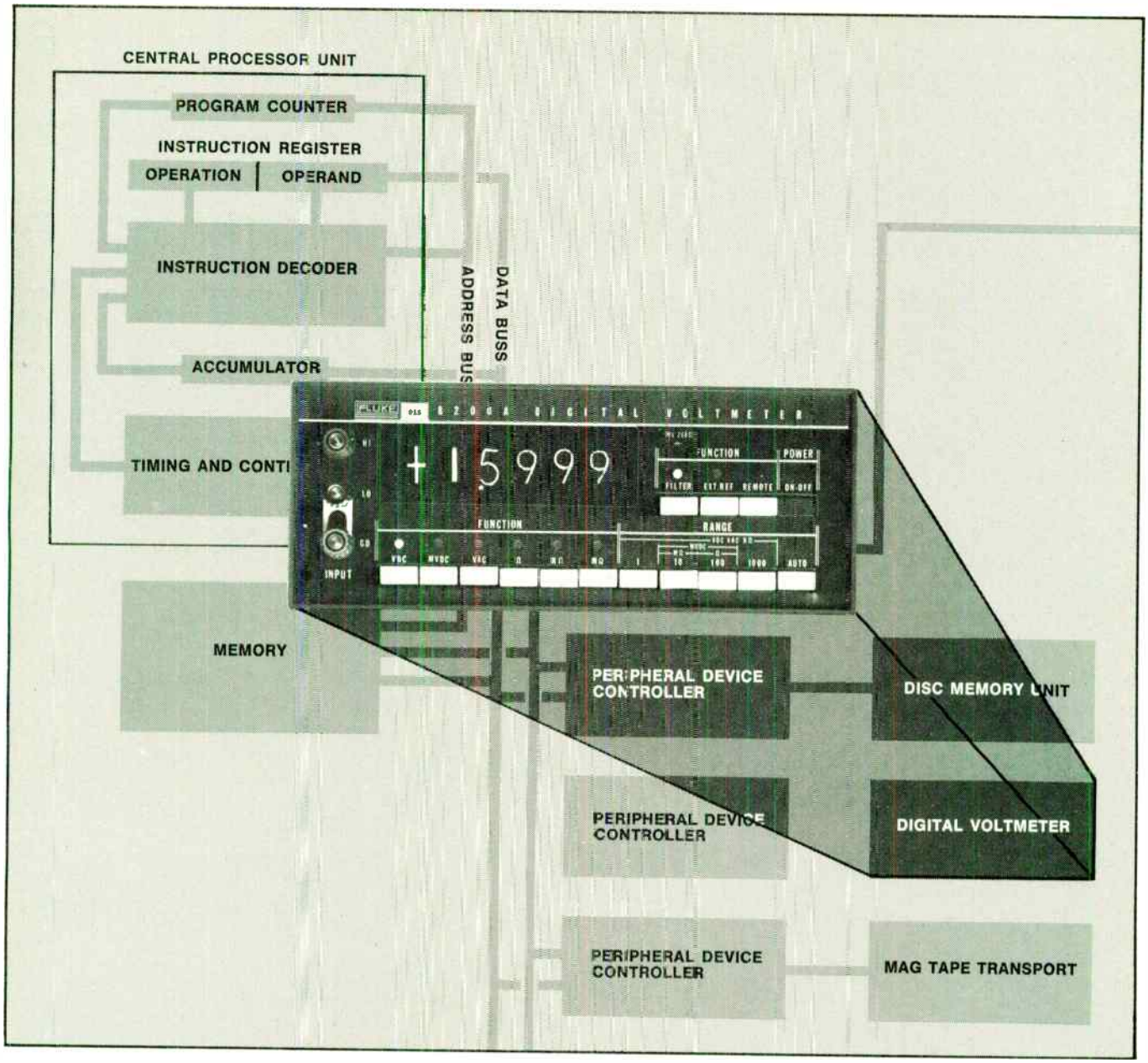
Greely regards power utilities as "a tremendous market. There's a power crisis in this country every summer. We can bring the sensor, computer and software, and real-time display technology to this market, and we're looking for a long-range relationship with power utilities." Other basic markets Narisco is now in, and Greely wants to stay in, are in automated telecommunications and non-defense Government markets. The firm has a classified contract for message processing from an undisclosed agency, and one from the Office of Education in the department of Health, Education and Welfare. The latter has Narisco "bringing the computer and systems approach plus file creation to the party" to monitor educational grants, Greely notes.

The new president's biggest task, though, will be to resist the temptation to bid on too many jobs, especially ones to which Narisco can't contribute anything unique. "What I really want to do is establish such good discipline that if a customer walks in with $400,000 to spend on building an automated ice-cream parlor, we'd turn him down because it's not our bag. I'd tell him to go see Carnation. I've seen too many small companies get into trouble because they don't know what their business is. We may limit growth to maximize profits."

The 43-year-old, prematurely white-haired "Zett" Greely started with the then North American Aviation Inc.'s Columbus, Ohio, division in manufacturing, then moved to contracts and pricing. He had majored in economics at Ohio State University, later passed the Ohio bar exam after graduating from Capitol University Law School. He also "was talked into running" for president of the city council in a small community outside Columbus, and won, serving as acting mayor during the mayor's absence.

He knows how local government works, and indicates that, though Narisco is working on several contracts from municipalities now, he will probably swing the company away from them in the future. "You can't work with them as easily as you can with the Federal or state governments," he comments.

At RCA's Solid State division in Somerville, N.J., they've finally settled on a marketing manager to take it all the way to its goal of being number 1 in sales of complementary metal oxide semiconductor devices. The new man is 37-year-old Daniel P. Del Frate, fresh from Westinghouse Electric Corp. where he has spent just about all his corpo-



The only fast new systems DVM

(400 samples per second, 60% overranging, autoranging and remote programming with memory).

The new Fluke 8200A DVM will give you years of topflight performance in either systems use or on the bench. A fast four digit instrument with an accuracy of 0.01%, the Fluke 8200A is small and lightweight.

We designed it to give you maximum flexibility. All the options can be added in the field so that it's easy to satisfy your changing requirements.

The Fluke 8200A gives you high accuracy, overranging, and **high sampling speed.** Standard features include autoranging **(millivolts through volts and ohms through megohms),** 1 millisecond sample and hold, half-rack width of 3½" high, modular construction with vertical plug-in boards, switched four pole filter in volts and **millivolts,** dc capability from 100 microvolts to 1100 volts, full guarding for 140 db common mode rejection dc to 60 Hz, 2 millisecond response time, and overload proof design.

The basic instrument goes for $995. Many options are available: two ranges of millivolts for **1 microvolt resolution,** six ranges for measurements from 10 milliohms to 16 megohms, four ranges of ac, true 4 wire ratio, isolated digital or printer output, and isolated remote control **with memory** for direct computer interface. A full bore Fluke 8200A with all options goes for $2,395.

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People

Del Frate: Aiming for No. 1 in C/MOS.

rate life. He started at the metals operation there in 1956, one year before he graduated from the University of Pittsburgh with majors in mathematics and physics. Beginning as a sales trainee in Western Pennsylvania, he progressed steadily, eventually shifting over to selling semiconductors. In late 1968 he became marketing manager for the Semiconductor division, Youngwood, Pa., and early this year moved up to corporate marketing director for Westinghouse's consumer products company.

And now at RCA he's back in the competitive whirl of semiconductors, reporting directly to vice president and general manager William C. Hittinger. In his post, Del Frate relieves Hittinger of the marketing chores he's been handling since coming to RCA almost a year and a half ago. Del Frate's appointment completes Hittinger's top-level management staff.

Del Frate is, of course, still getting used to his new surroundings but he is particularly impressed with RCA's "total corporate commitment" to becoming a major factor in the integrated circuits field. He has been quite pleased to learn the company's C/MOS line has so far this year exceeded its sales objectives. So although the overall market for RCA's power semiconductor products may be off this year, Del Frate has the chance to make the IC side really sing.

We took everything they could throw at us

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We've written enough of the "book" on shielding to know there's no substitute for experience when solving tough EMI problems. That's why it took us practically twenty years to build our comprehensive line of shielding products... one solution at a time.

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Circle 17 on reader service card

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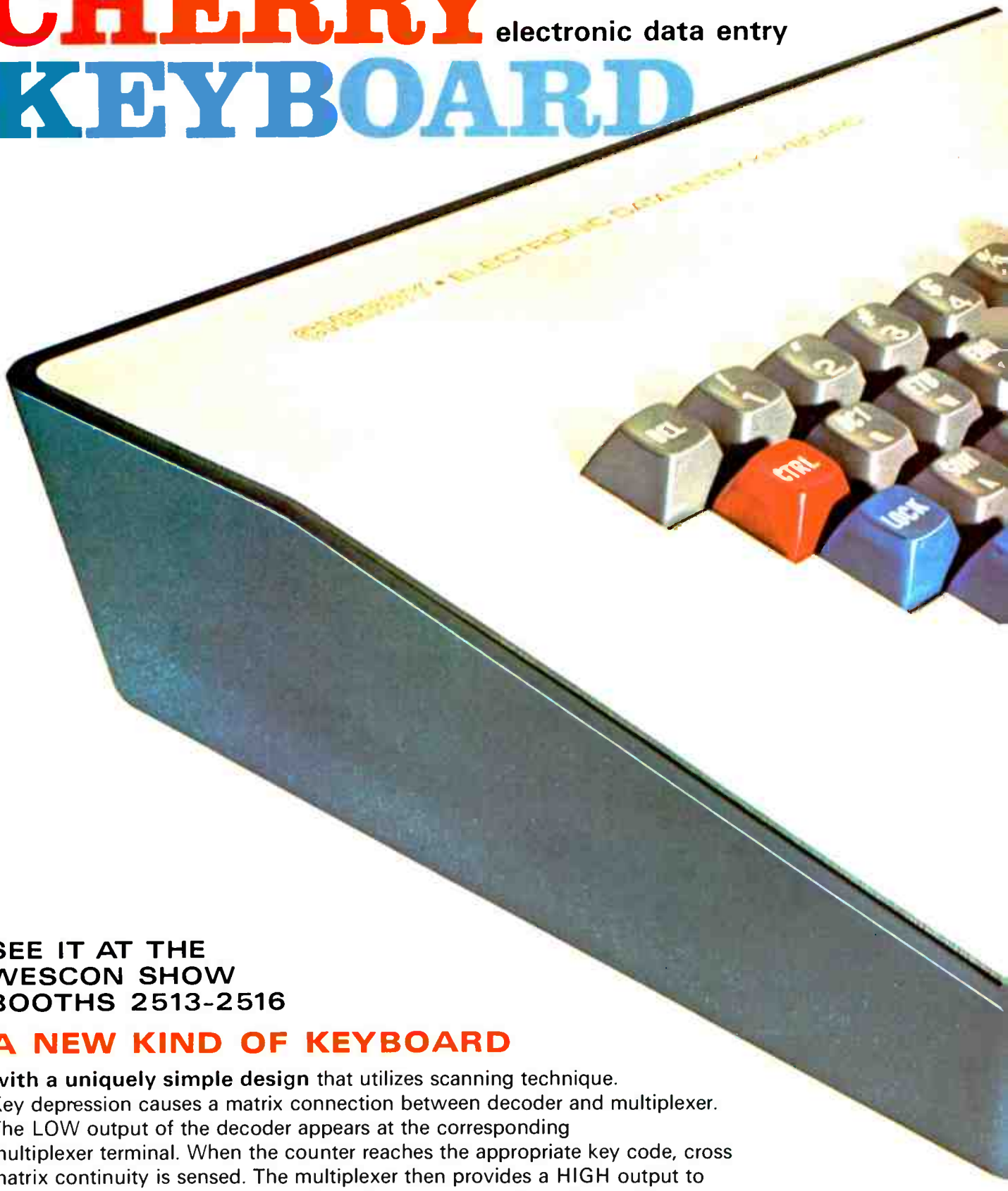

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A NEW KIND OF KEYBOARD

with a uniquely simple design that utilizes scanning technique. Key depression causes a matrix connection between decoder and multiplexer. The LOW output of the decoder appears at the corresponding multiplexer terminal. When the counter reaches the appropriate key code, cross matrix continuity is sensed. The multiplexer then provides a HIGH output to the monostable multivibrator causing a 1 millisecond pulse. This inhibits the clock and stops the counter on the desired code.

A NEW KIND OF KEY

with gold "crosspoint" contacts that eliminate the two main causes of contact failure—(1) formation of insulating chemical film on contact surfaces and (2) mechanical interference of foreign particles on contacts. This proven design concept (Gold prisms at right angles to each other) provides high force per unit of contact area and virtually eliminates contact closure interference from foreign particles.

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Quality A-B variable resistors at a competitive price.

*Standard unit with plain bushing and hardware, 20% tolerance in 1,000 piece quantities. Prices subject to change without notice

Type W variable resistors feature a solid hot molded resistance track for long operating life. Tests show less than 10% resistance change after 50,000 complete rotations. The noise level is low and the resolution is virtually infinite. Low inductance permits operation at high frequencies where wirewound variable resistors are useless. A lot of variable resistor for less than a dollar

Type W: ½ inch diameter, ½ watt rating at 70°C. Can be operated at 120°C ambient. The entire unit is immersion sealed. Available in resistance values from 100 ohms to 5 megohms.

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Circle 20 on reader service card

40 years ago

From the pages of Electronics, August 1931

When a company advertises radio sets for sale, it must specify whether the prices quoted include an outfit of tubes with each set. The Federal Trade Commission has so ruled in the case of a manufacturer, whose identity was not disclosed, but who was found advertising "in a way which tends to deceive buyers into believing that the prices quoted by the company for its sets include an outfit of tubes with each set, when such is not the fact."

There is perhaps no field where instruments have played such an important role in the advance of an art as in the radio, sound, and allied industries.

Instrument manufacturers by their ingenuity, patience, and workmanship have produced many standard and special instruments to meet the most exacting requirements of development engineers and the production line. To make even a partial list of such instruments would run up into the hundreds. Instruments are man's most valuable tools.

As an indication of the practical application of vacuum-tube control of traffic signals at dangerous street crossings, one company has already installed such units in 169 municipalities within the last two years. Traffic officials readily recognize the greater efficiency and economy of such controls over a detail of police.

Television, according to the prophets, is just around the corner—like prosperity. The prophets are behind the times, as stock salesmen will tell you. "Help-wanted" advertising appearing in New York newspapers gives the impression that stock salesmen do not agree with the prophets and the engineers—and the editors—who do not believe that television is ready for popular consumption.

Those familiar with the early days of the radio boom wonder if television is to be beset with similar stock market activities—which led to vast quantities of money being lost by a misguided investing public.

Meetings

Western Electronics Show and Convention (WESCON), Western Electronics Manufacturers Association, IEEE; Brooks Hall/Civic Auditorium, San Francisco, Aug. 24-27

Geoscience Electronics Symposium, IEEE; Marriott Twin Bridges Motor Hotel, Washington, Aug. 25-27.

Conference on Displays, IEE; University of Loughborough, England, Sept. 7-10

International Conference on Engineering in the Ocean Environment, IEEE; Town & Country Hotel, San Diego, Calif., Sept. 14-16.

Joint Power Generation Technical Conference, IEEE; Chase Park Plaza Hotel, St. Louis, Mo., Sept. 19-23

International G-AP Symposium & USNC/URSI Meeting, IEEE; University of California, Los Angeles, Sept., 20-23.

Conference on Infra-Red Techniques, IEE; University of Reading, Reading, Berkshire, England, Sept. 21-23.

International Computer Technical Conference, IEEE; Boston, Mass., Sept. 22-24

Fall Broadcast Technical Symposium, IEEE; the Washington Hilton Hotel, Washington, D.C., Sept. 23-25

International Telemetry Conference, Instrument Society of America, Electronic Industries Association; Washington Hilton Hotel, Washington, D.C., Sept. 27-29.

CALL FOR PAPERS

International Symposium on Fault-Tolerant Computing, IEEE, Massachusetts Institute of Technology; Boston, June 19-21, 1972. **Nov. 1** is deadline for submission of papers to Prof. Gernot Metze, Coordinated Science Laboratory, University of Illinois, Urbana, Ill. 61801.

You've had static card readers before. You know the problems. Now there's an optical static card reader that doesn't give you static. Panasonic's.

Our new static card reader is a simple micro-optical device for reading Hollerith type cards or badges. It has superb features that make it worth reading *about*. Like remarkably compact size. Extreme reliability. And tremendous simplicity of operation.

All these wonderful features are due to Panasonic's latest breakthrough. Unique, super-sensitive, diode-isolated light sensors.

We've arranged our new sensors in an X-Y matrix on a PC board. They're activated by tiny incandescent bulbs that shine through the holes in Hollerith cards. And they provide enough output voltage to drive your DTL or TTL directly.

Panasonic's optical static card reader

All you have to do is plug our reader into your standard connectors. And you're ready to start scanning. Perfectly.

As if it weren't enough to make a reader that's infallible, we've made personnel infallible too. With an electro-optical and mechanical system that absolutely prevents improper card insertion.

The Panasonic optical static card reader is available in sizes to read any size Hollerith card. From small 10 x 10 to big 12 x 80. Send in the coupon below and find out more. We'll put your card reading problems in a whole new light.

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☐ Please send me information about Panasonic's optical static card reader.
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We've finally found a reliable card reader.

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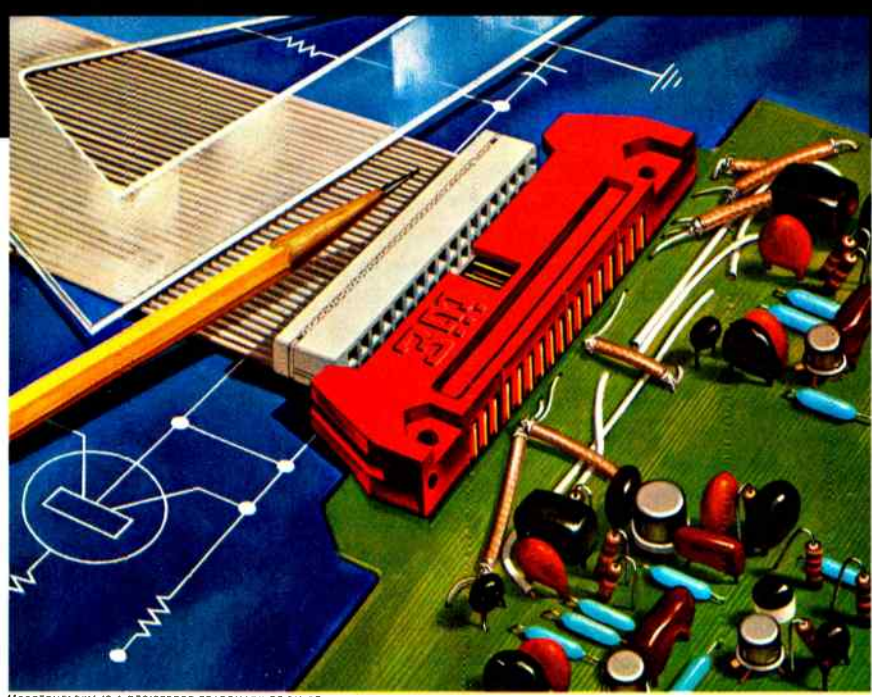
See Panasonic's card reader, unique HPF products, relays, motors and VTR equipment at WESCON, booth #1811

Circle 23 on reader service card

For built-in reliability, design with "Scotchflex" Flat Cable/Connector Systems.



"SCOTCHFLEX" IS A REGISTERED TRADEMARK OF 3M CO.

"Scotchflex" Flat Cable and Connectors can offer you trouble-free packaging for your next generation equipment.

There's built-in reliability for your circuit inter-connects. Our flat, flexible PVC Cable has up to 50 precisely spaced conductors. The gold plated U-contacts are set into a plastic body to provide positive alignment. They strip through the insulation, capture the conductor, and provide a gas-tight pressure connection.

Assembly cost reductions are built-in, too. "Scotchflex" Connectors make up to 50 simultaneous connections without stripping or soldering. No special training or costly assembly equipment is needed.

Off-the-shelf stock offers you flat cable in a choice of lengths and number of conductors from 14 to 50. Connector models interface with standard DIP sockets, wrap posts on .100 x .100 in. grid, or printed circuit boards. Headers are available to provide a de-pluggable inter-connection between cable jumpers and printed circuit boards (as shown). Custom assemblies are also available on request.

For full information on the "Scotchflex" systems approach to circuitry, write to Dept. EAH-1, 3M Center, St. Paul, Minn. 55101.

3M COMPANY

Electronics Newsletter

August 16, 1971

TRW back in ICs with Sylvania SUHL

TRW Semiconductors is back in the IC business, making—of all things—TTL products. TRW sources confirm only that much now, but reliable outside sources report that **the firm is using processing equipment purchased from Sylvania Semiconductor, is making the former Sylvania SUHL** variety of TTL, and has also picked up a guaranteed customer—Automatic Electric Co.—in a multifaceted transaction with GTE Sylvania. Automatic Electric manufactures equipment for General Telephone & Electronics.

TRW Semiconductors, which has the original patent for TTL because of early work done by its forerunner, Pacific Semiconductors, got out of the IC business several years ago after making circuits for military missiles. It would seem suicidal for a company to get into the price-slashing TTL business at this stage. **But if TRW has a link with Automatic Electric, the move could be a sound one.** TRW normally seeks to dominate the segment of a market it chooses to penetrate in the semiconductor business.

Point-of-sale gear registering faults

Electronic point-of-sale systems for retailers are facing rough going from department store requirements. The National Retail Merchants Association (NRMA) is coordinating a series of 13 pilot projects across the country to evaluate terminals and systems, but so far **not one manufacturer has met all the retailers' criteria.**

For example, giant National Cash Register Co. struck out at a J. C. Penney trial primarily because its basic terminal couldn't handle credit verification. However, an association spokesman says that **NCR has indicated it will meet all the final specifications** in order to stay in this potentially lucrative market.

By fall the retail association will have a report on 21 separate test efforts and then intends to set detailed, final specifications for manufacturers. The Department of Commerce is helping the association write these specs.

Worried Nerem changes plans

With a worried look at lagging income and attendance figures for the IEEE and Wescon shows, **the Northeast Electronics Research and Engineering Meeting (Nerem) is trying to change with the times.**

The usual technical program for the Nov. 3-5 meeting in Boston is abbreviated. Instead, Nerem has placed at least six specialized programs under its umbrella: the 1971 Eastern Electronics Packaging Conference, and two-day special conferences on medical engineering, transportation, pollution measurement and control, computer applications, and solid state circuits and devices. Noting the dropoff in exhibit sales at Wescon (see page 58), Nerem also is offering half-size booths at about one-third the price of regular space; users would hand-carry their goods to these booths.

Comsat working on China TV link

While AT&T is telling the press about its plans to reopen telephone communication with the People's Republic of China, **Communications Satellite Corp. is working quietly with the White House to get a satellite ground station into China for coverage of President Nixon's visit to**

Electronics Newsletter

Peking. The hope is that the Chinese will approve the link and perhaps let it remain after the President's departure. Plans are being worked out through the White House Communications Agency, the President's own small communications organization, and also the Office of Telecommunications Policy.

Four options are reportedly being considered for presentation to the Chinese:

(1) A small portable earth station with an antenna diameter of about 10 feet to be used only for the Nixon visit;

(2) a similar small installation to remain in China;

(3) a larger portable station using the 32-foot antenna developed for Comsat by Raytheon for temporary use,

(4) a larger station for fixed installation.

EVR cassette reproduction goes to real time

A color beam recorder that will duplicate Electronic Video Recording cassettes in real time, with master and slave moving at a rate four times faster than playing time, is in the final stage of testing at CBS Laboratories. Up to sixteen cassettes at a time can be produced automatically.

CBS' present duplicator, the Minibeam, which operates at one-sixth real time, will be used for small orders of 50 cassettes. The company is banking on its faster recorder to cut notoriously high reproduction costs, and aims at turning out at least 600,000 cassettes within a year for its expanding commercial market. The recorder is expected to go into production soon at the Rockleigh, N.J., plant that manufactures the EVR cassettes.

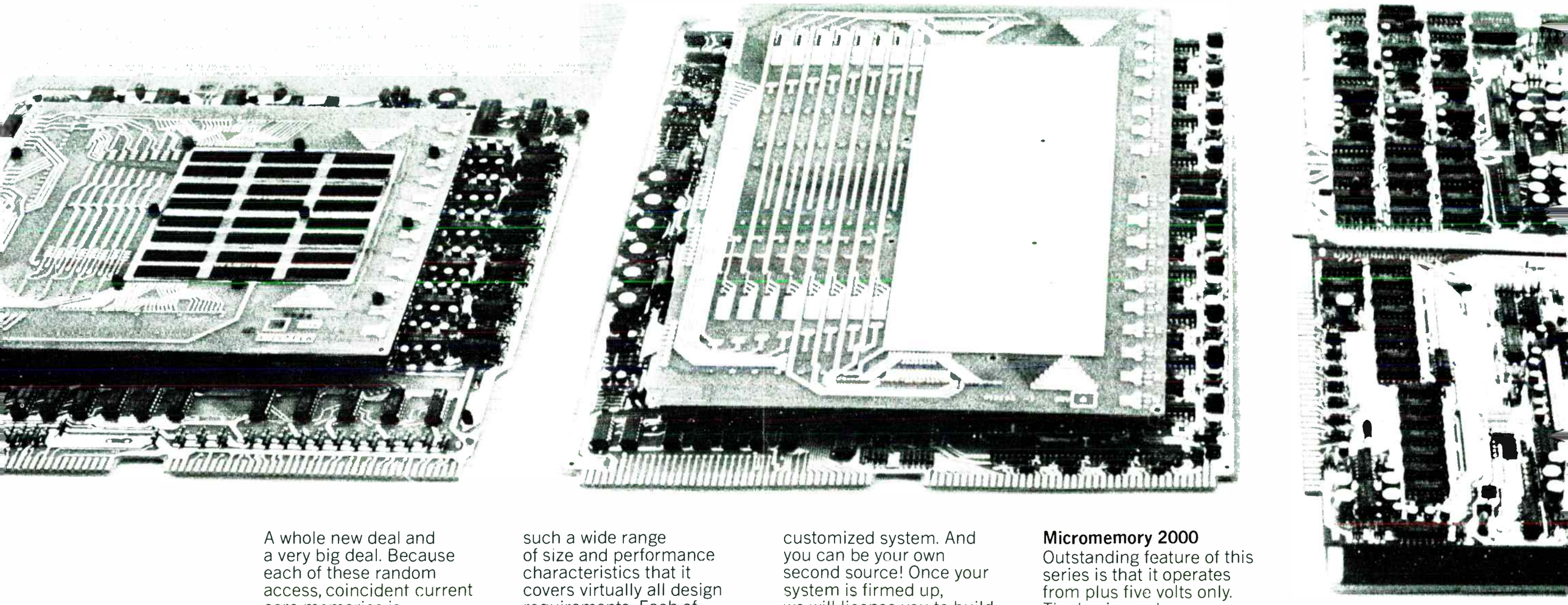
NR investment in Collins could turn into merger

It now looks like a true merger is shaping up between Collins Radio and North American Rockwell. "Affiliation" is the official NR word covering negotiations for it to invest an initial $35 million in cash-short Collins [*Electronics*, June 21, p. 36]. But one official close to the talks says that merger eventually could result because NR would own more than half of Collins' stock, and would hold control of the board. The deal needs only the approval of Collins shareholders on August 31, since both companies' boards have blessed the deal.

Addenda

Western Digital Corp., new name for the Newport Beach, Calif., company founded by Alvin B. Phillips, president, as General Digital Corp., is now in production with custom MOS/LSI chips for calculators and credit card verifiers. Phillips won't name his customers, but says his custom chip backlog has topped $1 million. . . . In a new approach to engineering seminars, Texas Instruments is going on a TV circuit with a 17-city, three-day seminar (Sept. 22-24) on MOS/LSI applications. Videotaped lectures will be broadcast directly from Dallas over the GE Command Performance network, the big-screen, theater-style setup with two-way audio communication. Admission: $195. . . . Instrument Systems Corp., a pioneer in the field of multiplexed passenger entertainment and service systems for aircraft, may have a leg up on competitors now that it has a patent on a system like the one it developed for the Boeing 747. ISC is putting together a similar layout for the Lockheed L-1011 airbus, while Hughes Aircraft has the contract for the McDonnell Douglas DC-10 airbus version.

With a full line of *every*thing-on-one-card memories available off-the-shelf and at prices you can't forget.



A whole new deal and a very big deal. Because each of these random access, coincident current core memories is completely contained on a single printed circuit card. And each circuit card contains all the required logic, drive and sense circuitry. All you have to add is a DC power supply. And we're offering this new concept in three different series with such a wide range of size and performance characteristics that it covers virtually all design requirements. Each of the cards shown is in quantity production for immediate off-the-shelf delivery. Each is fully TTL compatible with no analog or critical timing inputs required.

The system design possibilities are almost unlimited. You can stack the individual cards to form any size system that you need. We'll be glad to do that job for you and deliver a customized system. And you can be your own second source! Once your system is firmed up, we will license you to build these cards with our stacks.

So read the descriptions. Check the specs. And read what we have to say about *costs*. That way we don't have to tell you how much you can save. You can figure it out for yourself.

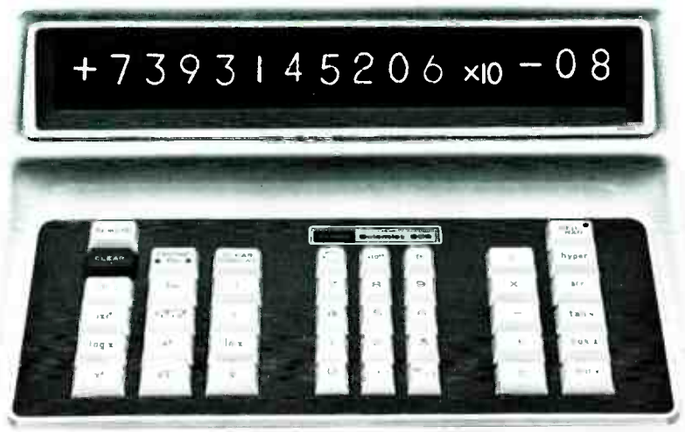
Micromemory 2000
Outstanding feature of this series is that it operates from plus five volts only. The basic card configuration is 4,096 words by 9 bits per word. Cycle time is one microsecond and access time is 400 nanoseconds.

Micromemory 3000
This is the one to look at if your requirement calls for high speed. Full cycle time is 650 nanoseconds and access time is 300 nanoseconds. Maximum capacity within a single card is 8,192 words by 18 bits per word or 16,384 by 9. Byte control and Data Save features are included.

Micromemory 4000
If your need is large capacity at low cost, this is the series to look at. Single module capacity is 32,768 words by 18 bits per word. Other standard capacity configurations are shown on the table of specs at right. Smaller capacities

Introducing the Tektronix calculator family

Tektronix calculators and their peripherals perform in a natural, human-oriented way which eliminates any need to know or learn specialized machine languages. For example, to operate the Scientist 909 or Statistician 911, you simply key in your mathematical expressions **directly** on the keyboard. The simplicity and power of the two calculators is extended by a full range of peripherals to provide more calculating capability at less cost than any other instrumentation on the market today. Your Tektronix field engineer will be happy to answer any questions or arrange for a demonstration. For complete specifications, contact us at 1089 Morse Avenue, Sunnyvale, CA 94086. Phone (408) 734-3630.



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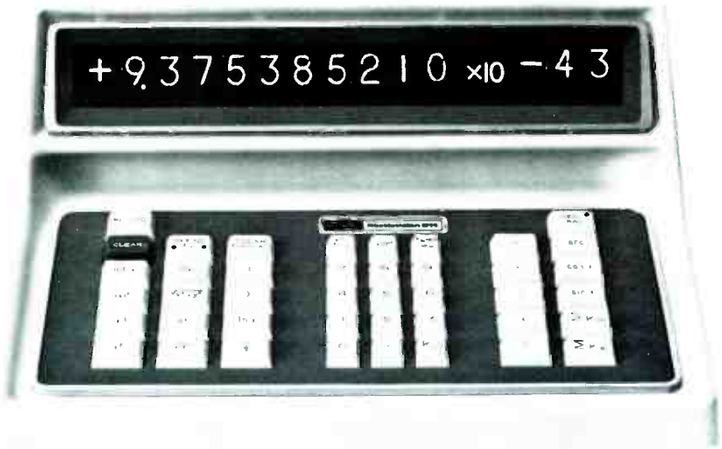
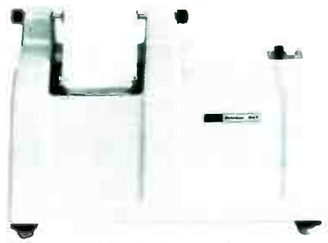
Scientist 909 and Statistician 911 programmable calculators.
Straightforward operation frees operator from confusion of machine languages. Offers more mathematical functions than any other machine with fewer total keys. f(x) programming to 85 steps, 256 optional; retains 26 constants, 100 optional. Price of 909 or 911, $3,780.



Programmer 926. Performs program steps with loops, branches, and subroutines. Stores up to 5120 steps on tape cartridge. Price $1,495.



Printer 941. Digitally prints out calculator display. Price $995.

f(x) Repeater 920. Allows looping of calculator programs. Price $95.

Instructor 928. Records and plays back calculator programs. Price $245.

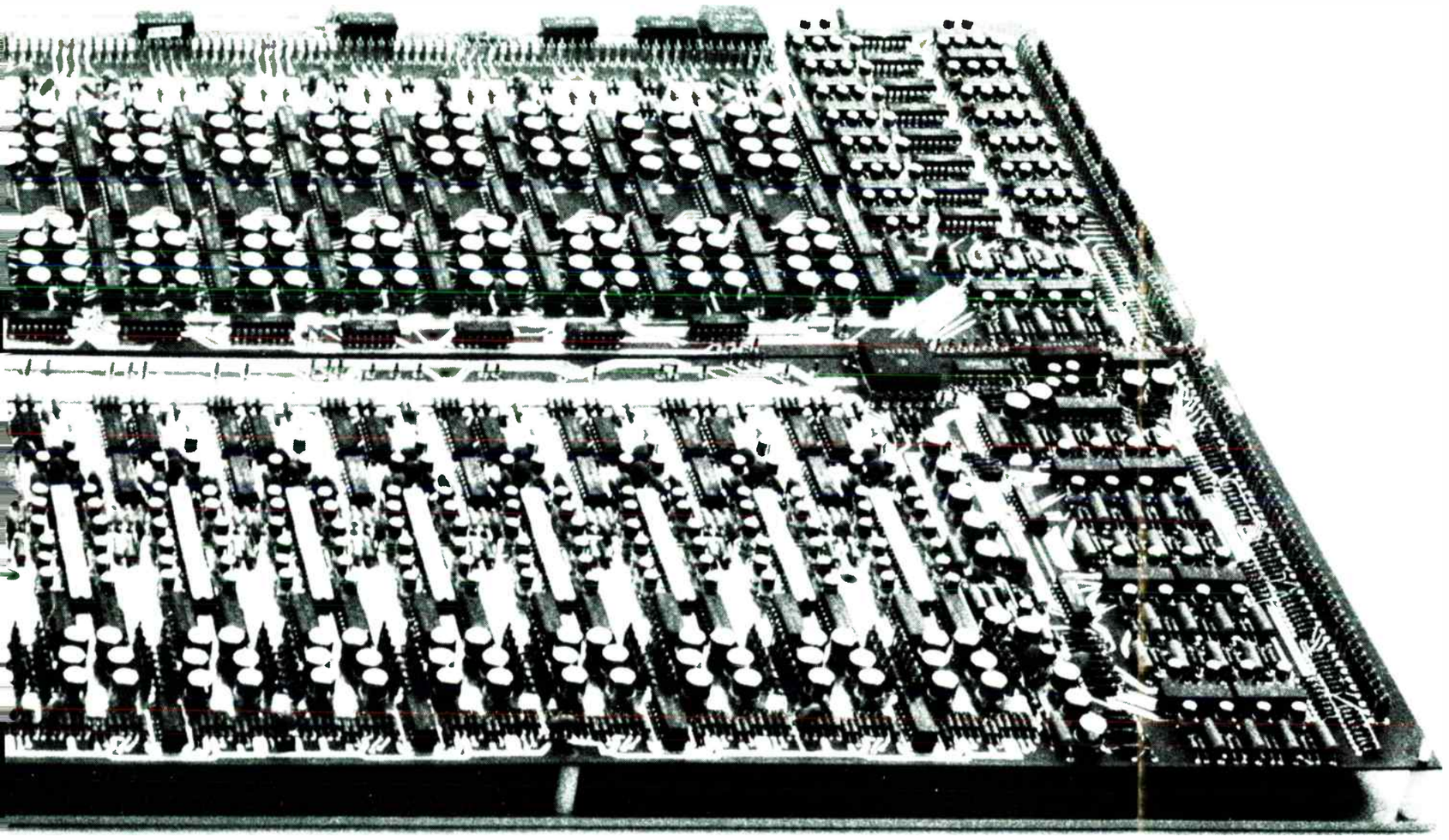
Card Reader 923. Programs calculators from hand-punched cards. Price $495.

All Tektronix calculator products are available under our new leasing plan.

See these new products at WESCON

Circle 27 on reader service card

We've just changed every game in town.



are achieved by depopulation. And, of course, larger capacities simply require the use of several cards. This card is expandable in a single chassis to the largest system requirements known today.

What about prices?

We wouldn't be making all this noise without remarkably low prices. The 4000 series is available in production quantities at .7 cents/bit. The 3000 series is as low as 1 cent/bit in production quantities. And the production quantity of the 2000 series is 2 cents/bit. What do we mean by "production quantities"?

We'll be glad to tell you, but just for the fun of it, we want you to take a guess. And we'll reward you for doing that (see next page).

electronic memories

A Division of Electronic Memories & Magnetics Corporation

SCORE CARD

	MICROMEMORY 2000	MICROMEMORY 3000	MICROMEMORY 4000
Configuration	4,096x9	8,192x18	32,768x18
Alterable to:	–	16,384x9	65,536x9
Full Cycle Time	1.0 μs	650 ns	1.5 μs
Access Time	400 ns	300 ns	800 ns
Modes	R/R. C/W. R/M/W	R/R. C/W. R/M/W	R/R. C/W. R/M/W
Byte Control	–	X	X
Data Save	X	X	X
Required Voltages	-5V	±15V, +5V	+5V
# of PCBA's	1	1	1
PCB Size	11¾"x15"	11¾"x15.4"	17½"x22"
Allowable PCB Spacing	1"	1"	2"
Expansion in a single chassis to:	16,384x9 8,192x18	65,536x9 32,768x18 16,384x36	Open
Extended address to:	32,768x9	65,536x18	256kx18
In increments of:	4,096x9	16,384x9 8,192x18	32,768x18 65,536x9
Stack	3W, 3D	3W, 3D	2W, 2½D
TTL Compatible	X	X	X

NOTE: Each PCBA contains a complete memory system, i.e., address registers, data registers, timing and control, etc.

OPTIONS: Power supplies and a chassis for 19" rack mounting are available.

Guess and *Win* Something to *Amuse* Your Friends

Fill out the coupon below, telling us what you think we mean by the term "production quantities" for the lowest cost per bit in each series. We will send you the correct quantity figures. We'll also send you a novel deck of playing cards that contains a thirteen of hearts, an eleven of clubs and a twelve of diamonds. Plus the normal fifty-two other cards. Makes for some very unusual bridge or poker hands. It'll only take you a minute to fill out the coupon.

Whole New Deal Coupon

Electronic Memories
a division of
Electronic Memories & Magnetics Corp.
12621 Chadron Avenue
Hawthorne, California 90250

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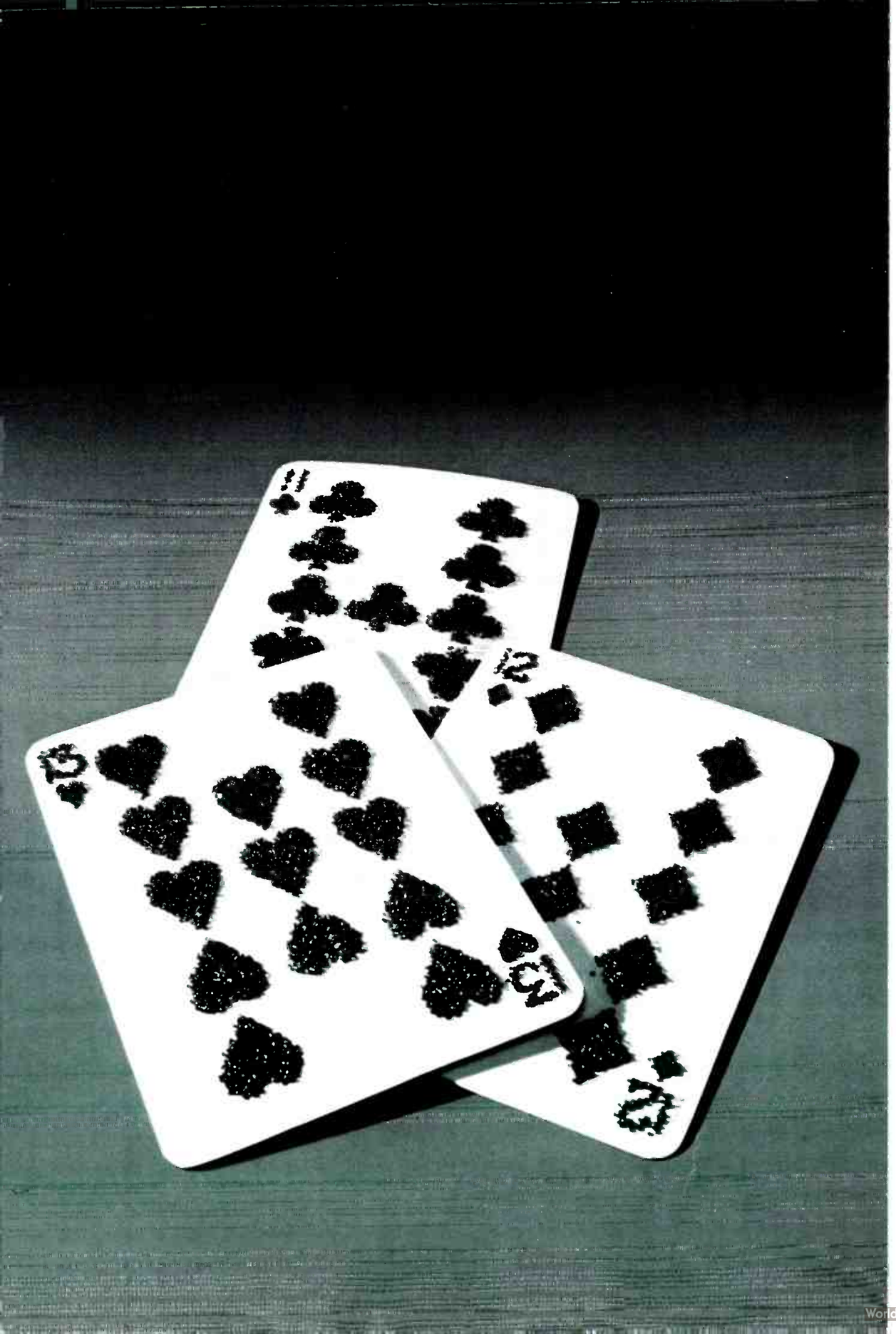

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Agencies react to electromagnetic radiation risks

Ongoing Federal research into non-ionizing radiation side-effects could be basis for protective standards

Standards limiting the exposure of the general population to non-ionizing radiation will be established within three years, predicts a ranking radiation official at the Environmental Protection Agency. "The only question now is one of degree, a question to be answered by further EPA studies." Although EPA isn't even hinting at the radiation limits it will seek, the young agency's action may set off a string of regulations from agencies that have the power to specify standards more directly impacting the electronics industries' products.

Officials in those other Federal agencies charged with screening the public from the hazards of microwave and other non-ionizing radiation say that their current studies are aimed less at promulgating standards than at estimating what rank should be given to electromagnetic radiation in the agencies' priorities.

And in fact the responsibility for standards-setting is diffused through all levels of government. On the Federal level, besides the Environmental Protection Agency, the newly created National Institute for Occupational Safety and Health can establish standards to protect employees in their work environments, and the Bureau of Radiological Health is responsible for radiation emissions from electronic products.

Standards that may arise from the bureau's studies would directly affect electronics companies; its microwave-oven standard, for example, which goes into effect Oct. 6, stimulated the redesign of microwave ovens. The bureau is now looking at small boat radars and medical diathermy devices.

Except for the Bureau of Radiological Health, however, Federal agencies appeared disinterested until industry and public concern was aroused recently by rumors of brain damage in engineers working on a classified defense electronics project. Government investigators decided the rumors probably are untrue, but the White House will soon fuel public concern with a report of its Office of Telecommunications Policy detailing federal involvement in electromagnetic radiation research.

Probe. At a meeting with Federal officials in late July, the Pennsylvania Division of Occupational Health reopened its file on cases of astrocytoma, a brain tumor, found in two of 23 engineers working on the defense project at Philco-Ford Corp., Philadelphia. While representatives of the agencies, including occupational safety, radiological health, and the Department of Defense, decided that "to date, no cause-and-effect relationship between the work environment and the cases of brain tumors has been demonstrated," they gave the occupational safety agency the job of investigating the incident further.

"We usually start an epidemiological study by looking at large populations, in this case by looking into tumor registries," says Vernon E. Rose, the institute's assistant director for health surveillance and biometries. "But this time we'll tackle the Philco-Ford incident first. Besides radiation, we'll look for other environmental factors that may have led to the brain damage."

Requests. The original investigation was unofficially closed by the state because of "manpower shortages and military security," but employees from three companies' EMC operations subsequently requested an official Bureau of Radiological Health statement, which led to the meeting.

A Philco-Ford spokesman calls the incident "an out and out hoax" [*Electronics*, Aug. 2, p. 17], and claims "the equipment contains no radiation generators." The company has made measurements from 14 kilohertz to 10 gigahertz and says "tests verify that the equipment emits no sensitive signals."

The only Federal investigation of the facility to date was conducted by DOD's Armed Forces Institute of Pathology and the Army's Environmental Hygiene Agency. DOD spokesmen reported that they had "found no microwave radiation in excess of the permissible standards where employees worked."

Standard. The official DOD triservice standard matches the voluntary industry standard—10 milliwatts per square centimeter.

As far back as 1965, the EIA-IEEE joint Technical Advisory Committee recommended that an interdisciplinary group should be formed to investigate biological effects of radiation. But report gathered dust until 1969, when the White House

Office of Telecommunications Policy formed its Electromagnetic Radiation Management Advisory Council to advise the Government what course it should take in regard to non-ionizing radiation.

According to sources close to the council, in about a month it will issue a report stating that far more research is needed about the side effects of non-ionizing radiation before decisions about tightening regulations can be made.

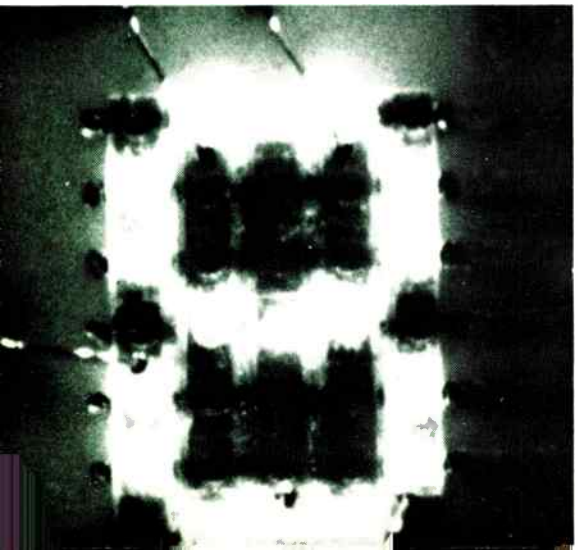
The report will also state how the research should be carried out. It is expected that much of the burden will fall on the radiological health bureau and the military. However, the services do not plan to accelerate their efforts unless the Nixon Administration budgets funds.

Donald Jansky, an OTP senior engineer and secretary of the council, says one of the first tasks to be performed is the validation of the 10-mW/cm^2 standard. "One of the first things we found out was that there is no real standard," he says. Industry pays lip service to the guideline, but it is applied in a number of different manners, and no correlation exists between power levels and frequencies, he notes.

Optoelectronics

Filling a GaP in displays, or is last GaAsP in sight?

When major laboratories began reporting efficiencies of 1% to 10% for red light emission from p-n junctions made with gallium phosphide, it was clearly just a matter of time before GaP would outshine GaAsP in dot-matrix displays. In addition to better efficiency, GaP emits red and green light, GaAsP only red. The big question then became: would arrays ultimately take a hybrid or a monolithic form?



General Electric Co. put its money into developing a monolithic capability [*Electronics*, March 11, p. 28], and demonstrated its technique with a 35-dot-matrix array capable of the full alphanumeric readout. And now it has improved the performance of such GaP displays well beyond that of equivalent GaAsP displays.

Working with more efficient materials, scientists at the company's research center have built alphanumeric devices that operate at a 0.5-milliamp average current yet glow as brightly as hybrid GaAsP matrixes running on ten times as much average current. Even at a 0.1-mA level, GE's GaP arrays are clearly visible in a well lighted environment.

Monolithic arrays are difficult to build because reliable n-type diffusions are not possible in wide-band-gap compounds like GaP. GE developed a liquid-phase epitaxial process to grow the n material in the GaP compound. More important, with this process GE developers for the first time were able to isolate, both electrically and optically, the n-type (cathode) region of the junction. Previously, only the p region (anode) could be isolated. Isolating both conductivity regions in a planar structure means that matrix-addressing can be accomplished on the chip itself without the external matrix connections needed for non-beam-leaded hybrids—beam-leaded hybrids reduce connections but tend to be fragile.

GE researchers say that the monolithic approach is the only practical way of addressing large numbers of elements on a single display panel. In a 5-by-7 array, for example, the number of external leads is reduced from 36 to 12. Similarly, a 200-character display using 7,000 LEDs can be made with only 170 external leads, while a whopping 7,001 leads would be required for individually addressed diodes. True, hybrid assemblies reduce external lead complexity as much as monolithics do, but at the cost of increasing the number of interconnections on the array. This introduces an unacceptable reliability problem into large displays.

Coming soon from GE's display lab: monolithic GaP arrays in green.

Government

Corporate reaction split on Lockheed loan guarantee

There is deep division in corporate ranks over the Federal guarantee of a $250 million loan to Lockheed Aircraft Corp., with many managers flatly opposed. A measure of this is that no one in the electronics or aerospace industries queried was willing to comment publicly on Congress's marginal approval of the loan—not even industry groups such as the Electronic Industries Association.

One angry reaction typical of those opposed to the loan guarantee was that of a highly-placed official at a major aerospace company that doesn't compete directly with Lockheed. If the Government is going to do only enough business to keep a limited number of aerospace companies in business, "it seems like a poor way to select those to remain by maintaining the one that gives the biggest problem."

More to come? "A number of us question," he adds, "whether the $250 million is the down payment or the final price." What he means is that Lockheed may have to come back for more Federally insured loans, and the Government would be in the position of further subsidizing inefficiency.

This executive also asks: By insuring the loan, "isn't it logical to conclude the Government will be sure it will get its money back by giving Lockheed more business than it deserves?" He's worried that the loan could throw some $2.5 billion busi-

ness Lockheed's way to maintain a 10% pre-tax profit.

Administration panic about the economy led to passage of the bill, the aerospace executive believes, figuring that it was triggered by the prospect of another 60,000 persons being laid off. On that point too, he's quite vocal:

"If the Government is interested in keeping 60,000 people employed, it would be better to do it by funding other programs that the Government needs rather than the L-1011 commercial transport. He cites the F-15 fighter and the Minuteman 3 ICBM programs.

But he admits that "what I'm saying is pretty thin soup. Lockheed achieved what it sought. It got a fifth down and scored a touchdown."

Commercial electronics

Supermarkets shopping for electronic checkout

After more than a decade of trying, supermarkets and their suppliers have taken the first step toward automating inventory and checkout computers by proposing a universal product code. A committee of top executives, representing grocery manufacturers, wholesalers, and retailers, has recommended that the industry accept a 10-digit coding system designed by McKinsey & Co., New York consulting firm, after an analysis of supermarket needs.

This move opens the way toward developing a code or symbol technology and eventually a booming market in automated checkout equipment, including in-store minicomputers, says Thomas W. Wilson, Jr., who headed the code system study. The present plan calls for supermarket suppliers to foot the bill for marking their products with some type of machine- and human-readable alphanumeric code.

The committee stopped short of recommending a specific optical or magnetic technique, and instead outlined guides for manufacturers to develop and evaluate systems. According to the present timetable, in-store tests of advanced checkout stands and scanning equipment will begin next year, but final symbol selection and supplier conversion to the system will not begin until early 1973. But whatever symbol technique is finally chosen, it will be the only code is used. Agreement on any one approach will depend partly on its availability to any and all hardware manufacturers.

Consequently, a score or more electronics firms are already getting into the supermarket checkout line, including RCA, IBM, Varian, Sweda, TRW, Hughes, and Europeans Anker and Zellwinger. The first operational systems are not expected until late 1973, but the eventual market could reach a billion dollars, McKinsey predicts. Meanwhile, the grocery industry leaders are moving cautiously.

"By first developing guidelines, considerable time will be saved. The guidelines are based on economic analyses of the user's need, thus leaving system design to those best qualified," says R.B. Gookin, chairman of the product code committee and president of H.J. Heinz Co.

The checkout stand envisioned in McKinsey's study could be a counter-level scanner hooked to a cash register to ring up the individual sale and to a minicomputer, to pull out the selling price and record the transaction—though a small store might just have the clerk enter the data by keyboard.

Manufacturers interested in joining the competition will find the system guidelines rugged. For example, the committee insists on an omnidirectional binary symbol unless either a 30% reduction in checker labor can be proved or equipment costs are low enough to yield a comparable return on the investment, which could be $120,000 for the average store. In addition, the system and symbol design must be capable of detecting a no-read 99.99% of the time and allow for the statistical possibility of simultaneously scanning two packages at speeds of up to 100 inches per second. Also, accuracy of scan and read must be 99.99% or better.

Space electronics

Color TV camera shines in spectacular Apollo mission

Star performer on the Apollo 15 mission was the color TV camera and transmitter on the Lunar Rover, which worked even better than NASA had expected.

The color camera mounted on the rover was built by RCA's Astro-electronics division, and the lunar communications relay unit, also on the rover vehicle, came from RCA's Communications System division. Design of the camera, which used a silicon target image intensifier, is based on the CBS Laboratories' color TV approach involving a field-sequential color wheel. The camera's azimuth, elevation, power, lens zoom and iris were controlled from the Manned Space Flight Center in Houston.

NASA originally expected that the camera signals received by the 85-ft earth receiving dishes would be snowy, while only the 210-ft antennas would provide clear reception. But as it turned out, all pictures were clear, with only a slight picture breakup experienced at times. The signals from the camera were transmitted to earth via the rover's relay unit band through an umbrella-shaped 23-dB gain, 38-inch diameter mesh parabola.

Electronics review

A lower-gain (6.5 dB), helical antenna was used for voice and data transmission, also on S band, primarily while the rover was moving. Vhf was used for transmission between the astronauts and the rover.

Since the rover and TV camera were independent of the lunar module, the remote-controlled camera for the first time provided live video transmission of the astronauts' blast-off from the moon. Plans to have live coverage of a solar eclipse by the earth on Aug. 6 from the moon were scrubbed when a circuit-breaker in the system kicked out on Aug. 4. The fault was apparently in the communications system.

The electronics aboard Apollo 15 performed well except for the 50-pound ruby laser altimeter in the command service module. Built by RCA Aerospace Systems division, the device was designed to work along with an optical camera built by Fairchild Camera's Space and Defense Systems division, which was used to map the lunar surface, and a panoramic camera from Itek Corp.'s Optical Systems division. The RCA altimeter began malfunctioning after about a day's operation and was finally shut off by the astronauts. According to RCA, the failure was in the data-handling portion of the altimeter system which extracted altitude information; the lasing portion continued to operate.

Companies

IBM's new feature: a sales slowdown

After a July financial report called disappointing even by IBM's managers—the first time in recent memory they've used the term—IBM would seem to have problems enough. But now, after surveying installations, sales, and releases to delivery, Arthur D. Little Inc., the Cambridge, Mass., consulting firm, estimates that, for the first time in two decades the company may have fewer large mainframes on-site than there were the year before, largely because of slow sales of the 370 line. This means that customers are giving up IBM mainframes faster than they are taking on new ones.

What's more, the consultant says that IBM's rental customer base, one of its greatest assets, may be eroding. It will have to erode for years, of course, before the competition could cut significantly into its market share. But the just announced increases of 3% to 8% in lease and purchase prices for 360s and 370s could hasten this erosion if competitors hold a firm price line. In any case, they aren't letting IBM's equipment rest on its laurels.

A case in point is the 3330 disk drive. An 800-megabyte store with a packing density that IBM says is three times that of present disks, the 3330 is widely viewed as an incentive to buy 370s: It won't work with the 360 and thus can't be retrofitted to give the speed and cost advantages that come with its technology. Now three or more of IBM's competitors, independent makers of peripherals, are readying 3330-type disk memories and hope to reach market by the second quarter of 1972, or about the time of promised first 3330 deliveries.

IBM management appears to feel that it's time to sweeten the 370 pot. Already being installed are beefed-up memory, data communications, and general input-output electronics. Users have griped most often about the 370 line's lack of adequate data communications.

Still more is promised. T. Vincent Learson, IBM's chairman and chief executive officer, is already talking about semiconductors that "in the near future" would offer 100 to 10,000 times the 370's present data packing density in memory, and 10 to 100 times the number of gates on a chip of a given size. Both apparently would be aimed at increasing the 370's price-performance ratio.

It will have to go up, in the consultant's opinion, as today's users are more inclined to "move sidewise in the market than to upgrade," a Little source says. "They have become quite adept at getting more out of existing machines through added memory and software modifications, for example. Buying a machine just because it's bigger isn't stylish; comptrollers are seeing to that."

IBM, like other large mainframe houses, talks a lot about shipments, sales, and backlog. Learson mentions that shipments of 370s are ahead of those for 360s right after introduction—but neglects to add perspective on the larger number of potential computer customers now. Also many firms, IBM included, now must hold machines in inventory because of tight money.

Education

Hard times improving training aids outlook

Personnel cuts during the last 18 months of recession have made a silver lining for the industrial segment of educational electronics. While school sales have been so-so, industrial business has begun to perk up because in order to get more out of trimmed-down staffs or to prepare engineers and salesmen for entering new markets, companies have put a premium on education.

This trend was apparent at the recent Education and Training Equipment Exposition, sponsored by the American Management Association, where a dizzying array of audio-visual gear vied for industrial education dollars. While interest in video cartridge and cassette players remained high, competition from less costly film projectors was vigorous. A. B. Dick of Chicago and Retention Communication Systems Inc. and North American Philips Corp., both of New York, showed super-8 cartridge or cassette individual instruction projectors. These do not have to be attached to TV sets, and sell for $190 to $375 without software, compared to $800 and over for industrial training version of video tape recorders and the CBS/Motorola electronic video recording unit.

"Video cassettes have not stopped us," says Dennis Zigmunt, marketing project manager for A. B. Dick.

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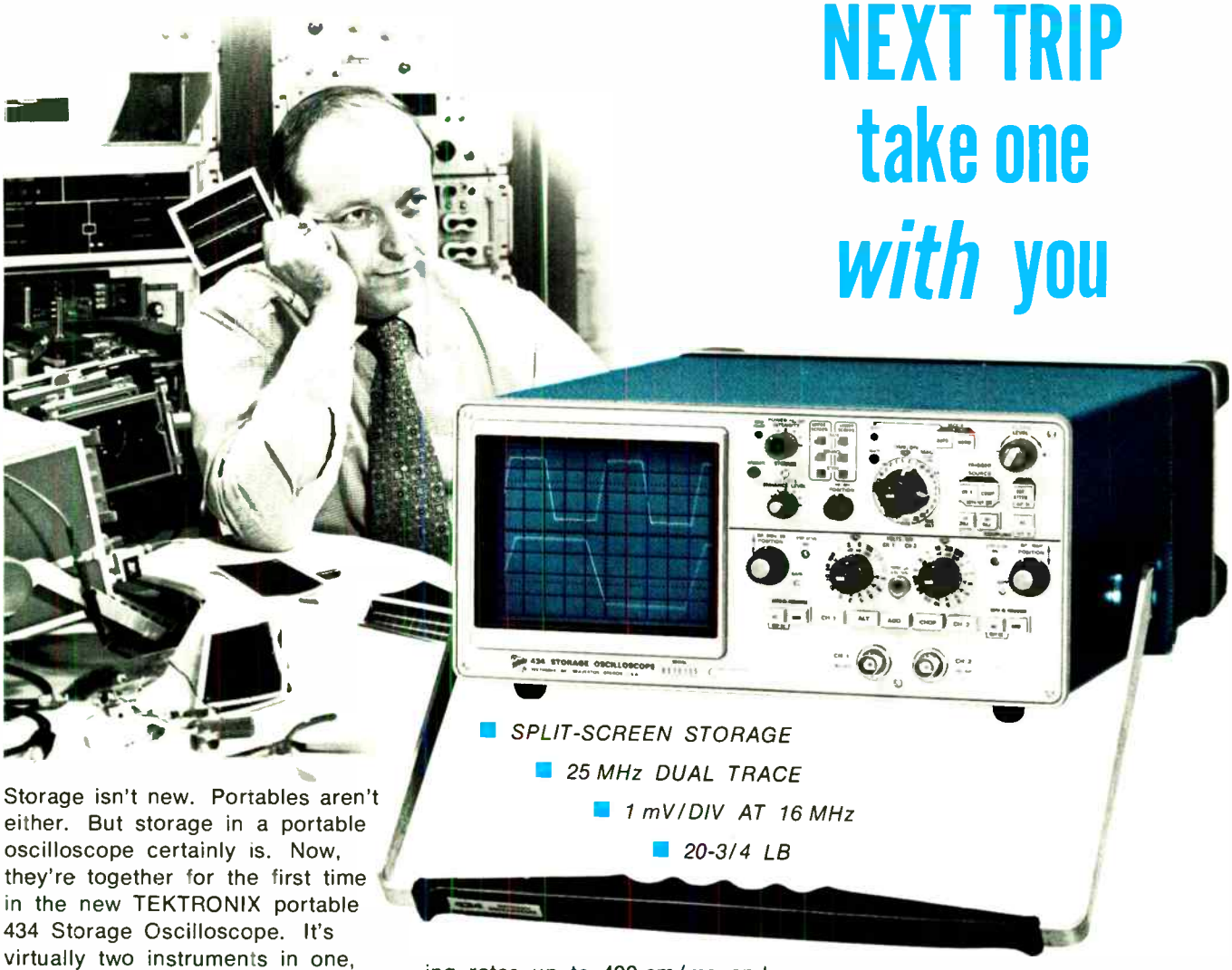

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The companion model 432 is a nonstorage model of the 434. Otherwise they're identical. Cabinet height is only 5-3/4 inches and rack height is 5-1/4 inches. Even so, there's room for a big 8 x 10-cm CRT. Bandwidth to 25 MHz, and sweep rates to 20 ns/div cover a wide spectrum of measurement needs. Deflection factors extend to 1 mV/div dual trace and are read out by lighted knob skirts even when you use the included 10X probes. Carrying weight is a very reasonable 20-3/4 pounds.

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Circle 39 on reader service card

"In fact, some industrial accounts got tired of waiting for video players and brought super-8 to keep up with their needs."

Equitable Life Assurance has throttled back on its intention to buy 200 EVR players and, though it will equip its 12 or so field offices, it will make another evaluation before deciding on what training displays to put into its 200 agencies.

Dr. Philip Lewis, President of Instructional Dynamics Inc., Chicago, says, "Audio-visual in the classic sense is dead. At one point 100 'teaching mediums' appeared, but there was no instructional software to support them. Now the key point is instructional packaging—putting hardware, software, and computer-aided instruction programing into a single system."

Consumer electronics

TV makers ask for component standards

Now that television manufacturers are meeting the third-stage TV radiation emission standard, which limits the allowable emission of sets during component or circuit failures, they are asking the Bureau of Radiological Health to go a step further. They want the Bureau to write performance standards for individual components to prevent the use of inferior replacement parts that would degrade sets.

"Assuming a 'worst-case' analysis for a given receiver could be traced to a specific component, we could protect public health by coming up with certain minimum criteria for that component," says Robert Elder, head of the bureau's division of Electronic Products. "I think our first step will be to go after rectifiers and shunt regulators. Federally enforced performance standards for rectifiers and shunt regulators are the only way we can protect good manufacturers from some other manufacturer who makes an electrically similar, but unshielded, tube," he continues.

The critical third-stage regulations differ from the second stage in requiring TV receivers to meet the Federal emission standard under "conditions identical to those which result from that component or circuit failure which maximizes X-radiation emissions." The earlier criteria, now incorporated into the third stage, require that TV receivers emit no more than 0.5 milliroentgen per hour, measured 5 centimeters from a set with all user and all service controls adjusted to maximize radiation.

Elder has won manufacturers over with his power to recommend exemptions to the stringent reporting and record-keeping requirements of the 1968 Radiation Control for Health and Safety Act. Current guidelines for exemption require maximum operating potential, under worst case analysis, not to exceed 20 kilovolts, with a maximum picture tube emission of 0.1 mR/hr and no more than 0.5 mR/hr from rectifiers and shunt regulators.

Manufacturers are now voluntarily submitting TV receivers to the bureau so that Elder's staff can determine compliance with the third-stage standards that went into effect June 1. The bureau will be doing a chassis-by-chassis analysis of circuits to pinpoint components that may be vulnerable to standard setting—with an eye toward eventually basing exemptions not only on the 20-kV guideline, but also on circuitry.

Computers

DEC's new minicomputers buck the nudity fashion

Probably it was an ancient Egyptian who first said that "naked women aren't nearly as much fun to look at as those with a few clothes on." The Digital Equipment Corp., Maynard, Mass., takes the same attitude with its introduction at Wescon of its not-so-naked PDP-11/05 and PDP-8/M computers. It's hoped that the new machines will drastically heat up competition in this new submarket.

The machines are DEC's answer to the recent trend towards selling users "only the parts of the computer they need." This allows users to assemble machines to suit their individual needs, thus saving them money. But DEC doesn't think it works out that way.

Wayne Furman, PDP-8 original equipment manufacturer marketing manager, feels that OEMs will swing to what could be called the "hot pants" mini because of what he calls hidden overhead in the stripped-down approach. "Power supply design and construction, engineering time, overall responsibility for performance all will add to the price of the Naked Mini's. The PDP-8M (and the PDP-11/05) has 4,096 words of core memory to start, and that's expandable, plus a complete power supply and packaging. In addition, there's a year's warranty on all modules and a month's on labor," he says.

Together. The new machines are software-compatible with their larger line-mates, and DEC spokesmen expect much of the software to be written on these larger machines.

But the price is unusually low for a DEC product, and is in fact notice of a new discount schedule designed to affect the industry-wide sag in OEM sales. In lots of 200, PDP-8/M's cost about $2,200 versus a one-shot price of $3,690. By comparison, Computer Automation Inc.'s well-known Naked Mini in similar quantities sells for about $1,800 and is an 8-bit machine. If the user needs 16 bits, the PDP-11/05 sells for less than $3,000 on the same discount schedule.

Getting the price down, says Furman, has been a matter of "designing the iron out." For example, the PDP-8/M weighs only 35 pounds versus about 95 for standard 8-series computers. The reduction was accomplished by using a smaller power supply, a smaller and lighter package, and by removing the programer's console, which DEC engineers don't expect will be used in most of the machine's OEM applications.

And though DEC doesn't put a figure on it, one of its larger cost savers is the PDP-8/M's use of parts

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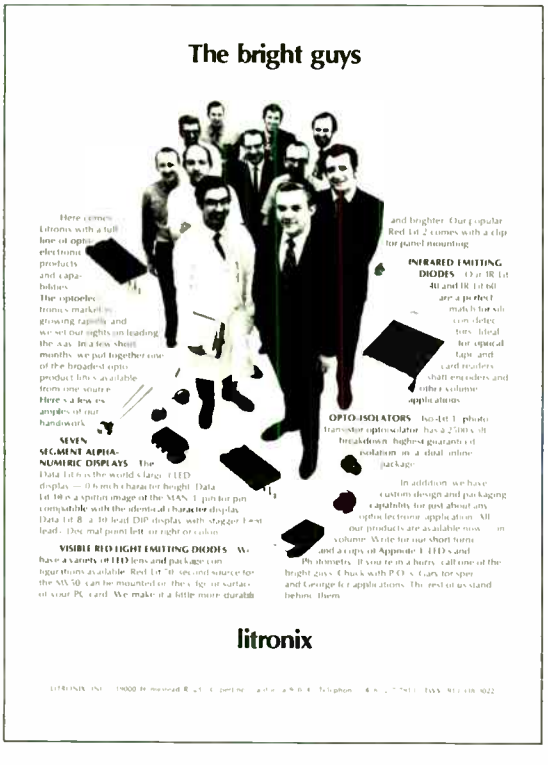

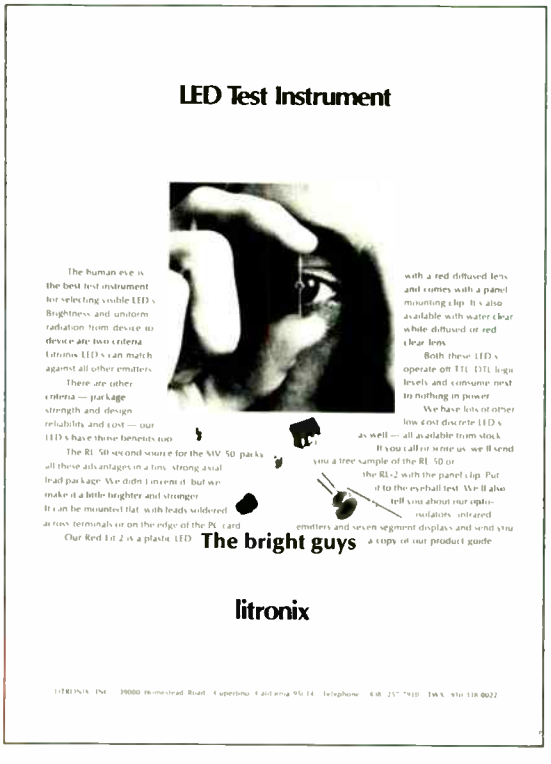

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and modules from the 8-series assembly line. This way the firm boosts parts cost leverage for the entire family, as well as cutting costs on the new machine.

PDP-11 group manager Andrew Knowles, says that most of the same cost reduction techniques used on the smaller PDP-8/M were used on the new 11. The PDP-11/05 retains the programer's console since it's aimed at higher-level applications, but it has replaced its miniature bulbs with light-emitting diodes, doing away with one of the biggest downtime features in any computer.

Though program-compatible with other 11s, the new machine will run a little slower to keep power dissipation, and thus power supply size down. Also, part of the new machine's central processor has been redesigned to act as a serial interface with a baud rate capability of from about 100 baud (teletype rate) to more than 4,800 baud.

Communications

U.S. hails arc-of-service agreement on satellites

U.S. delegates to the World Administrative Radio Conference are confident that acceptance of their arc-of-service proposal was the single most important action taken at the Geneva meeting. It will preclude nations not ready to launch geostationary satellites from laying claim to orbital space that would lie fallow, they point out.

Under the plan, the idea of orbital slots disappears. Instead, nations that plan to launch synchronous satellites must provide the International Telecommunications Union with information about the power, frequency, and the width of arc that would be visible from ground stations pointed at an angle of no less than 10 from the horizon (this is the span called the arc of vision). In filing its application with the union, the nation must also state the parameters of the orbital arc that could serve all the points it plans to interconnect. And if the arcs of vision and service differ at all, the country must explain just why this is so.

To prevent nations from claiming arcs they do not plan to use, the draft treaty states that the first nation to launch a satellite in a particular orbital arc has the first claim on the arc.

If another nation then decides to launch a satellite that could interfere, "the monkey's on the latest comer's back," says Donald Jansky, the engineer for the White House Office of Telecommunications Policy who developed the arc-of-service concept.

If nations plan to launch satellites that would add more than 2% interference to an existing satellite system's total noise budget, Jansky says, "a flag is raised. It doesn't mean you have a problem, it just means you may have a problem." At this point, detailed interference calculations will be made, and if interference seems likely to be harmful the nation proposing the new satellite must take the first step to reduce interference by changing its proposed orbits, changing the polarization of its space to earth beams, or adding spot beams. If the proposer fails to come up with a solution to the interference, it may then negotiate with the owner of the existing satellite to come to its aid—such as by moving the existing satellite.

Instruments

New head helps double tape recording time

For years makers of instrumentation recorders have tried to squeeze more and more bandwidth onto tapes without increasing speeds. But with each improvement their job has become harder, and not since the early 1960s—when they nearly doubled bandwidth—have they taken a really big step forward. Now Bell & Howell's Instruments division has done just that by adding a capability to its VR-3700B magnetic tape recorder/reproducer that makes possible a 2-megahertz bandwidth at 60 inches a second. Engineers at the Pasadena, Calif. division, part of the Electronics and Instruments Group, maintain that this advance doubles the recording time of the typical tape reel because frequencies this high before were possible only at 120 in./s.

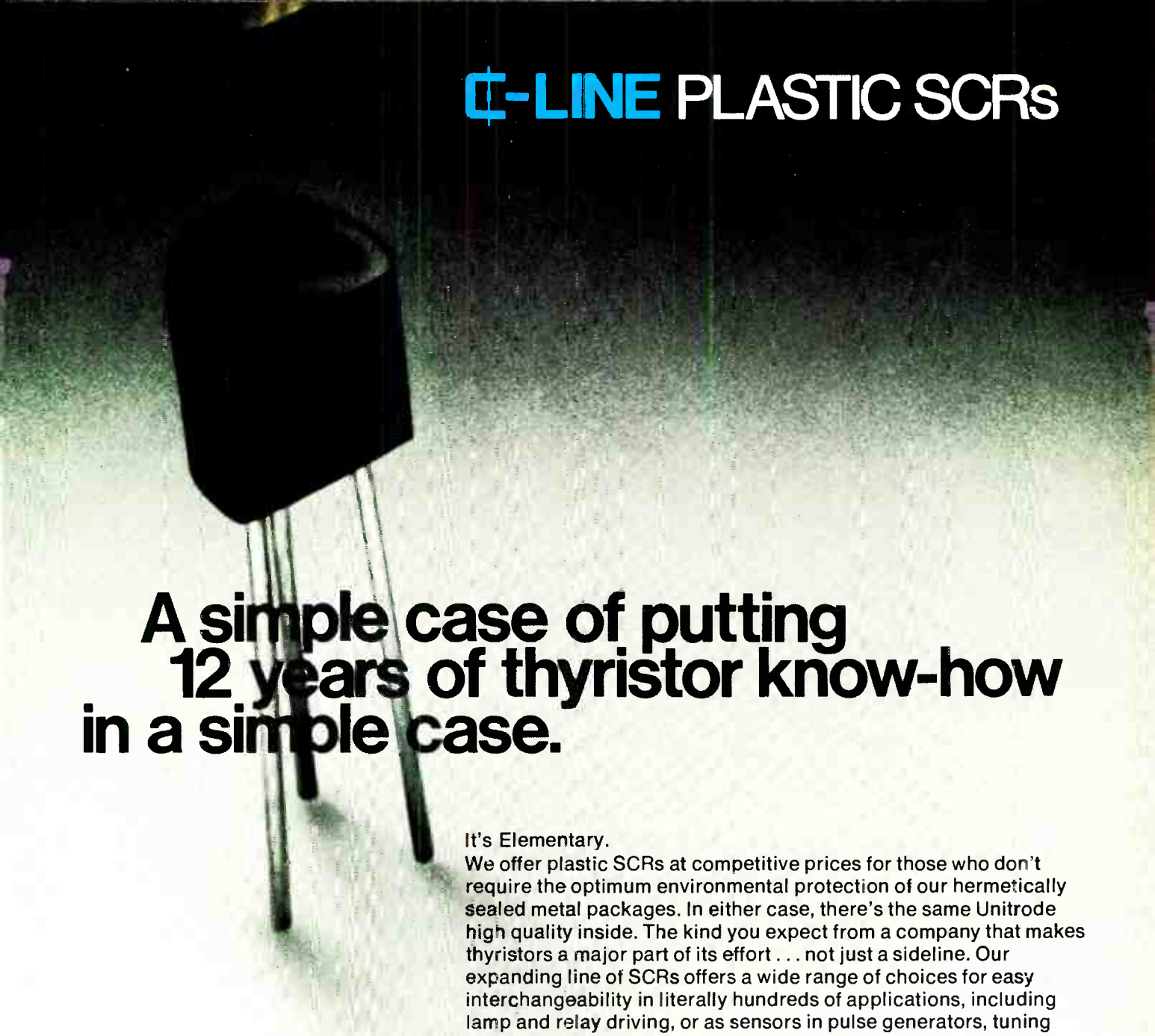
New head. Chief credit for the big jump goes to a newly designed record/reproduce head for the year-old VR-3700B, says Richard Canzoneri, the division's chief engineer for development. Other important factors he notes are the design of the machine's transport to minimize dynamic flutter and skew, and the availability of magnetic tape that accepts 2 MHz at 60 in./s.

Bell & Howell engineers are reluctant to divulge details of the record/reproduce head design. However, Canzoneri says that one of the key advances is that the gap between head and tape has to be one-half to one-third of the wavelength being recorded, or as little as 10 microinches. Just how that miniscule gap is maintained is proprietary, but Canzoneri will say that ferrite-core, hardtipped heads that the division makes are used.

The head's flatness has to be within a tenth of a wavelength of light, and surface finish has to be in the neighborhood of 1 microinch. Roger Mersing, a project engineer, puts those tolerances and the gap between the heads and the tape in perspective when he says that a typical dust particle is 40 microinches.

Jon Wells, manager of development engineering for tape recorders, adds that precise mechanical tolerances in the VR-3700B's transport and its advanced capstan servo also help, contributing to low flutter (0.12% at 120 ips) and low time base error (0.5 microsecond) in the transport.

A bonus of the record/reproduce heads' flatness and surface finish is longer life; Bell & Howell will guarantee 5,000 hours versus the more usual 3,000 hours. Adding the 2-Mhz, 60-in./s feature to the VR-3700B, which came out originally with a 2-MHz bandwidth at 120 in./s will mean a 10% to 15% increase in the machine's $30,000 price.



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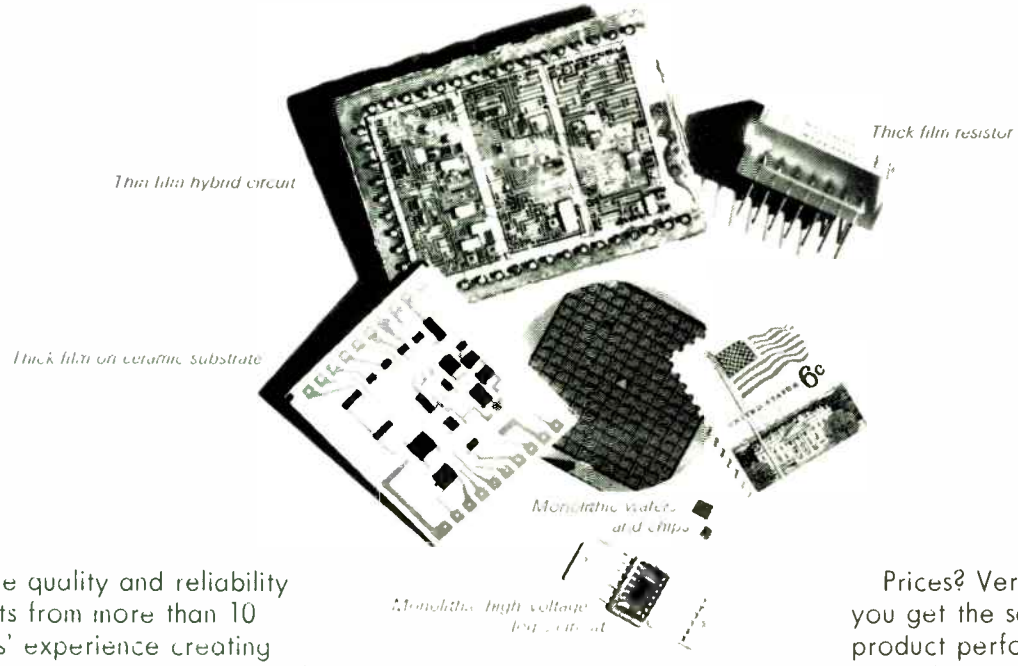
Circle 43 on reader service card

A couple of things you ought to know about Boeing's custom hybrid circuits.

1. High quality.
2. High quantity.



The quality and reliability results from more than 10 years' experience creating electronic parts and systems for demanding aerospace programs. Some $600 million worth of electronic products thus far.

The quantity is possible because of our extensive facilities and manpower resources. Consider our delivery capability. We can make hybrid microcircuits to your specifications and production rate using the technologies shown above.

We're organized to respond quickly and efficiently. Our 700-man team has all the engineering, manufacturing, QC, contract and sales specialists needed to give you direct service. They're backed by a company that has the unique ability to custom design your microcircuitry and to select the technology that is right for your custom requirements.

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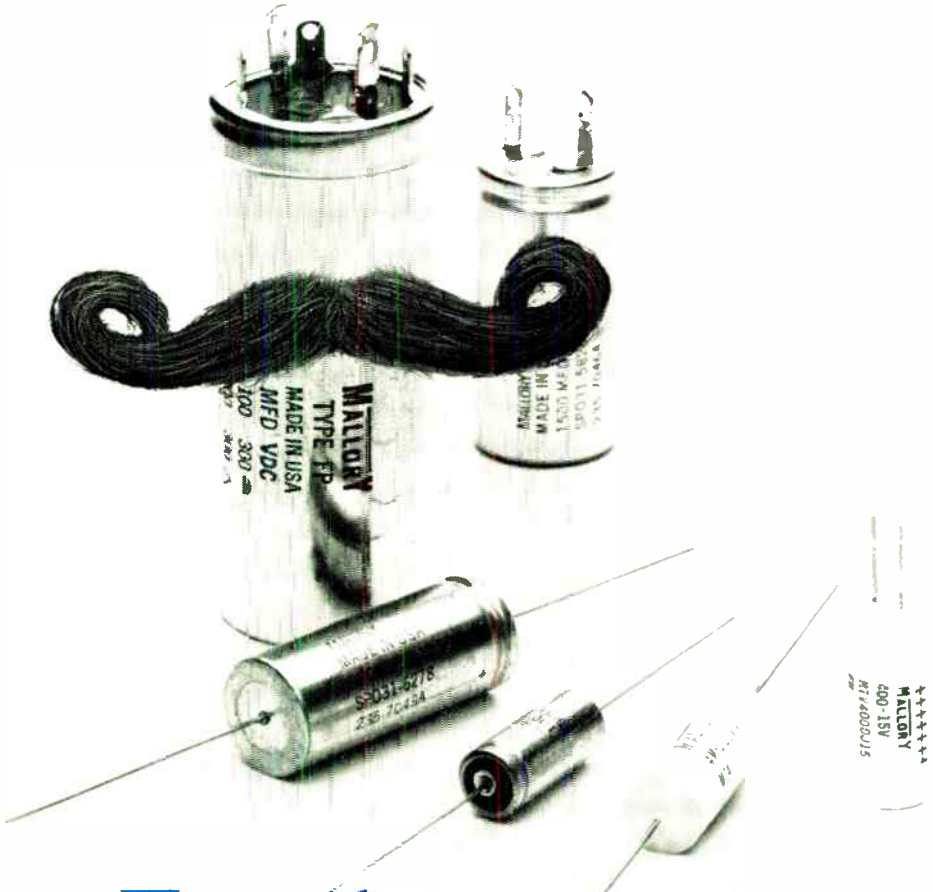
BOEING ELECTRONIC PRODUCTS



Family portrait.

Take a good look at one of America's first families—the Mallory family of aluminum electrolytic capacitors. And you'll see quality, experience and dependability.

THE FP. "Pop" has been around quite awhile and is still going strong. It's got a twist mount, solder lug terminals, —30 to +85°C temperature range, 80 to 60,000 mfd capacitances and voltages from 3 to 475 VDC.

THE TC. "Mom's" got temperature ranges of —40 to +85°C, —30 to +85°C and —20 to +65°C; capacitances of 5 to 3,000 mfd; and voltages from 50 to 500 VDC.

THE TCW has axial leads and all-welded construction. It operates from —40 to +85°C, in capacitances from 2 to 20,000 mfd and voltages from 3 to 450 VDC.

THE TT is a miniature axial lead capacitor with beautiful performance from —40 to +85°C. The TT goes from 1 to 4600 mfd, in voltages from 3 to 150 VDC.

THE MTA has axial leads and all-welded construction—in a good-looking molded plastic case. It operates in a range from —30 to +85°C, with 3 to 4500 mfd capacitances and voltages from 3 to 100 VDC.

THE MTV is the latest addition to our aluminum electrolytic, molded-plastic-case family. It's all-welded, with a single-ended vertical mount. And has an operating range of —30 to +85°C, capacitances from 5 to 1400 mfd and voltages from 3 to 100 VDC.

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It tips the scale at around seventy pounds. So you can take it anywhere. That's the light part.

Now the fantastic. It's a high performance, seven speed, seven channel recorder/reproducer that comes in for a bit over $1k a channel.

It's the CPR-4000. Designed by the boys in the back to placate the sales engineers. "Give us a mag tape system with practically everything, for practically nothing," they begged. And the boys in the back did pretty well.

From the top, the seven speeds are electrically selectable (15/16 through 60 ips). It takes ½" tape on 8" reels.

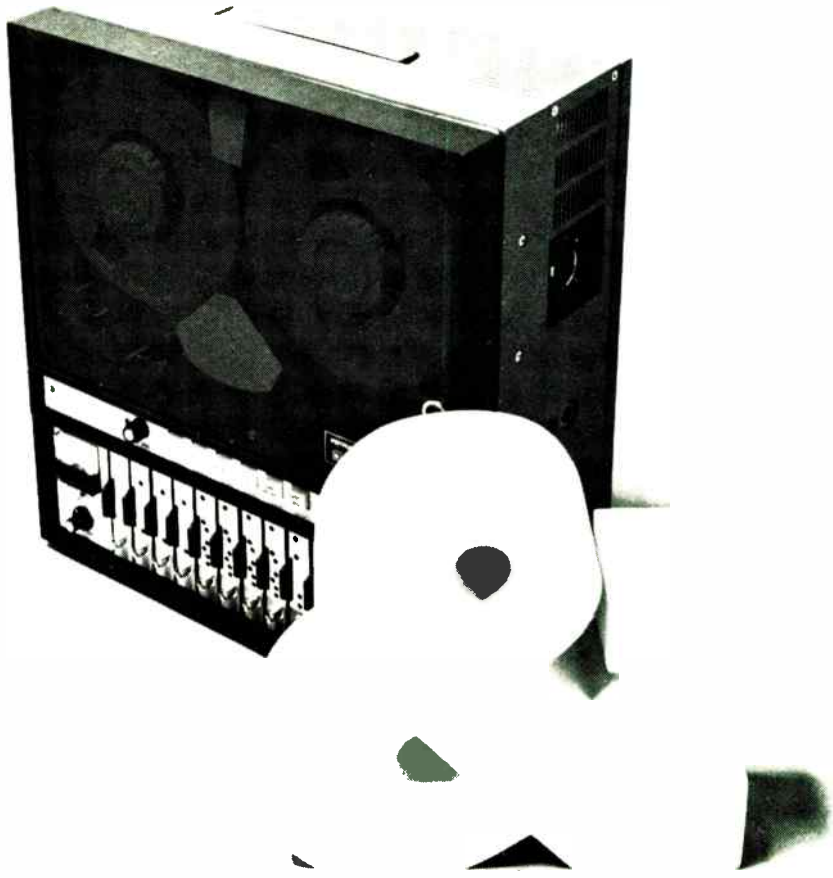
The heads have an edge track voice channel and don't require a touch worth of alignment or adjustment after first installation. In fact, those heads are so darn good, we'll guarantee you 1,000 hours of head life.

Dual capstans keep the tape away from any motion disturbances, give minimum flutter, constant tape tension and a uniform head to tape contact. It doesn't have any solenoid actuated pinch rollers like you normally find around. So that cuts down power consumption and gives you more precise tape guidance and better short wavelength recording.

But probably the best feature is an automatic load, automatic feed option. Not only is that faster, it cuts out the mess ups and wipe outs.

And of course, the CPR-4000 has the latest in IC circuitry, is all modular, has solid state plug-in record/reproduce amplifiers, comes direct or FM and is just the nice new ticket for over a hundred lab, mobile or remote facility applications.

The light fantastic. You can get one now. (The specs don't take that long, though.) Just write Bell & Howell, Instruments Division, 360 Sierra Madre Villa, Pasadena, California 91109.



INSTRUMENTS DIVISION

BELL & HOWELL

Washington Newsletter

August 16, 1971

Bailout No. 2: Pentagon buys Hamilton Watch

In the sound and fury that surrounded the precedent-setting $250 million U.S. loan guarantee to Lockheed Aircraft (see p. 36), hardly anyone noticed the Defense Department's move to purchase outright another contractor: Hamilton Watch Co., Lancaster, Pa., maker of electromechanical military ordnance fuzes. **Though subject to the same pressures as other makers of point detonating devices**—rising competition from electronic proximity fuzes and a declining market reflecting U.S. withdrawal from Southeast Asia—**Hamilton is being rescued by the Pentagon because it is the last fully integrated watchmaker in the U.S. able to turn out precision timing device parts vital to the country's industrial base.** Other electromechanical fuze manufacturers, who include many electronics companies, buy these abroad, primarily in Switzerland.

The Pentagon paid $2 million for Hamilton's production equipment, and took a $40,000 lease option on the plant preparatory to turning it into a Government-owned, contractor-operated facility. Additionally, **stiffer application of "Buy American" procurement regulations requiring use of U.S.-made parts in military aircraft clocks, fuzes, and safe-arming devices will be made to help Hamilton—but is also likely to benefit the competition** since U.S. electronic fuzemakers have used "homemade" parts from the start.

FCC proposals for CATV seen open to ambush...

Washington attorneys are advising their cable television clients they are not yet out of the political woods despite Federal Communications Commission Chairman Dean Burch's ability to get a 6-1 vote favorable to CATV development (see p. 109). **Burch's uncommon compromise—a 55-page "letter of intent" to Congress** on commission plans for CATV, instead of a report and order—**is seen by some lawyers as jeopardizing the FCC's status as an independent regulatory body.** Others say it merely demonstrates Burch's ability, as a good politician, to recognize the realities of life.

Communications legal specialists are agreed on one point, however: **new CATV rules still being drafted will not be effective before March 1, 1972, "making them 'fair game' for Congressional and perhaps Presidential sniping,"** as one major law firm put it. CATV operators were warned, "The road between the adoption of the new rules and their effective date is alive with ambush opportunities." Cautioned another attorney, "Operators can't afford to fumble around now. They may be on the scoreboard, but they've yet to win the ball game."

...but its standards aims are praised by technologists

Electronic equipment makers are pleased with the FCC's approach to developing technical standards both because of its simplicity and because of the commission's request for industry help. Unlike over-the-air broadcast standards for types of equipment and transmission performance, **the FCC thrust on CATV will be based on a minimum performance standard for the signal received at the subscriber's terminal. Moreover, Chairman Burch says he will "call on various technical industries for advice and consultation,"** adding that he plans "soon to announce formation of a task force of experts to advise us in designated areas."

New systems will be required to have a two-way capability, whether or not it is to be used initially. **That service will be the last of four channel**

classes recommended by the FCC, with Class 1 for bandwidths used to carry standard TV signals, Class 2 for cable-originated programs, and Class 3 for miscellaneous non-TV services such as printed material. It was because standards for the different services will vary, explains Burch, that the FCC set up four classes.

Opposition to DOD $21 billion bill softens in Senate

Problems still lie ahead for the Pentagon's fiscal 1972 procurement bill when Congress reconvenes in September. But the Senate Armed Services Committe has approved a bill very close to that already passed by the House—$21 billion as against $21.1 billion—and this indicates that the difficulties will be far less severe than a year ago, at the height of the Southeast Asia withdrawal controversy. The Congressional versions compare with a $22.2 billion Pentagon request for research, development, and procurement.

The Senate, like the House, restored $806.1 million for 48 of the Navy's F-14A fleet defense fighters to be built by Grumman, although the upper chamber is requiring a guarantee that the money will buy all 48 planes or the contract must be cancelled. Other differences are relatively minor. Nevertheless, the Senate version must still go to the floor for a vote, and opponents are expected to propose major cuts at that time.

Clinic/doctor communications links to be studied

Communications links between remote clinics and resource physician groups—called "telemedicine"—will move a step nearer implementation now that systems studies funded by "out-and-out grants" have been promised by Health Services and Mental Health Administration officials. Their interest was aroused by a report from the National Academy of Engineering's Committee on Telecommunications, which recommended a one-year study that would model various telemedicine systems and would determine such parameters as the level of skill required of physician-assistants, and the kind of equipment needed by remote clinics. The most likely candidate for the $300,000 to $400,000 involved is NAE's own committee on the interplay of engineering with biology and medicine, which recently recommended a telemedicine system to NASA's Office of Technology Utilization.

Brooks pressures FAA for collision avoidance decision

The House subcommittee on Government activities, chaired by Rep. Jack Brooks (D., Tex.) is leaning hard on the Federal Aviation Administration to adopt a standard for collision avoidance systems. And Brooks' latest hearing on the matter gave RCA the opportunity to make a high-powered presentation of its asynchronous Secant-B system [*Electronics*, April 13, 1970, p. 46], which it claims is cheaper and more reliable than time frequency synchronization systems such as McDonnell Douglas' Eros now used by the Navy.

RCA's hard sell is widely interpreted as panic on the part of the company, which recognizes it must persuade the FAA to adopt a transponder-oriented system standard now or be edged out of the market. And it will be an uphill battle. For while the FAA has not fixed a date for its decision on CAS standards, it has budgeted $29.5 million for time frequency ground stations over the next 10 years. The Air Transport Association has gone on record as supporting the time frequency approach, and the Air Line Pilots Association is urging early adoption of a standard—a position that also favors time frequency.

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Amphenol's new 303 Series MINIform coaxial switch line is the answer to today's biggest component problem: Getting higher performance, using less space at the lowest possible cost.

High performance we have. From 0 to 1.0 GHz, the MINIform switches handle up to 150 watts CW, maintain maximum VSWR of only 1.1:1, 80 dB minimum crosstalk attenuation and 0.1 dB insertion loss. Maximum VSWR over the 1.1 through 3.0 GHz range is only 1.2:1 with power handling capabilities up to 70 watts CW.

True to their name, MINIform switches weigh only 1.2 ounces and occupy less than ½ cubic inch of precious space.

Three popular termination styles are available: SMA connectors, Amphenol SUB-Minax 27 Series connectors and pc contacts for solder or solderless wrap terminations.

To find out more about MINIform and how it can cut your switch costs in half, write to Amphenol RF Division, Bunker Ramo Corporation, 33 East Franklin Street, Danbury, Connecticut 06810.

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Circle 49 on reader service card

When the Atlas was retired as an ICBM it was the beginning of a new career.

To make a rocket fly, you really have to find out how to do three basic things.

Find a way to guide it. Find a way to hold it together as it flies. And find a way to keep down its weight, so it carries more than itself.

Finding a way to solve all that was, to say the least, one big problem. We know.

We build the Atlas rocket.

First, how do you steer a rocket?

We invented a new way. We made the main engines do two things at once: besides pushing the rocket up, the engines swivel on their axes and control flight.

The effect is like this: balance a baseball bat upright in the palm of your hand. To keep it stable, your hand is constantly correcting for the motion of the bat.

The engines do about the same thing for the rocket.

How do you build a structure strong enough to withstand the pressure of leaving the atmosphere?

Until Atlas, the hardest material around was boiler plate.

We developed another idea. Roll steel so thin that it almost reaches its breaking point. This steel will take four times the pressure per square inch of ordinary steel, but will not take an ounce more stress.

This thin steel, thin as a dime, became the outer skin of the Atlas. It reduced weight. It also let us do one other important thing.

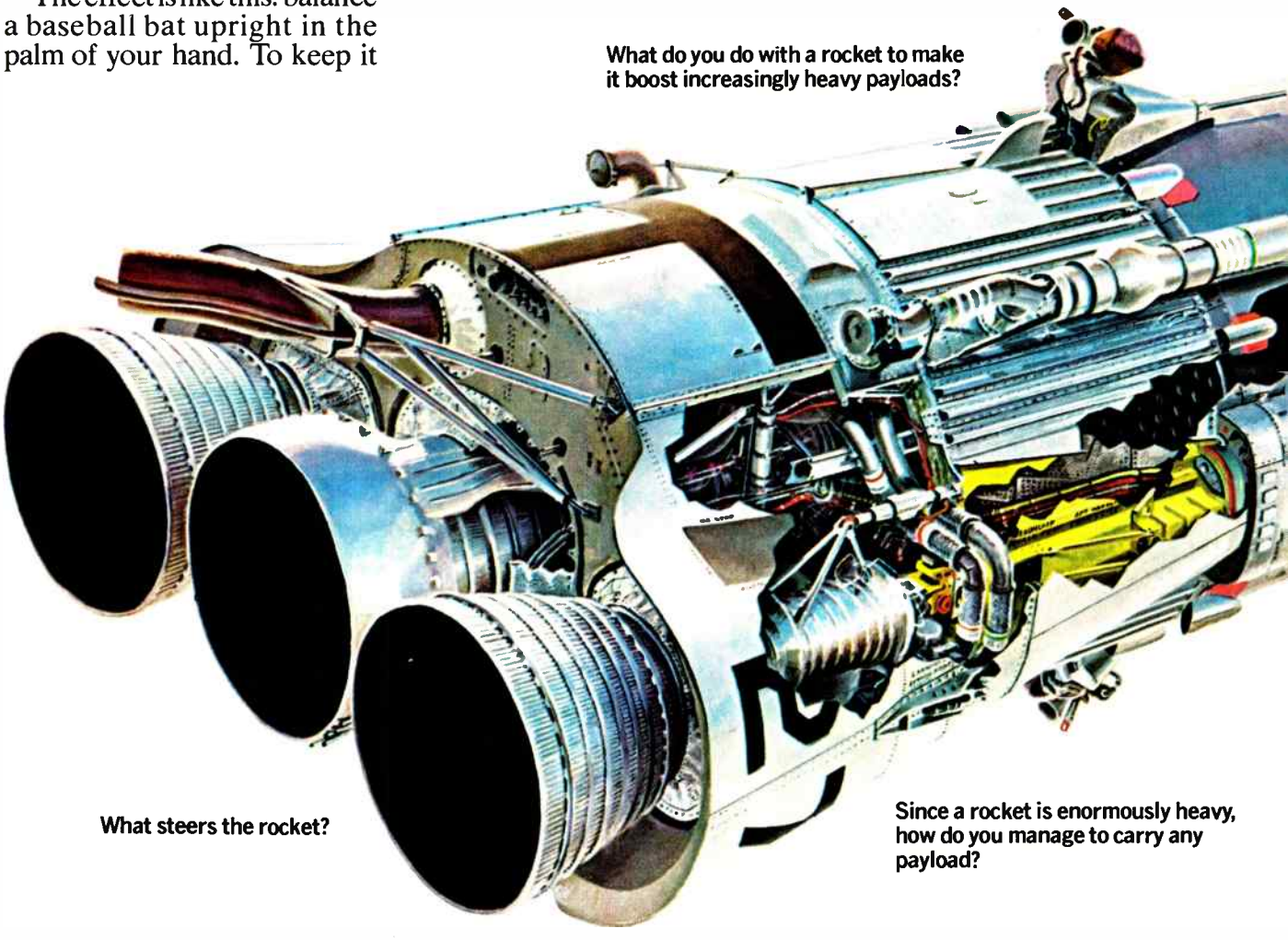
It let us design a fuel tank like a balloon, so the fuel not only provided power but also held the tank rigid, and reduced structural weight even more.

In 1954, after all this work by our Convair Aerospace Division, we began to develop the Atlas under government contract.

In 1957, the first Atlas flew.

It was ready for mass production as our first ICBM. Happily, Atlas was never called on to

What do you do with a rocket to make it boost increasingly heavy payloads?



What steers the rocket?

Since a rocket is enormously heavy, how do you manage to carry any payload?

carry out this mission.

But as new requirements developed, the booster was modified to handle them.

To date, Atlas has fulfilled dozens of different missions for NASA and the U.S. Air Force. So far, Atlas has been launched more than 390 times.

These launchings include putting the first American into orbit; boosting our first unmanned payload to the moon; sending our first orbiting spacecraft around the moon; and launching the first close-up probes of Venus and Mars.

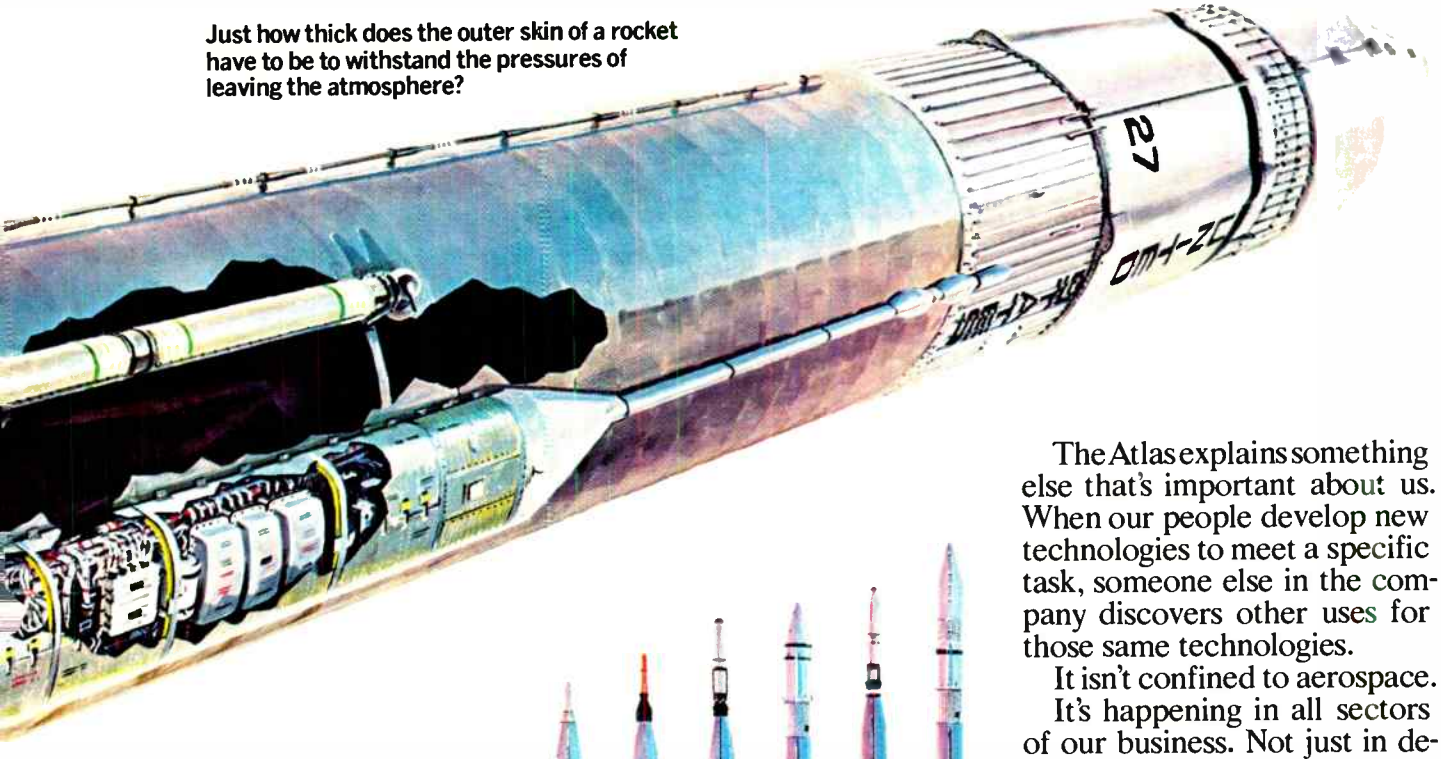
After all this, Atlas is far from a museum piece. Through the years, the addition of its second-stage mate, Centaur, has helped enlarge Atlas' capabilities.

In this decade, Atlas-Centaur has been selected to send probes on their way to Venus, Mercury, Mars and Jupiter.

Recently, Atlas-Centaur boosted the first of a series of the heaviest, most complex communications satellites ever put into orbit: Intelsat IV. It can relay more than five thousand telephone conversations at once, greatly expanding world communications.

When we first began designing the Atlas, we couldn't have foreseen all its uses.

But we designed in the basic adaptability that has accounted for its varied missions through the years.



Just how thick does the outer skin of a rocket have to be to withstand the pressures of leaving the atmosphere?

Doesn't the fuel tank have to be very rigid to hold all its fuel?

The booster Atlas has been modified, upgraded, and changed through the years to handle missions ranging from ICBM to communications satellite booster.

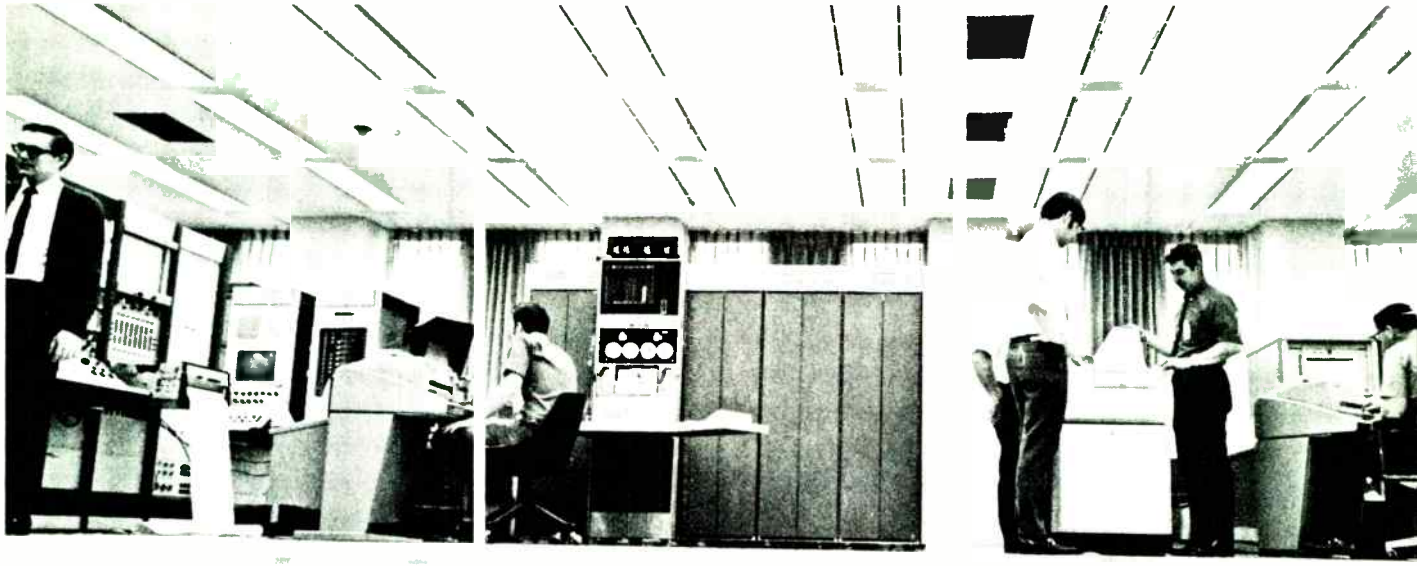
The Atlas explains something else that's important about us. When our people develop new technologies to meet a specific task, someone else in the company discovers other uses for those same technologies.

It isn't confined to aerospace.

It's happening in all sectors of our business. Not just in defense work, but in growing commercial markets: shipbuilding, telephone systems, electronics and natural resources.

It's productive technology that makes us a company that keeps making things no one ever made before.

GENERAL DYNAMICS



The Gould 4800 helps Battelle-Northwest analyze thermal discharges.

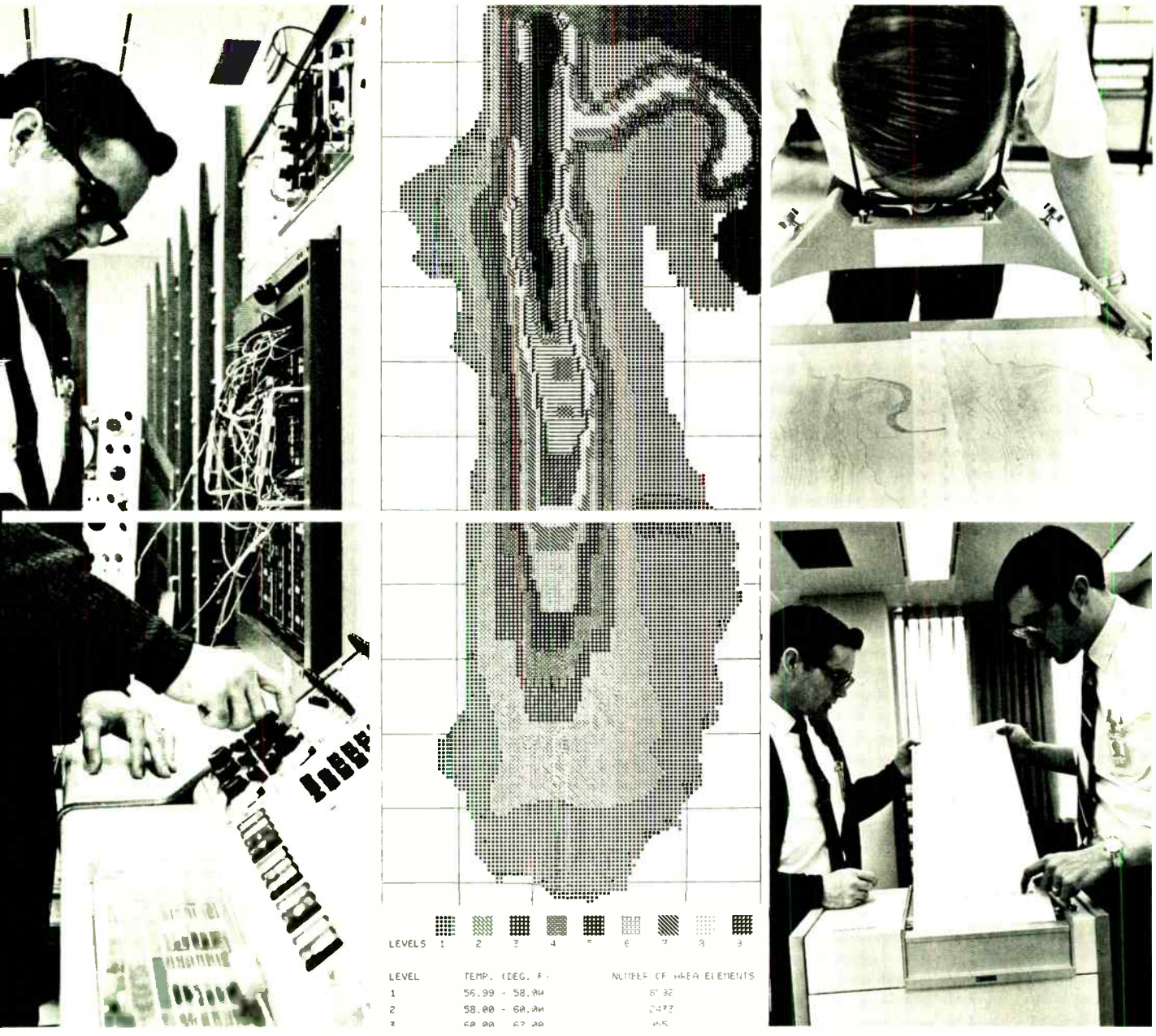
The Gould 4800 high-speed printer is playing a big part in the thermal pollution research being conducted at Battelle-Northwest.

Battelle Memorial Institute, established over 40 years ago, is a not-for-profit research corporation with four major labs and offices around the world. Battelle handles many projects on a contract basis, with heavy emphasis on applied research.

Projects currently underway at Battelle-Northwest in Richland, Washington, include studies that determine patterns of wastewater discharges from industrial and municipal operations and to evaluate their effects on surrounding waters. The research technique, developed by Battelle, consists of collecting aerial infrared and tracer dye imagery of surface water discharges.

Data recorded from the infrared imager is processed by Battelle's computer system, a unique hybrid facility. A Beckman EASE 2133 analog computer is coupled to a DEC PDP 7 digital computer.

The Gould 4800 then prints out isothermal plots, density plots, and contour plots. The contour plots provide two different views.



COMPUTER PRODUCTS

GOULD

Used with a stereoscope, these two views provide simulated three-dimensional temperature contours.

Researchers depend heavily on the Gould 4800's graphics capabilities for output of the simulation and modeling projects. And even with their small computer, they get high speed alphanumerics and graphics.

The Gould 4800 operates with the hybrid system in many other projects at Battelle, ranging from physics to social sciences. In addition, by means of a time sharing system, the 4800 operates simultaneously with an SEL 840 computer for basic math and science calculations.

Battelle's initial investment in the Gould 4800 was less than the cost of impact printer and plotter equipment, and they developed their own interfaces and software for it. Since the 4800 has few moving parts, as well as solid-state electronics, there is also a minimum of maintenance and servicing.

The Gould 4800 high-speed printer. Put it to work for you. Write Computer Products, Brush Division, Gould Inc., 3631 Perkins Ave., Cleveland, Ohio 44114.

By 1979, you'll shop for stocks in your supermarket.

The stock exchange is going electronic.

Millions of dollars are now being invested in computers, terminals and electronic components to break today's paper bottleneck. Already, Wall Street is the biggest single market for read-out devices.

By the end of this decade, the securities industry may well be one of the biggest single markets for all electronics.

You'll buy and sell stocks through terminals located not only in brokerage houses, but in hotels, restaurants, private offices and even supermarkets. So, if the price of sirloin is up, you may still save the day with a great buy on IBM common. Just slip your identification card into the terminal and buy or sell any stock you want. Each transaction will be verified instantly, with your account statement printed out on the spot.

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Among them design, quality, and production engineers in components, computers and computer peripheral equipment.

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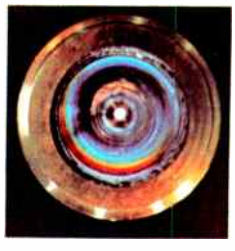


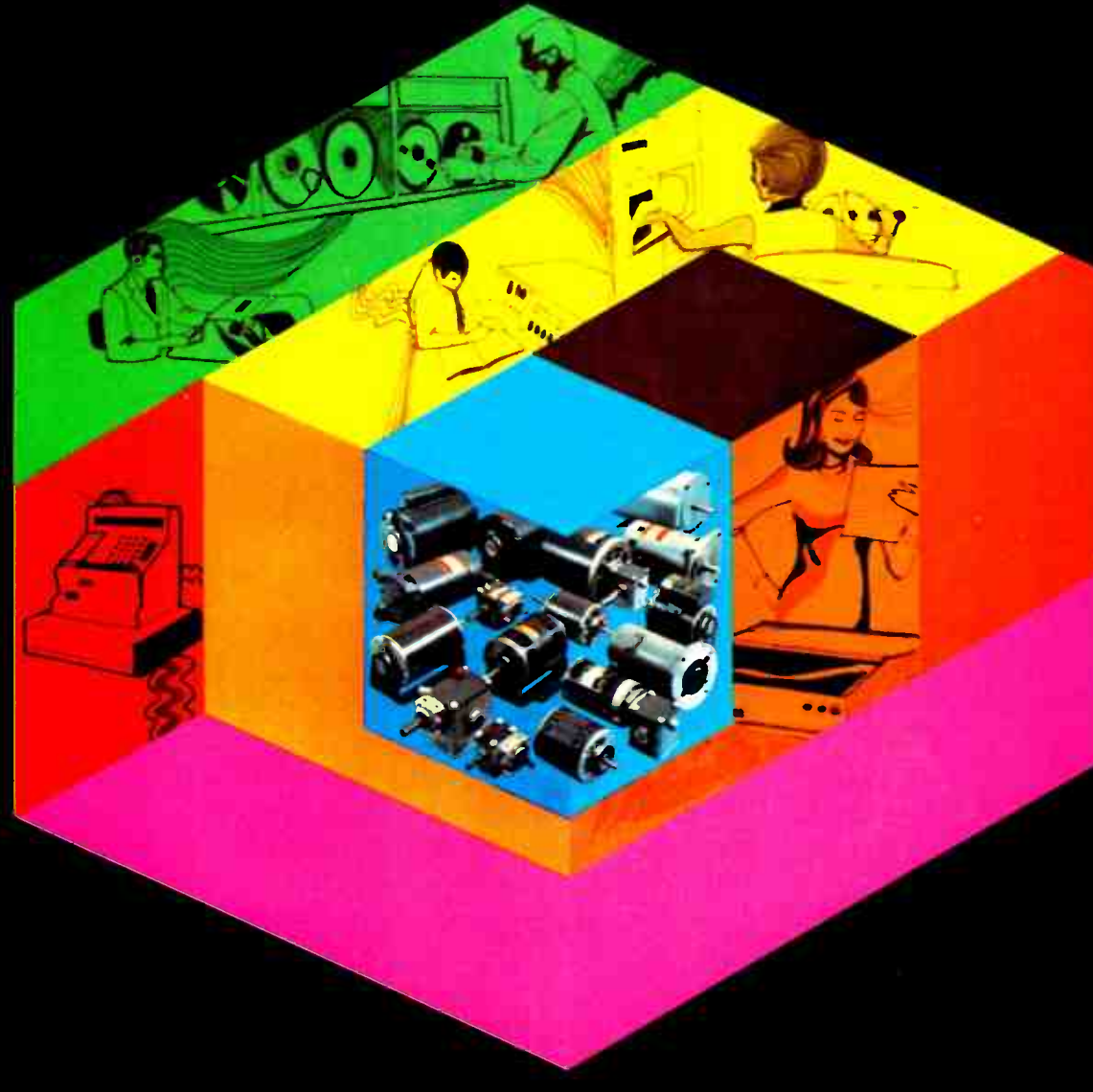
New generation business machines benefit from General Electric's full-line motor capability

Electronic technology has put office equipment into a new generation. Information handling systems, drive-in banking equipment, copy machines and many others all have advanced to the 70's with a new look that will continue to change our way of business life.

General Electric motor technology has grown with these new developments. High performance computer drives, tape drives, keypunch drives, cooling motors . . . all for your new generation of machines. And as your new equipment is born, you can depend on General Electric motors to drive it.

General Electric Company, General Purpose Motor Department, Fort Wayne, Indiana.

720-01



GENERAL ELECTRIC

Technical articles

The crisis of Wescon: changing markets and the recession: p. 58 (cover)

With exhibits and exhibitors off by nearly half from last year, the big West Coast show and convention faces up to the hard task of changing to bring in the new breed of customers that companies are seeking. Though many doubt the future of the broad, horizontal trade show, Wescon plans to compete with the mushrooming, narrower, user-oriented show.

Western industry on the diversification road again—is it for real? p. 65

Heavily aerospace/military-oriented Western companies facing the latest and steepest dip in those roller-coaster sales curves, go all out this time to diversify through the internal growth and acquisition routes. The question is: have they learned that it takes more than superior technology to succeed in a new market or product line?

Wescon technical program: don't look for the state-of-the-art paper: p. 70

By choice, by chance, Wescon offers its broad, user-oriented mix of sessions; the design engineer looking for the latest in technology and new applications of technology will find the pickings are slim. Emphasis is on testing, manufacturing, and applying electronic data processing equipment.

Sceptre wields power for computer-aided designers, p. 72

Although unmatched by other programs for handling complex linear and nonlinear circuit problems, Sceptre hasn't been widely used because it is complicated and consumes a lot of expensive computer time. But now, according to author George C. Kenney, new software (along with some practical guidance outlined in the article) permits nonlinear problem-solving at reasonable cost.

Bringing out a semiconductor memory's latent talents, p. 82

Simply by exploiting a natural characteristic of semiconductor flip-flops, authors Irving T. Ho and Gerald M. Maley have conceived a way to overcome the volatility problem and also get more function out of an IC memory chip. The idea is to force the flip-flops to assume a predetermined on-off pattern when power is removed. The result: a built-in reloadable control store.

Capacitive position sensor licks the fringing problem, p. 86

Strictly electronic position sensors have it all over electromechanical types in terms of simplicity and reliability, but they've lacked high accuracy in low-cost versions. A new three-terminal capacitive transducer, described by E.V. Hardway, Jr., overcomes the fringing effects that degraded the accuracy of previous devices.

And in the next issue . . .

C/MOS micropower circuits . . . low current measurement techniques . . . designing digital automatic gain controls . . . setting up an IC screening program.

WESCON SPECIAL REPORT

How can Wescon survive market fragmentation?

Wescon management has gradually shifted the show's focus away from the designer and towards the user; but as types of users multiply, many debate the future of nonspecialized trade shows—even if times improve

by Robert Henkel, *Managing Editor, News*

☐ "Wescon has been hit by the double whammy of changing markets and bad business from which it may never recover."

That comment sums up the current crisis of Wescon, the big, horizontal Western trade show that has been an electronics industries landmark for the past two decades. It was made, not by a disgruntled exhibitor or competitor, but by the chairman of the Wescon executive committee, Palo Alto consultant Stanley F. Kaisel.

To many, the outlook is becoming increasingly clear. Even when good times return, a growing number of managers predict, the broad, general trade shows like Wescon will disappear. Even if Wescon does survive its present ordeal—and you can find many industry leaders who say it may not—it will not only be a much smaller show than Wescons of the past but one strikingly different in format and audience.

The good old days: Will the crowds ever come back to Wescon?

The show's decline this year, off by nearly half in exhibits and exhibiting companies from 1970, already has triggered a great deal of concern and even some internal squabbling between the people running Wescon and its two sponsors; the Western Electronics Manufacturers Association, which started it, and the 6th Region of the Institute of Electrical and Electronic Engineers.

There's no doubt that a major cause in the decline of Wescon—and the only larger electronics trade show, the New York IEEE show—has been bad business conditions. But the root of the problem for the two, and for all the remaining horizontal trade shows, goes beyond any dip in the economy.

"Shows like Wescon only reflect what's happening to the electronics industry—and the industry is fragmenting," says Wescon general manager, Don Larson. "We're getting to the stage where electronics technology and products are used everywhere." So Wescon has to do the things that are necessary to bring in the current customers of the electronics companies, he says. Exhibitors keep telling Wescon, another show official says, that "we're not selling all our products to the design engineers anymore."

While Wescon has demonstrated for years that it can bring in the traditional industry customers—the design engineers—it hasn't demonstrated clearly yet that it can bring in the users from outside the electronics industry. And coming up fast to fill that void is the specialized or narrow trade show, which covers one slice of the industry pie or caters to one user industry.

But it's not as if Wescon got caught with its pants down. Its professional management, headed by Larson since 1950 when it was a 234-booth show, is regarded by everyone as the top show staff in the industry. As far back as 1964, Wescon was studying the tying in of allied user areas to the then existing format of "industry talking to itself." Wescon had to become more user-oriented, a show official said at the time.

Wescon now plans to move even farther away from the traditional technical program than it has already done. In the works, too, is a plan to group the exhibits, now categorized by hardware, into user sections. Vertical shows will be set up within the Wescon show umbrella. New application paper categories and seminars will support these user exhibit sections.

Later this year, Wescon will sponsor formal research

to identify "realistic and manageable user categories," states Ted Shields, Wescon's veteran assistant general manager. "Since all of the categories selected can't be implemented at the same time, the most viable vertical shows will be woven into Wescon one or two at a time," he says, "possibly beginning in Los Angeles next year."

The numbers game

There's not much doubt that fewer and fewer exhibitors are interested in the broad type of Wescon audience. And there's the question raised about whether companies "grow out" of Wescon as they become better known and build large sales staffs. One of Wescon's problems in trying to sell the show to a large manufacturer, such as Hewlett-Packard, is that "their salesmen see more West Coast customers in one day than they could see at Wescon," says T. J. O'Rourke, president of Tymshare in Palo Alto and a WEMA board member.

"Wescon is doing the best job, by far, of any broad trade show, but it's hard to visualize that Wescon could be set up in such a way as to attract our types of customers," says Wendell B. Sell, president of Hoffman Electronics Corp., El Monte, Calif., and former WEMA president. "I just don't see the big show—Wescon or IEEE—offering us very much." Hoffman's markets are the military, education, and consumer fields. Sell sees many companies going to Wescon for the prestige and appearance: "I don't see us going there just to create an image."

"What we're seeing is a much harder look at the show by exhibitors and what the show does for them," says Robert M. Ward, manager of corporate development, Perkin Elmer Corp., Palo Alto, Calif. and this year's chairman of the Wescon board. Another Palo Alto marketing executive agrees, saying "many companies used to just write Wescon in their budget and automatically go each year." The decision to exhibit was not a thoughtful marketing decision. With tighter budgets, more and more companies are examining all shows more carefully. But companies are "no more rational in pulling out of a show than they were when they decided to go to a show," says Perkin Elmer's Ward. There are still many "who don't know why they're in Wescon."

The turnout forecast for this year's attendance is a grim one. Late in July, 316 companies had signed up for 548 booths, though late arrivals may boost these figures to 335 companies and 580 booths. This is a precipitous drop from the 604 companies and 999 booths last year—and off by more than half from 1964, when 707 companies exhibited in 1,210 booths.

Attendance is looking grim, too. One Wescon official predicts about 30,000, but the show won't do any official forecasting. This number looks overly optimistic to some show watchers, who expect the total registration to run closer to 25,000. For comparison, 38,111 came last year, and attendance peaked at 48,480 in 1968.

The design engineer who hasn't gone to a Wescon technical session in recent years would be surprised at the difference between the sessions today and other IEEE-sponsored technical conferences, which are traditionally aimed at bringing the engineer up to date on the state of the art by reporting new developments. Even engineers who have attended Wescon may not fully realize the deliberate evolutionary changes made in the sessions over the past six years: the design engineer is not the major target anymore. The sessions' reason for being is to bring in the audience that the exhibitor wants to reach. And the design engineer is just a part of that audience—and a declining one at that.

Wescon management's problem is product development, points out consultant Kaisel, who formerly headed Microwave Electronics Corp., Palo Alto, and stayed in the post when it became the Teledyne MEC division. Kaisel says "Wescon has to develop a new product or series of products for our customers [the exhibitor]. We're no different than any other business. If papers aren't the way to go, then we have to look for something else to bring the buyers in."

But Wescon still believes that the sessions are the best avenue to bringing in the right audience. "We're revamping and restyling the sessions to make ourselves more relevant," points out a Wescon spokesman.

Next year, Wescon will even drop the name "technical program." As part of its plan to group exhibits into user sections, sessions will be aimed at supporting the user categories. This will mean even more presentations in the management, marketing, and applications areas.

It all started in 1965, when Wescon overhauled its technical sessions and adopted the "topic-bound, team-approach." When Wescon did this, a show official admits, "we gave up a lot of things—the individual paper that deserves to be heard and papers that emphasize state-of-the-art and theoretical subjects." He says such papers can be better covered at specialty conferences, and he could have added that big shows like Wescon and IEEE always have had trouble attracting good papers of this type.

Since then, Wescon technical sessions, with varying degrees of success, have emphasized job-related needs, trends, and applications. The IEEE members who make up each year's new technical program committee sometimes have difficulty hewing to the Wescon program approach. It happened this year. The technical committee got off to a flying start by selecting 12 engineers representing 12 groups of the IEEE and appeared to be going after sessions and papers in the old way. It took a quick meeting with Wescon representatives to set them straight. There were still minor differences of opinion. A management session thrown out by the IEEE committee was restored, and the session it wanted on engineering unions was dropped.

Under this broader approach, technical sessions attendance ran fairly steadily between 5,300 and 5,800 until last year. Attendance last year plummeted to 3,680, largely because of the drop in overall attendance. But a closer look reveals a potential problem. The percentage of registrants who attended the sessions declined from about 12% in 1969 to 10% in 1970.

Specialized shows—the competition

Wescon has been wrestling with the growing competition of specialized trade shows for years and as the situation gets more critical, the number of suggestions on what to do about it grows larger and louder.

Here are some recent suggestions from some current

and former Wescon show exhibitors.

- "Cut the show in size and run it more times a year with each show specializing in such areas as components and computers."
- "I'd be highly in favor of splitting Wescon into four specialty shows a year."
- "Shrink it in size and turn it into a traveling show—same show with the same exhibits and exhibitors traveling to three or four locations, perhaps even around the country."
- "Combine Wescon and IEEE as one show in Chicago, since the city has excellent facilities and is no more than a few hours flying time from anywhere in the country."
- "Specialized trade shows have a problem getting above critical size, so Wescon should try to serve as an umbrella over five or six vertical specialized shows."

"The purchasers of a growing number of electronic products are not going to be EE's, but such people as the radiologist, retail credit manager, and perhaps even the shoe department manager," says Wescon board chairman Ward. "We have to find a way to talk to these people, because a show that doesn't bring in the exhibitor's audience is no show at all."

Ward's personal opinion is that "a small guy, say in physiological monitoring, gets buried in a 900-booth show. But if he is in a 250-booth show, all related, where anesthesiologists and doctors will come to see what's happening, they can find him."

But attracting the user market audience is a thorny problem. Asks Tymshare's president O'Rourke: "What medical doctor would go to Wescon?" To move into these new markets, "you have to get together with other groups—and in the long term other professional groups," says Ward. "But getting the American Surgical Society together with the IEEE would be really tough.

Wescon has to be certain that it is truly important enough to attract non-traditional exhibitors, says Robert L. Boniface, vice president, marketing, Hewlett-Packard Co., Palo Alto, Calif. If the show went to a medical electronics category, it would be hard for him to justify exhibiting. "And there's no way to attract doctors from all over the country to a medical electronics show within Wescon," he says. "Wescon has to specialize on market areas, then concentrate on them." It should not split into several shows, because "with the right categories, it can attract the right customers." For example, he says, if they develop a strong computer activity, they can attract the right regional customers. "If they try to make the show all things to everyone, Wescon will fall flat on its face," he cautions.

So what about the growing Wescon competition—the specialized trade show? Some executives believe that Wescon will never build back their exhibits because companies have seen what the specialized show can do. "The big shows are going to lose out," predicts Arthur Heller, marketing services manager at Fairchild Semiconductor, Mountain View, Calif.

What appears to be happening is that Peter Sherrill's studies for Wescon as far back as 1963 were so on target that his findings are being carried to the extreme, says Heller. Sherrill concluded that to make Wescon visible for specialized interests, it should be divided into special interest categories. But with these specialized needs have also accelerated the rise of the narrow trade show, Heller believes.

Electronics company convertees to the specialized shows are legion. Hewlett-Packard is looking at more specialized shows, Boniface says. "We're going to our customers' trade shows."

Even some of the smaller instrument makers are doubtful about the future of the big trade show. "Frankly, the day of the big trade show is about over," says an official of one Southern California house. The economy will demand a more defined show. "If they ever had a show devoted to digital electronic test instrumentation, no manufacturer of such products could afford to stay out." But Wescon could do it, he believes, by separating into two shows—one for components and one for instrumentation.

Semicon, the semiconductor equipment and materials show held for the first time last May at the San Mateo, Calif., county fairgrounds, had a "decided effect" on Wescon, believes Frederick W. Kulicke, Jr. president of Kulicke & Soffa Industries, Inc., Fort Washington, Pa. Kulicke, who might be a little biased because he was one of the founders of the show, says it "did the West Coast exposure job" for his equipment company and he "doesn't feel the need to go to Wescon now."

William B. Hugle, chairman of Hugle Industries in Sunnyvale, Calif., who almost single-handedly made Semicon's debut a success, says the show came about after a group of 16 unhappy exhibitors at the 1970 IEEE show formed the Semiconductor Equipment and Materials Institute. Semicon attracted about 100 exhibitors, 120 booths, and 3,750 registrants. Wescon is "not specific enough for our exhibitors," Hugle believes, adding that there are too many extraneous people at Wescon who don't have anything to do with SEMI member's products, and "they tie up booth people for nothing."

So what has Wescon been doing while specialized shows and changing markets ate away at its exhibitor

Wescon management: Ted Shields, assistant manager, and Don Larson, manager, work to make the show "more relevant."

The No. 2 show tries harder

Exhibits may be off by nearly half, but Wescon is hanging on to its reputation of being the best organized and promoted trade show in the electronics industry. The famous Wescon volunteers are out in force, drumming up the support of West Coast companies in sending their employees to the show. And there's a couple of new items in their sample cases—one for this year, one for 1972. There are two new locations—in San Francisco and in Los Angeles—designed from the inside out to handle shows like Wescon, a luxury Wescon has never had.

Granted, only the shrinking size of the show made it possible this year. Wescon surprised most everyone when it made a last minute switch by moving the show to San Francisco's downtown, underground exhibition center. Since this year's exhibits could not fill the old Cow Palace, long the home of Bay-area Wescons, the board, concerned about vacant areas making its exhibit look bad, decided to make the change.

Wescon is quick to point out the many advantages of the new location, both to exhibitors and to attendees. While the Cow Palace show always overflowed into adjacent buildings originally constructed as cow barns, Brooks Hall was designed for exhibitions and is air-conditioned. It also has meeting rooms, which Wescon always had to build on its own at the Cow Palace.

An advantage to Wescon in moving the show is that "we're going to save $50,000 to $60,000," Don Larson, Wescon's general manager, says. This comes from not having to make the massive physical alterations to the Cow Palace to convert it into an exhibit hall and conference room complex.

Holding Wescon at Brooks Hall has one potentially complicating factor. An antique show ends before Wescon opens. To make the quick switch, Wescon plans to go in with a large hired crew at the 7 p.m. closing time and dismantle this show overnight.

One complaint from exhibitors that Larson won't have to hear again is the split between the Sports Arena and the Hollywood Park racetrack in Los Angeles, where no one single facility could handle the big show. Last month, Los Angeles opened its new $41 million convention and exhibition center. Ironically, while Wescon had desperately needed such a hall for at least 10 years, the 1972 show probably won't fill much more than half the new hall's column-free, 213,000 square feet of exhibit space.

The new center, just south of downtown Los Angeles, looks tailormade for the Wescons of old, and that's no accident. Larson headed up the advisory committee on its design. He says it has "practically no mistakes," and though it's not as big as Detroit's Cobo Hall or Chicago's McCormick Place, it has much better meeting rooms—18 ranging in capacity from 46 to 1,000.

1972's Wescon will also record another show first: instead of the usual late August dates, the show will be held September 19 through 22. The change was made to avoid both August's temperatures and prime vacation months. At any one time during the summer, at least 10% of the potential audience is on vacation, Larson estimates.

Larson's budget has been cut sharply, but not his massive promotion program, which includes such items as arranging special lower-cost flights for show visitors, and sending personal letters to user company executives.

In addition, it has expanded its rental booth program to make it less expensive for companies to exhibit. For $610, for example, an exhibitor gets a booth with lights, furniture, and carpeting, and saves on shipping, which might cost $1,100 round-trip for a 20-foot booth from New York. As of early August, more than 130 booths—22% of the entire show—had been ordered by exhibitors, many of whom might have stayed home otherwise.

lists? For one thing, Wescon management knew what was coming. Six years ago, in another of his Wescon studies, Sherrill pointed out that many exhibitors believed that specialty shows were better than Wescon. He made a strong point that Wescon had hard tasks ahead: to provide specialty audiences from outside the industry and to provide a group of specialty product shows.

But, as one insider puts it, "it is hard to convince people in good times that bad times are coming." So nothing much was done, apparently because Wescon's cosponsors weren't willing to tinker with a money-making show. Wescon has drawers of plans for specialized shows, but no plan has been formally presented—they've only been discussed as ideas. And Wescon's planned vertical-show study will be concerned only about bringing in the user audience to the present Wescon bigtop.

Where does Wescon go now?

In a meeting earlier this year with top marketing executives, Wescon officials asked: what direction should we be going? Wescon's Larson says the unanimous reaction was "don't fragment the show—keep one big show." Out of this came the idea for market-oriented sessions. "We also polled exhibitors last year about splitting the show into little shows," Larson adds. The vote was 87 to break Wescon up and 286 to keep it.

Though the principals won't discuss it, a meeting of sponsors and show management reportedly will be held before Wescon to examine the purpose of the show. The original Wescon charter is somewhat vague: advance the state of the art in West Coast electronics, technically and industrially.

"Wescon is in business," Kaisel says flatly. "We've got a product to sell—a marketing tool for our customers. If our tool can't meet the payout analysis that exhibitors make, we don't deserve to be in business."

WEMA's Ed Ferrey: "We're looking at other shows."

The meeting on the charter will discuss whether Wescon should go out and run specialized shows, and Kaisel isn't sure the charter says this. "We'll ask sponsors what they want Wescon to do?"

He says the sponsors could say: "Income is so important that we want you to broaden our charter and run specialized shows. The stockholders [sponsors] want their dividend." Or, he says, the answer could be no; they could say: "See if you can operate the big show and make it more effective, and stick to the original charter." Kaisel says: "I don't believe this will work."

While the people involved won't talk about it, an internal squabble has developed among the Wescon principals and could have major impact on the type of show Wescon will be in the future. Wescon, or WEMA, with or without the professional Wescon show management, could end up running or sponsoring other, perhaps new, specialized shows. There is no restriction in the Wescon contract with IEEE that prevents WEMA from putting on a trade show by itself or with someone else. WEMA's membership has broadened in recent years just as the industry has broadened, he says, and "many WEMA members just don't serve the electronics industry per se."

WEMA isn't concerned that Wescon is smaller this year, because there is a basic need for Wescon, Ferrey says. "But it isn't feasible to make a market place for all these products of WEMA members in one show." So, he says, WEMA is looking at other shows to be sure "we adequately serve the needs of our membership." The association rode out the past recessionary year in relatively good shape. Dues income is within 2% of last year, Ferrey says. The association presently has 600 members, down only 5% from 634 a year ago.

However, WEMA is looking at income harder than ever, Ferrey notes, though he hasn't raised membership dues since 1966. "Costs go up, but we can't get more money from Wescon." Wescon income is important to WEMA, because "we've been able to do a lot more without our membership paying for it—new services." In recent years Wescon has contributed on the order of $200,000 to the two sponsors, WEMA's half is close to one-third of its estimated $350,000 budget.

WEMA reportedly has been interested in other shows—such as a computer show, for at least two years. But the closest it has gotten apparently is its curent discussions with Hugle's SEMI board over next year's Semicon. WEMA has had exploratory discussions with SEMI, but there have been no specific proposals and nothing in writing, confirms Ferrey. "We have 90 member companies in the semiconductor equipment and materials area," he says. "If they have needs that aren't being served, WEMA has the responsibility to help meet them."

Hugle says the SEMI board will meet Sept. 2 to decide what to do and he predicts that the board will probably vote to cosponsor a West Coast Semicon put on by WEMA. If SEMI comes back and asks for a proposal from WEMA, Ferrey says he'd want to know what other services SEMI wants—in newsletters, an executive secretary, surveys and Government affairs liaison. Ferrey acknowledges he's interested in WEMA doing all of it.

He doesn't know now whether Wescon or WEMA staff would be running next May's Semicon. "We could contract with Wescon to handle the show with IEEE permission," he says. If WEMA decided to run the show, it would have to hire an experienced show manager. Asked whether running SEMI would put WEMA in the position of backing two competitive shows, Ferrey says: "I don't think the two shows are competitive. Semicon has a very special niche and its exhibitors are not being served by the large, horizontal shows."

Based on the past year's struggle between Semicon and Wescon over exhibitors, though, it's certain that Wescon doesn't feel that way. Wescon worked hard to attract this type of exhibitor to this year's show. It is not only putting on several related technical sessions but will have a complete MOS/LSI fabrication, test, and assembly line operating at the show.

Will component exhibits disappear?

Wescon is usually labeled by many in the industries as a "components and instruments show," and the parts people indeed have been a mainstay of the exhibit. But it has been the component companies, led by the semiconductor manufacturers, that began a wholesale defection in recent years. In fact, many company officials see component exhibitors disappearing from Wescon.

"Wescon will sooner or later lose the component makers," predicts David C. McNeely, vice president and division manager at Beckman Instruments' Helipot division, Fullerton, Calif. Wescon's Larson generally agrees that components will be gone from the show in a few years—but, with the continuing trend toward circuit integration, "what components will there be?"

"Helipot was the first pot company to drop out of Wescon, and the others followed," McNeely recalls. "The show just didn't do enough for us. The good customer prospects that did come by the exhibit came by just to say hello. They weren't interested in the booth because they were already covered by our salesmen."

Burndy Corp., in Norwalk, Conn., is also disappointed with audience quality at the large national shows. "We dropped out of Wescon this year for the same reason we dropped out of the IEEE show several years ago," a spokesman for the connector firm says. "A smaller and smaller percentage of the people coming to our booth seemed interested in our products," he says.

C. P. Clare & Co., which is passing up Wescon this year for the second year in a row, also was not reaching enough of the right people at Wescon, explains Richard H. Marks, vice president for marketing of the Chicago components firm.

To someone who hadn't visited Wescon in recent years, the most dramatic change in the exhibit would be the absence of the aggressive, hard-charging semiconductor industry. The Big Three, as well as most of the smaller solid state producers won't be there this year. RCA's solid state division is the only large semiconductor house still in the show. The Somerville, N.J., di-

Are big shows dinosaurs?

If Wescon is sick, then last rites should be given to the two other major horizontal trade shows: the National Electronics Conference in Chicago and the New York IEEE show. While Wescon has been doing its homework and trying to change as industry changes, the other two shows differ little—except for the sharp drop in exhibitors and visitors—from their golden years.

NEC surprised many in June when its board canceled this year's show. The main reason, according to R. J. Napolitan, NEC manager, was that, because of the economy, no one wanted to participate. The 1972 show is still scheduled for McCormick Place, but the board will cancel again "if it is still not time for a show," he says. NEC will have a difficult time ever coming back, forecasts one veteran show watcher.

A major blunder appears to have been the decision to move the 1971 show from the Conrad Hilton to the huge McCormick Place exhibit center; they should have stayed in the hotel with a smaller show, one observer says. Robert M. Janowiak, NEC board chairman, admits that "our plans were to greatly expand the exhibition when we went into McCormick Place." Janowiak, director of computer science at Illinois Institute of Technology's Research Institute, maintains that more companies than had exhibited at the 1970 NEC signed up, but that was still not enough.

David C. McNeely, vice president and manager of Beckman Instruments Helipot division, Fullerton, Calif., says he "wasn't surprised" at NEC folding. "It was the first broad trade show we got out of."

NEC was always "a badly managed show," declares a vice president for a major Northern California company. Several former exhibitors agreed with his comment that the show was run primarily by and for the educational community, and that the professors regarded the exhibits as a "necessary evil."

The IEEE show in New York had its peak year in 1962, and it has been downhill ever since. That year 74,734 people tramped through the aisles, checking on the wares of 1,307 exhibitors. Last year, total attendance had dropped to 35,228. Even this low figure was challenged: at least one exhibitor claims he saw students bussed into the show and counted as bona fide attendees. The 426 companies exhibiting in 1971 were also the fewest in more than a decade.

The 1972 show is going to be even tougher, declares one Palo Alto marketing executive. He believes the unique problems of exhibiting in New York are catching up with the show. Exhibitors must contend with New York's high cost and unions. There are many horror stories: one former exhibitor remembers when his power lines were cut after one of his engineers plugged in a product in the exhibit. "They have to get away from New York," he says.

RCA's Solid State division, Somerville, N.J., pulled out of the 1970 show because it was "too institutional in its approach. In today's economic climate, the whole business at a show is sell," an official comments. "And the people who come to the IEEE show just don't seem to be interested in buying." "The days are over when you had to be in IEEE," an official for another West Coast company adds. "Since all your major competitors are dropping out, you can too."

The IEEE show has to go the same way as Wescon, says Robert M. Ward, manager of Perkin Elmer Corp.'s corporate development in Palo Alto. "It has to have an organizational restructuring." Unless they know how to attract the kind of customers that exhibitors want to see, the show will die, he says.

vision will use Wescon to see its West Coast customers.

Wescon is "just not a components show," insists a spokesman for General Electric's Semiconductor Products Department, Syracuse, N.Y., in explaining why they had not exhibited at Wescon for three years. Because the cost of exhibiting has gone up to "exorbitant heights" and the quality of booth traffic was "way down," he says, it just wasn't worth it.

"Let's face it. You go to Wescon or any trade show to sell," says Gene McClenning, who pulled Fairchild Semiconductor out of Wescon in 1966—the first big semiconductor firm to do so. "We did some pretty exhaustive analysis to find out if we were selling and how much it cost us." He kept track of all costs related to the show and found it cost Fairchild about $132 for each lead, "so we couldn't justify Wescon, and these leads weren't traceable to sales."

Another reason for the departure of semiconductor makers from the horizontal trade show are the changing ways they market their products: it's either through purchasing departments or at the design level. Working at the design stage is a long, involved process, says McClenning, who is now director of marketing operations at Four-Phase Systems, Inc., Cupertino, Calif. "This involves a lot of direct salesman's work playing with the part at the customer's bench." This can't be done at a trade show. "When you want to marry a chorus girl, the best place to go is the stage door."

Signetics Corp. made headlines two years ago—and made Wescon happy—when it publicized a special study that showed it cost only about $14 for every person who left his name at the firm's 1968 exhibit. Further, about

Two views. Hoffman's Sell: "I just don't see the big show offering us very much." H-P's Boniface: "If they try to make the show all things to everyone, Wescon will fall flat on its face."

100 requests for sales calls amounted to nearly $3 million in "potential business"—half of which the Signetics salesmen had not previously been aware of. However, the semiconductor maker isn't in this year's show.

The reasons why they aren't correspond with the feelings several companies have about the show. "In 1968, Signetics had a small sales staff and we were a small, new company that needed exposure," a spokesman comments. Now the picture has changed. The Sunnyvale, Calif., company is known, and has grown.

Wescon's traditional market—the electronics industry itself—is still an important reason for many companies to exhibit. The Electronics Group of North American Rockwell Corp., Anaheim, Calif., will be exhibiting this year for the first time since 1965. It recognized it had "little or no identity in non-aerospace electronics," an official says, so it decided to design a booth to exhibit this capability. North American Rockwell is pointing its exhibit at other Wescon exhibitors and their management. The approach—an "electronics supermarket of ideas"—will be used not only in selling but in talking about licensing, joint ventures, or even acqusitions.

The traditional component maker may be fast disappearing from Wescon, but at least one new "component" maker will be exhibiting at the 1971 Wescon—Computer Automation, Inc. The component is an 8-bit word, stripped minicomputer—the "Naked Mini". "We've got to sell the Naked Mini just like a switch or power supply—it's the same thing to the OEM; he buries it in his system," says marketing services director Armstrong. "We're trying to appeal to many users, and we need the broad exposure of a show like Wescon."

An increasingly tough sell for Wescon though is the systems maker like Computer Automation, or the large, diversified company like NR's Electronics Group. In the good old days, nearly all of the big "blue-chip" electronics companies would be exhibiting at the show. Few of these companies are exhibiting now, though some have a division at Wescon. This is a major dilemma for Wescon, H-P's Boniface says. "If you lose the big companies in the electronics industry, like they have, they lose a big drawing point. It's important you have your leaders," he adds.

Made for instrument makers

Instrument companies, too, have been one of the strongest segments of the Wescon exhibit. They have the advantage of a dynamic display and it's often difficult for the instrument maker to take his product to the customer. So the trade show fills the bill. And one marketing man adds that instrument manufacturers have "tremendous leverage in cost per demonstration." By comparing what it costs to demonstrate an instrument these days, he says, such companies can "justify a show's expense."

Hewlett-Packard's Boniface disagrees somewhat with those who say the show is a good place to demonstrate hardware that can't be taken to the customer. "Big instrumentation systems are hard to display and hard to explain," he says. "It takes 45 minutes to go over some of them with a visitor and this just isn't realistic at a show."

Typical of the instrumentation house that will be at the show is Teradyne, Inc. The Boston test equipment maker says Wescon is "very important to us as a West Coast exposure to our products."

Dana Laboratories, Inc., on the other hand, won't be in Wescon this year, though it has exhibited there for the past several years. "We have the money if we wanted to go," a spokesman says, "but this year we want to use the money in areas that will do us more good, such as sales support."

Hewlett-Packard is back in Wescon this year with its instruments and systems—much to the relief of show management—after missing last year for the first time. It did have a small components exhibit in 1970, but the huge, carpeted, eye-catching exhibit familiar to showgoers was missing because "we were in the middle of rethinking the validity of the big show," says Boniface.

But Boniface gives the distinct impression that his jury is still out on Wescon and that the big show will have to make more major changes if it wants to keep H-P. Some of his unanswered questions: Is Wescon really a show for a big company? Does a company grow up and out of a show like Wescon?

Despite the growing number of exhibitors who feel that the horizontal trade show is not the answer to their marketing problems—and the subsequent loss of these companies to be the smaller, narrower based show—Wescon believes it can "verticalize" to compete effectively with many of these shows. But Wescon also is convinced it will continue to draw the small company—the new firm, for example, with a limited marketing staff. Wescon's Larson sees the electronics industries continuing to be made up of many of these small companies, with new firms continuing to be formed.

If Larson is correct and these trends do continue, there's no doubt that they would help Wescon since many exhibitors agree with Hewlett-Packard's Boniface that the real value of a Wescon is to the small, young company that needs recognition in the marketplace. "It's the only way a small company can see a mass audience in a few days," he comments.

New companies can always gain more by exhibiting than an old, established company, Larson points out. A small company at Wescon "can sit next to a big company like RCA and look just as good," a selling point that the very successful show manager has made many times, and will probably use many times again.

It would be hard to imagine a summer in this business without a Wescon, but the big show has a difficult task ahead in making the right changes to meet the changing needs of the exhibitor. Wescon consistently has identified the marketing trends impacting on the show—and it has and will change. The question is, though, in whatever new form Wescon takes, will it attract those kinds of visitors that exhibitors currently are seeking—including those who never thought of attending Wescon because "I'm not an EE."· □

As Wescon 71 rolls in, the West diversifies

With no recovery from the dive in military/aerospace sales in sight, Western companies are making their first sustained effort to enter other markets; acquisition of firms with sales know-how is the favored route

by Lawrence Curran, *Los Angeles bureau manager*

☐ Whenever military/aerospace business dipped in recent years, Western companies dependent on these markets started looking frantically for new business in other fields. But a new round of military business would come along, and companies would rush back to their traditional marketplace, promptly killing most of these diversification plans.

But it just might be different this time. Lamentations about the continued recession, the steep dip in new military/aerospace business, and increasing layoffs have tended to obscure the fact that Western companies may have learned their lesson. They're diversifying in a big way, through internal growth and acquisition, to get more of the action in commercial/industrial markets and to smooth out their roller-coaster sales curves in military/aerospace hardware.

Whether they have learned enough of a lesson is another question. For it takes more than superior technology to succeed in a new market or product line. John Nichols, vice president for finance at Aerojet-General Corp. in El Monte, Calif., observes that "there are a lot of corpses on the trail of diversification." It's difficult, he points out, to crack a market already served by companies that know it well. "The question is how you swim into another pool—with some other barracudas."

Aerojet itself, which rocketed to its peak sales mainly as a propulsion company in the halcyon days of the manned spaceflight and Titan ICBM programs, then slumped badly after 1963, is stirring strongly again, having reorganized into 11 decentralized companies; and diversification is no small part of its new look. Managements at the Boeing Co., North American Rockwell Corp.'s Electronic Group, GTE Sylvania, Systron-Donner and Hughes Aircraft Co. have also realized that they'd better move more into commercial and industrial markets. Even much smaller companies such as are embarked on the same course.

Still, though the march into new markets appears to be on irrevocably in the West, few companies heavily into military or NASA programs are ready to abandon that part of their business—they simply want to get a better mix of Government and commercial/industrial sales. And not many of them are counting on any quick returns from possible ventures into the potential new Federal markets of transportation, law enforcement or pollution control. What money is available appears to be spread too thin for early exploitation.

Teledyne Systems Co., Northridge, Calif., which manufactures avionics systems, "intends to be one of the survivors in the military/NASA market," says Teck Wilson, its director of advanced systems. He probably sums up the military supplier's attitude best when he says, "It's too easy to forget that the military budget is still more than $70 billion. We're not going out of the military electronics business. It's not obvious that we should get upwind and head for the trackless desert of the civil systems market."

Teledyne will try to be one of the military/NASA supplier survivors by keeping its eyes open for opportunities and moving rapidly after them, Wilson maintains. "We don't do a whole lot of formalized long-range planning, because we're less convinced than some that it can be done properly. If we put our energy into much long-range planning, we tend to believe it and may commit the company to a path that may be wrong."

For all that, Teledyne Systems, too, has cracked a market recently that's new to the company—commercial airline airborne integrated data systems. The company has contracts with at least nine major airlines, and is counting on orders for 300 or more systems for Boeing 747s and McDonnell Douglas DC-10s. "We've recognized that the commercial aircraft business has to grow, in area navigation systems and relatively low-cost computers," Wilson says.

Nor is North American Rockwell's Electronics Group turning off on military business. Says Donn Williams, the group's president, "We want to build a broad base of product capabilities—commercial, industrial and defense (the latter now accounts for 90% of the group's business) without weakening our defense business capability. Maybe we'll have 50% of our sales in the defense business when we reach our goal, yet not have the defense portion shrink." The Electronics Group consists of the Autonetics division, North American Rockwell Microelectronics Co. (NRMEC), and North American Rockwell Information Systems Co. (Narisco). All are in Anaheim, Calif., and group sales are running "between $300 and $400 million now," Williams says.

Wanted: knowledge of the market

Today, though, Western firms are also looking to penetrate new markets, with product lines that are new to them and not necessarily outgrowths of military system

capability. Some are doing it with home-grown products, but increasingly both large and small companies are acquiring quick market penetration by buying other companies or specific product lines—and attracting or retaining the marketing force that's been selling the product. Little Burr-Brown Research Corp., with 1971 annual sales running at an $8 million rate, just bought part of Sloan Microelectronics, El Segundo, Calif.—its thin film hybrid capabilities—to complement Burr-Brown's own thick film hybrid expertise.

Burr-Brown intends to be a major factor in the business of hybrid a-d and d-a converters, for which it formerly had to buy the necessary thin film parts. The same thin film know-how, moreover, allows the company also to penetrate a new market and diversify further by gaining the market for the Sloan components. "We'll sell the same products through the Sloan organization and under the Sloan label, and to existing customers," says James Burns, newly named director of business development.

Systron-Donner Corp., Concord, Calif., which had been on a small acquisition binge until the recession, on balance would rather acquire a company or a key product line from another company than try to attack new markets by internal growth. Frank Marble, vice president in charge of administration, says the advantage of buying a going firm is that the product and market are developed, and the company has a proven track record.

Hewlett-Packard Co., Palo Alto, Calif., continues to diversify, and Thomas Perkins, director of corporate development, says the company prefers to do it first by acquisition, and only secondly through in-house operations. The company's Computer division resulted from a combination of in-house development and acquisition—five people were acquired from Union Carbide to form the nucleus around which the group was built.

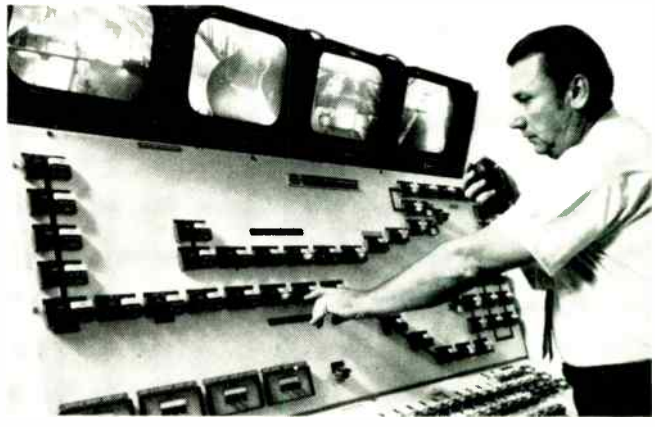
H-P Laboratories, however, was started six years ago deliberately to help the company diversify, and has proven very successful at broadening Hewlett-Packard's product line—into electronic calculators and laser distance-measuring equipment, for instance. The laboratories "receive about 10% of our development dollars," Perkins points out, and they "take on the riskier projects."

The merger of North American Aviation Inc. and Rockwell Standard Corp. in 1967 is just now becoming fully implemented, and both sides are looking to see where NR Electronics Group technology might be transferred to the commercial efforts of the Rockwell side's become very acquisition-minded, which could lead to further diversification beyond technology transfer in-house and commercial microelectronics with NRMEC's MOS/LSI expertise, and into data management systems and software through Narisco.

But that firm's Autonetics division has stubbed its toe more than once in the past, trying to push aerospace technology into a commercial market that either wasn't ready for it or couldn't afford Autonetics' pricing. Then just early this year, the sales subsidiary the original North American Aviation Inc. set up to market commercial "fallouts" from Aerospace work—Navan Inc.—went out of business, selling some of the products in its inventory to another firm. The technology in these products was often good, such as oxide pinhole detectors for semiconductor manufacturers, but the marketing organization didn't exist to get them to customers at a competitive price.

Now, however, under newer corporate and Electronics Group management—Williams at the group and president Robert Anderson at the corporate level—the word is out that the low-profit and sometimes no-profit contract days of the old Autonetics are gone, and a new emphasis is being placed on marketing capabilities. Williams has cut the Electronics Group to the bone, eliminating overlapping middle-management layers and gearing for profit. He's also been closely involved in discussions with Collins Radio Co. about what kind of "affiliation" of his group and Collins might come about as a result of NR's investing in Collins.

This reflects Anaheim's active interest in acquisitions provided there's "technology coupling" between them and NRMEC, Narisco or Autonetics. The group has carved the 1975 market into several segments, two of which best match the group's commercial growth criteria: digital data collection and transmission, instrumentation and process control, graphic arts electronics, rf communications, and commercial avionics and marine electronics.



Successful diversification: Aerojet-General's airline baggage system stems from industrial programable controller capability.

Williams comments: "We can develop products almost everywhere we look that will be more economical to sell because of the infusion of our financial strength and advanced technology, but service after sales hasn't been one of our strong points." For example, although no business strategy, including acquisition, has evolved yet in the data collection segment, "we have plated wire, MOS, bubble domains, and disks in the storage field. Now we want someone who can bring a background of memory or computer sales and service to match our financial strength and technology. But we're not looking for companies that need only money. We've both got to have something to offer each other."

Williams has touched on a nerve that's making most

acquisition-minded companies in the West twitch: the companies most actively seeking to be acquired are in a cash bind because of the recession or because of poor management. Eugene Prince, vice president and general manager of Ampex Corp.'s Computer Products division, Culver City, Calif., says most of them "have just gone through $2-$5 million in a start-up situation and they've never made any money." But he's quick to stress that the channels are open for acquisitions. "Our one basic rule is that if it isn't in the computer industry, we're not interested."

Movements from within

At Boeing, however, according to O. C. "Ollie" Boileau, who is group vice president for aerospace and also charged with shepherding the company's diversification efforts, the move into new markets is coming from inside. Acquisition isn't the way for the company to go now, Boeing sources say, because Boeing stock value is too low to make it easy to acquire another company through an exchange of stock.

The Seattle, Wash., giant set up a study team of key executives last year to probe into opportunities in new business areas. They began with about 160 product or business opportunities, by the end of three months had narrowed it down to five broad areas: field services, computer services, electronics, mass transportation, and real estate development.

As a result, the most successful diversification move to date has taken place in the Field Operations and Support division, which has annual sales of $20 million and employs 1,800. Its first contract was with the Kennedy Space Center in Florida to handle plant security and fire protection, test support management, plant engineering and maintenance, documentation support services, quality assurance, logistics support, and new employee training.

More recently, in May 1970, Boeing Computer Services was formed, a separate company with 2,400 employees that Boileau expects to reach some $90 million in sales by year's end. Only about $7 million of that is non-Boeing work; the company decided to put its extensive computer facilities to work, though, and would like to turn up more than the 275 outside customers now in the fold.

There's also been a big move into electronics through the Boeing Electronic Products Organization, which will do about $45 million in sales this year. But again, only about $5 million of it will be with outside customers. The ratio is expected to become about 50-50 within five years, though, with outside sales predicted to hit $45 million. The Electronic Products Organization makes hybrid circuits, multilayer boards, and voice privacy modems for law enforcement agencies, and it also expects to announce a new, low-cost landing aid for commercial aviation before the end of the summer.

While Boeing's diversification attempts have stemmed from formally planned internal expansion, rather than acquisition, Hughes Aircraft Co. is going after new markets for commercial communications satellites, and wants to be in the business of operating the satellites—mainly as the result of some entrepreneurial effort by a small group of engineers who were convinced they could make spin-stabilized, synchronous-altitude communications satellites work—and did so.

Albert "Bud" Wheelon, vice president and group executive for the recently organized Space and Communications Group, says the early believers in spin-stabilized communications satellites approached Hughes president Lawrence Hyland with $10,000 of their own money and asked for financial support to develop their ideas. They got it, and a whole family of communications satellites—plus a significantly growing commercial business—was born. Syncom came first, and the last two commercial Comsats in the line to date, Intelsat 4 and a smaller satellite with Intelsat 4's 12-television channel capability, are chiefly responsible for the $51 million in commercial sales the group will do this year. Total group sales will be $150 million.

The smaller satellite is known as "Cansat" around Hughes because it's the one the company has sold as a domestic communications satellite to Canada. The Canadian program alone will be worth about $30 million in commercial sales to the group, but it won't stop there. "We're now bidding Cansat all over the world," says Wheelon, with antenna variations depending on the pattern of coverage desired.

Ampex's Prince: "We're open for acquisitions, but if it isn't the computer industry, we're not interested."

Wheelon won't say to which countries Hughes has proposed Cansat, but points out that logical candidates for it are the larger countries, such as Brazil, Australia, India, and Japan, although Japan would probably prefer to build its own domestic Comsat. Wheelon emphasizes that Hughes has to create the market for a domestic Comsat in a foreign country. "We've got to grab these guys by the tie and tell them they need a satellite, and then find out how the country operates—what tumblers have to fall before the lock opens. It's a lot different from the military market. We're not in the RFP-answering mode; we're trying to create the opportunities rather than wait for them."

Hughes also was one of eight organizations that applied for a license grant to the Federal Communications Commission to operate a U.S. domestic communications satellite system. The Cansat design was bid as the satellite. But whether or not Hughes is successful in winning the nod actually to operate the system, the company expects to build satellites for the system—

Wheelon says that at least three of the other seven applicants showed Hughes satellite designs as part of their plans.

Not all that glitters

Not all the Western diversification attempts have been so successful, however, and the jury is still out on some. Aerojet General's Nichols, for one, regards the semiconductor industry as immature and describes its pricing as "nutty." "No big company has made it in diversifying into semiconductors," he says. He's not ready to pass judgment on North American Rockwell.

One attempt after a new market that failed at Aerojet-General resulted when the parent firm set up Aerometrics Co. to manufacture and market infrared brazing equipment commercially. This was an outgrowth of expertise built up working on propulsion systems. Says vp-finance Nichols, "the technique was reduced to a nifty product that was sold to the Navy to repair pipes on nuclear submarines," reducing some brazing jobs from 20 to 3 minutes. "We went to Linde and Alcoa, among others, and they liked the product, but there was resistance to it in the market. Plumbers, for example, are accustomed to gas brazing, and ir brazing turned them off, so we closed the company."

Beckman Instruments Inc., Fullerton, Calif., too, which used to do about 18% of its business with military and NASA customers, in both direct and indirect sales, has learned its lesson the hard way. The company cut that percentage back to 9%, because, says Robert Lineberger, vice president for finance, "the profit opportunities were far lower than others we had," including the commercial and medical instrumentation markets.

Along the way, though, Beckman had to disband its Systems division, which had been supplying such hardware as data-acquisition systems and Beckman-built computers to both DOD and NASA. G. Howard Teeter, senior vice president for operations, comments, "Even though we had great people and great technology, we didn't want to spend our energies in a market where you have inadequate control over your destiny."

Electronic calculators provide an example of the effect of timing in getting into a new market. Fairchild Camera and Instrument Corp., Mountain View, Calif., will either sell or discontinue its calculator line because the company was too late into the market. Developed by the Microwave and Optoelectronics division, "it's a beautiful machine," says C. Lester Hogan, Fairchild president and chief executive officer. "If we'd had it three years ago, we'd be in the calculator business today, but today it isn't unique. There is nothing in it that isn't available to anyone else."

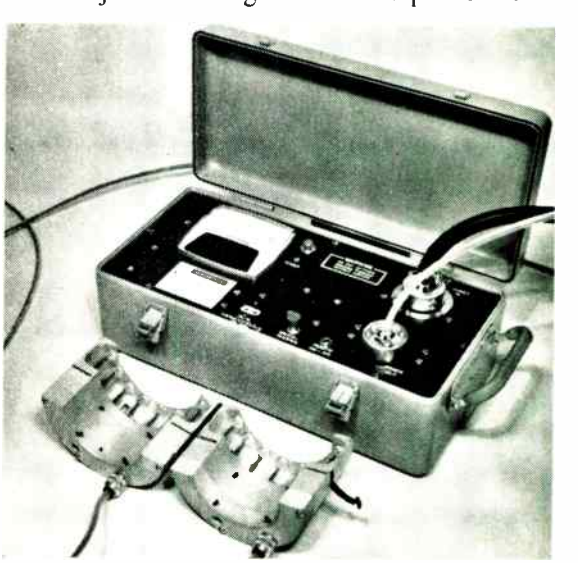
New products from old

But the bootstrapping efforts to penetrate new markets with products derived from resident technology are paying off for some Western companies, and there's a lot of hope for new operations that have yet to contribute profits. One market that's attractive to such firms as Ampex Computer Products division, Electronic Memories & Magnetics Corp., Lockheed Electronics Co., and California Computer Products Inc. is in computer peripherals, particularly IBM-compatible memory systems and peripherals for the 360 and 370 computer series.

Ampex has been in the business little more than 18 months yet is already profitably supplying add-on and replacement core memory systems for IBM 360s. The company is also selling disk and tape drives that are plug-interchangeable with IBM 360 peripherals. In June EM&M announced formation of a Computer Products division in Los Angeles, to sell add-on and replacement memory systems for IBM 360s. Lockheed Electronics' Data Products division in Los Angeles came out with its MM365, a substitute for the IBM 2365 core memory extension for use with the IBM 360/65. All of these moves came about as evolutionary diversifications from existing product lines.

At Calcomp, in Anaheim, Calif., however, purchase of 65% interest in Century Data Systems Inc., also in Anaheim, came just at the right time. The plotter busi-

NR's Williams: He's getting the word out that the low profit and sometimes no-profit contract days of the old Autonetics are gone, and that a new emphasis is being placed by the company on marketing capabilities.



Unsuccessful diversification: Aerojet-General tried to sell an industrial infrared brazing system based on one it had developed for repairing pipes on nuclear subs, but failed when it ran into resistance to IR brazing on the marketplace.

ness, Calcomp's specialty, had gone flat, but Century's IBM-compatible disk drives contributed about 50% of Calcomp's revenues in the year ended June 30. Calcomp is negotiating to buy the remaining 35% of Century. James Pyle, assistant to the president at Calcomp, points out that the disk drive business is good because "it's a recession business—you sell it to a company using IBM equipment at a lower price than an IBM disk drive. So you save him cash, which is especially important in a recession."

That fact isn't lost on either Ampex's Prince or EM&M's vice president for development, Milton Rosenberg. Both firms are marketing, or will market, systems that offer better performance at a lower price than the IBM memories or peripherals they replace. And both are aware they'll need semiconductor memory systems in their IBM-compatible arsenals, and are doing something about it.

Ampex bought the semiconductor facility vacated by Varadyne Inc., in Santa Monica, Calif., earlier this year. Prince says it's logical to conclude that the Computer Products division will market replacement memory systems for the semiconductor units in the IBM 370/135 and 370/145 when enough of those units are in the field to create a market.

EM&M's Rosenberg recognizes that while the IBM memory replacement market today is for core systems for the 360 series, "we'll need both core and semiconductor plug-compatible replacements when the IBM 370 comes into widespread usage." That's why the company helped bankroll Semiconductor Electronic Memories in Phoenix. "The SEMI people started with bipolars in a package pioneered by IBM," Rosenberg relates. "We felt that was the lowest-risk way to get into semiconductor memories." The founders of SEMI came from IBM.

New applications for old

Other companies can't diversify by evolution from existing product lines because their aerospace markets are shrinking. But some are assessing the technology they've accumulated, to find out where it can be applied in a market new to the company. Aerojet-General has done that. So has little Ogden Technology Laboratories Inc., Sunnyvale, Calif., a firm that formerly specialized in environmental testing for the aerospace industry. It's now testing integrated circuits, which William Byars, Ogden's general manager, says his firm can do less expensively than the IC manufacturer. "And in some cases," he says, "the IC makers just don't have the capacity they need. We're looking to get some of the overflow." The company has bought a computer-controlled IC tester that can run 20,000 tests a second and accommodate eight stations.

Aerojet-General's Nichols says candidly that "we haven't accomplished a heck of a lot yet in new markets," but it has made a start with the Envirogenics Co., which specializes in water purification and solid waste handling. To form Envirogenics, Aerojet combined its own cryogenic and heat-transfer technologies with the "dirty-hands capability to translate some of our bright ideas into products" that came with the acquisition of Graver Tank Co. A manufacturer of tanks for liquid natural gases, Graver has 40 years' valuable experience in a specialized market.

The Envirogenics Co. will account for 10–12% ($35–40 million) of Aerojet sales this year, and will be profitable. Aerojet's Industrial Systems division has also pioneered a new market in material sorting and freight forwarding, and with an annual sales rate of $16 million, is soon to become an autonomous company. It recently installed a $1.2 million baggage-handling system for United Air Lines at Chicago's O'Hare International Airport. Other customers include Sears, Roebuck and Co., and United Parcel Service.

In Mountain View, Calif., the Western division of the Electronic Systems Group of GTE Sylvania Inc. "detected a change in the mood of the nation three years ago," says T. H. McKenzie, vice president and general manager of the Electronic Systems Group division in the West. The new mood was one of unhappiness with the war in Southeast Asia plus an increasing awareness of crime, pollution, and other urban problems. Sylvania then formed its Sociosystems Laboratory, to explore how systems development could be applied to community problems. The lab team was given a limited budget and a year to determine where its systems experience might be applied. It decided to focus on law enforcement and highway safety, and its products to date include a 3-lb night-vision device for police, a digital communications system, a digital vehicle-location system, and an extremely high-intensity portable light for investigation purposes.

Not many Western companies, however, have found the secret to doing business with companies or Government agencies in these areas. Most say that it's too early to pinpoint markets in pollution control, for example, and that there's little money available for ecology, law enforcement, or transportation. Or if there is money, it's not getting out to industry very fast.

Beckman's Teeter, for example, says, "Pollution monitoring will grow, but the signal-to-noise ratio isn't good now," equating the signal with market dollars and the noise with public discussion. Beckman's Lineberger adds that the company is getting its share of the pollution-monitoring market now, "but that market is much less than people would extrapolate from the headlines of the politicians."

All in all, Western firms would do well to heed the advice of those who have found by bitter experience and red ink that advanced technology must be tied to marketing effectiveness and market knowledge if it is to be converted into sales and profits. "Aerospace companies have a lot of technology," says Beckman's Teeter, "but the knowledge they need is knowledge to discern the subtleties of a new market. It's much tougher to develop a market where no stated requirement exists."

And at Aerojet-General, which is fighting back from the aerospace decline, Nichols chimes in. "Too often people think that once they've spent a million dollars on product development they have it licked. But it may cost many times that to enter the market—build the marketing and servicing organization and then be willing to wait a long time to overcome buyer resistance."

Today, if you build a better mousetrap, the world does not automatically beat a path to your door. □

WESCON SPECIAL REPORT

Technical sessions focus strongly on economics and manufacturing

Wescon organizers deliberately reflect the changed business climate in a mix of sessions that contains less for the design engineer and a good many more for manufacturers and users of electronic equipment

by Stephen Wm. Fields, *San Francisco bureau manager*

☐ Bankruptcy, employee loyalty, new markets and economics will join with lasers, ion implantation and inductorless filters in the technical sessions at this year's Wescon in San Francisco, August 24-27. Not only will the engineer be told how to design a product, but he will also be told how to augment the design with the help of a computer, assemble it automatically, test it automatically, hire and fire the employees who build and market it, get out of bankruptcy after he finds out that he can't sell it, and how to get into a new market.

To judge by the preprints that were available in late July, the design engineer looking for the latest in technology and new applications of existing technology will find the pickings are slim. But this is by choice and not chance. For the past few years, the Wescon technical committee has been shifting the program away from narrow, state-of-the-art, theoretical papers and more toward broader sessions aimed at users of electronic equipment and not just the designers. "We were an industry talking to itself," says a Wescon spokesman. "But as the industry moves toward more interdisciplinary fields, trade shows must also be broadened."

However, Raymond D. Egan, co-chairman of the Wescon technical committee and vice president of Granger Associates, Palo Alto, stresses that "our objective is to supply information that is directly usable to the Wescon attendees." High-technology, state-of-the-art papers are not ruled out: Egan says that "high technology is important where it can be applied now." So there are still sessions that have direct appeal to the design engineer looking for the latest in technology, for example, Session 6, which has as its subject "Direct Detection Laser Communications."

This area has attracted much attention of late not only for satellite communications but also for land-based digital communications system [*Electronics*, July 5, p. 46 and p. 77]. Because of the quantity of information that can be gathered by a satellite or the amount of digital information that private industry generates, some means must be found for transmitting data at rates up to 1 gigabit per second. Session 6 explores modulation, transmission, angle tracking, and signal-processing techniques for such a system.

According to Gary Lee and Earl Paddon of McDonnell Douglas Astronautics Co., St. Louis, (6-1) laser communications systems are very attractive for high-data-rate space communication because of their narrow beamwidth, large bandwidth capability, and extreme security. In designing a laser communications system, different modulation techniques—pulse-gated, pulse-delay, and pulse-polarization binary modulation—must be analyzed in terms of the probability of errors per bit, bit rate, laser frequency, and so on.

After the digital information is transmitted, the next problem is to detect it. Arthur R. Kraemer of GTE Sylvania's Electro-Optics organization, Mountain View, Calif., (6-2) says that for a 1-Gb/s data rate, a direct detection link between satellites separated by 40,000 kilometers is within the capability of present technology, provided that the beam width is on the order of 10 microradians. Narrower beam widths will require that new techniques be developed to initially establish the correct line of sight between the two satellites and to continue the contact as the satellites move.

The critical components in a high-data-rate laser communications system, besides the modulator, are the laser and the receiver. R.R. Rice, S.I. Green and L.B. Allen of McDonnell Douglas (6-3) employ a mode-locked neodymium-YAG laser that has an efficiency of about 1%. Another approach [*Electronics*, May 10, p. 48 and March 1, p. 17] in this field is Lockheed Missiles and Space Co.'s continuous-wave neodymium-YAG laser which, says Lockheed, requires less primary power.

In a more down-to-earth vein, the design engineer will find about 18 papers on testing—what to test (Session 21), how to test (Session 17), how to program a tester (Session 14), and how to test something automatically (Session 18). One of the more interesting subjects, according to L.H. Bohl of Avco Systems division, Wilmington, Mass., (21-3) is a new family of automatic test sytems that employ computerized synthesis—a relatively new technique in which software replaces hardware.

Bohl says that the new Avco system (called Avmots for Avco modular test system) eliminates a wide variety

of instruments. Thus there is less hardware to be bought, be maintained, and depreciate. Calibration is simplified: the only standards the system uses are voltage and time. And the values themselves are not adjusted; instead, the actual values are stored in the systems memory. "The ability to use software to select not only what you want to measure but how accurately you want to measure it," Bohl says, "makes the synthesis technique quite desirable in a test environment where a high degree of flexibility is mandatory."

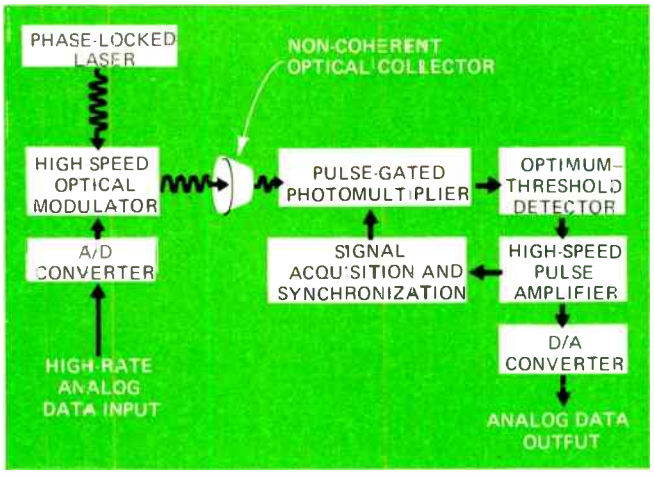
Two other aspects of computerized testing—whether it is worth the money and whether the results live up to expectations—are answered by Davis S. Kline of Hewlett-Packard (21-1). From a detailed review of three case histories, Kline concludes that "commercial, computerized, automatic test equipment can give dramatic reductions in the time and cost of taking, evaluating, and recording measurements.

Automating waveform measurement is the subject of Session 17. According to David R. McCracken, Tektronix Inc., Beverton, Ore., "one of the primary problems in building automated test systems is that of waveform measurement." He says (17-2) that, though it can be done with a dedicated piece of hardware, this type of equipment forces the instrument designer "to make judicious choices and tradeoffs to make the instrument attractive to the largest possible market." On the other hand, McCracken points out, waveform measurements can be made with a programable oscilloscope interfaced with a minicomputer. "Here the design tradeoffs are quite different. Most of the measurement capability of such a system now becomes a function of the software, with the oscilloscope and the interface serving only as a controlled data-acquisition channel." The key to this type of system is the interface.

The Wescon program also emphasizes the subjects of manufacturing and of choosing and applying electronic data processing equipment, devoting six sessions to each. But if there is a conflict between a manufacturing session and an EDP session, the design engineer would do better to attend the manufacturing session. One of the EDP topics, Session 19, is "Tomorrow's Programmable Calculators"—their design, what they will do, how they will fit into systems, and who will use them. The preprints indicate that the answers are simple—they will employ MSI and LSI ICs, will calculate and do some controlling, will fit into systems controlled by binary-coded-decimal lines, and will be used by everyone. Granted, the papers are not aimed at calculator experts, but the design engineer could get as much information from sales brochures as from the papers. In fact, in the preprint of the H-P paper, the company's latest machine [*Electronics*, July 19, p. 32] isn't even mentioned.

On the plus side, Session 1, "Choosing a Minicomputer—the User's Viewpoint," could prove to be of value, as could Session 5, "Peripherals for Minicomputers." Both could help sort out the machines and accessories that have been brought to the market in the past two years.

Both EDP and manufacturing are combined in Session 22, "Computer-aided Manufacturing." Clark E. Coffee (22-1) says that the development of a digital computer data base is the key to computer-aided manufacturing. "The more directly the control computer can communicate with the N/C tools on the shop floor, the better. The direct interconnection of machine controllers with the central computer offers the feedback necessary to completely automate production, inventory, and cost control."



Laser communications: McDonnell Douglas high-data-rate system, employing a neodymium-YAG laser, will be described at Wescon

Another aspect of computer-aided manufacturing—the production of logic layouts and the assembling of boards—is coming into more widespread use, especially with small production runs and systems that require customizing. According to William Q. Fordiani (22-4), it's now possible for a logic designer to give a hand-drawn logic diagram to a supplier and in four to six weeks receive an operating system with a complete set of computer-generated, design-analysis reports and wiring documentation.

Besides computer-aided manufacturing, some narrower topics—including beam-lead packaging concepts and the problems of making a hermetic seal—are also covered. Beam-lead ICs have been around for several years, but according to J. Acosta and H. Segal of the Raytheon Co., they have very limited use, mainly because of the lack of good reliability data—most of it is either classified or nonexistent. To get around this, Raytheon's Missile Systems and Submarine Signal divisions undertook a program to investigate beam-lead devices from two points of view: the reliability of the basic sealed-junction chip (nitride-passivated), and beam-lead chip packaging with a conformal coating.

Non-engineering sessions on markets, business, and financing are playing a much more important role this year. Papers on how to get money for a new venture (4-4) and how to get out of chapter XI bankruptcy (16-1) are musts for those thinking of starting out on their own. The first piece of advice of one group of venture capitalists, Thomas J. Davis, Wallace F. Davis and Frank G. Myers, of Mayfield Partners, (4-4) is don't go into the military business—get into the civilian market, in such areas as medical, ecological, and law enforcement electronics. Communications—CATV and the new intercity microwave links—also look good to them. And probably most important, make sure that the starting team is broad-based. Marketing, production, finance, and management are as essential as engineering. □

Sceptre rules benevolently over computer-aided design

Some practical tips on solving nonlinear problems with Sceptre reduce the complexity and cost of this computer program; tradeoffs must be made between circuit models, solution accuracy, and running time

by George C. Kenney, *North American Philips Corp., Briarcliff Manor, N.Y.*

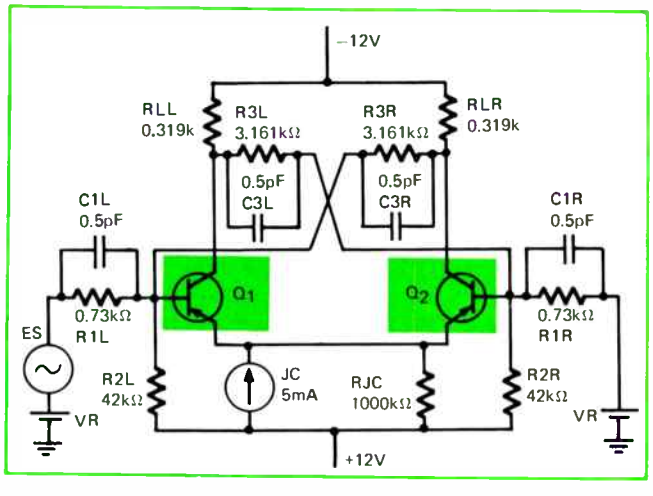
☐ Solving linear and nonlinear circuit problems is the province of a powerful computer program called Sceptre. Unfortunately, its reign has been limited by its complexity, high cost, and lengthy computer time. Sceptre, however, can be a practical and very valuable engineering instrument if used properly.

Sceptre, which stands for system for circuit evaluation and prediction of transient radiation effects, can determine initial dc conditions and transient responses to general forcing functions for linear and nonlinear systems. Although it is primarily intended for circuits, it can find solutions for systems in any discipline.

Until recently, Sceptre was available only by batch run at a computer facility, making it costly, time-consuming, and difficult to use. As a result, many nonlinear problems were solved by hand calculations, circuit experiments, or by piecewise linearization with ECAP (electronic circuit analysis program).

But now, input/output data for a Sceptre program can be handled by a remote teletypewriter terminal (through software provided by Computer Sciences Corp., Infonet div., El Segundo, Calif.). This allows the user to solve nonlinear problems with an ease approaching that of time-shared ECAP, and with reasonable expenditure of time and cost.

1. Circuit problem. Hysteresis of this flip-flop can be computed and plotted with Sceptre. Circuit elements are labeled for easy computer callout, with letters L and R differentiating between left and right side of flip-flop. Current sources are denoted by J.



Sceptre accepts input system data in two forms: as nonlinear, first-order, differential equations or as engineering descriptions of a circuit (similar to ECAP). Initial dc conditions are computed or supplied by the user if known, then a transient analysis of the system's response to forcing functions—such as time-varying voltages or currents—is carried out. It is also possible to run initial conditions only and then, after inspection, run transient conditions, or compute only the transient mode by supplying the initial conditions.

Sceptre recognizes standard passive elements such as resistors, capacitors, inductors, transformers, and the ideal diode. Linear dependent sources—like voltage-controlled current or voltage sources or current-controlled voltage or current sources—can also be used. These circuit elements enable the user to synthesize Ebers-Moll models for transistors as well as diodes that are operational in the large- or small-signal region.

Models stored on tape can be retrieved for use at any point in a circuit. The models can be interconnected groups of passive or active, linear and nonlinear elements. Nonlinear "black boxes" are implemented by tables or a Fortran expression. A special section allows special parameters to be defined that may be unrelated to the primary problem. Moreover, the user may write his own Fortran program and insert it into a normal Sceptre run as a subroutine.

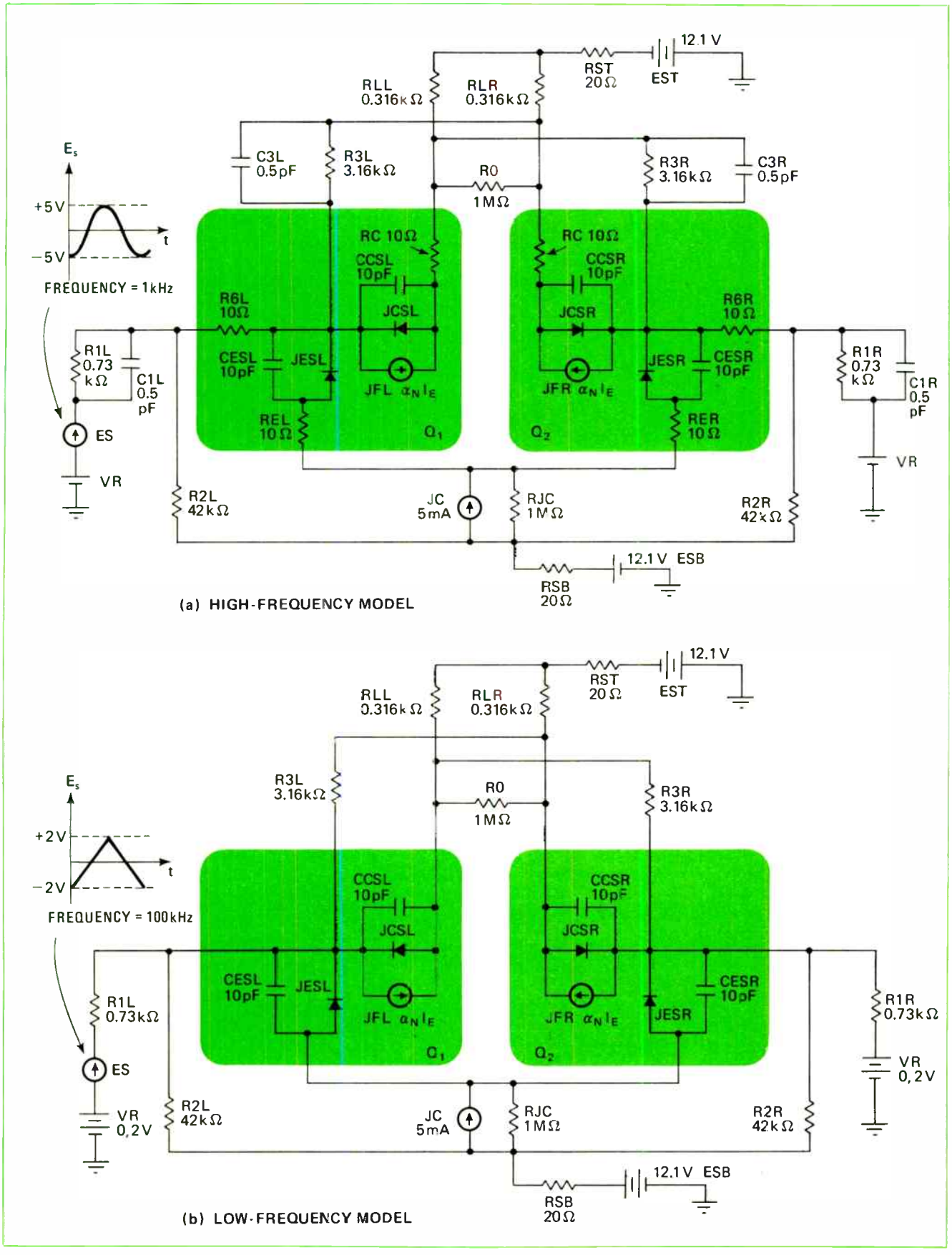
Using Sceptre. Printout is in tabular and/or selected graphical form. Sceptre will print any or all sources, in addition to circuit element currents or voltages, which are defined as a function of time or of any other parameter. The plots are easily requested, automatically scaled, and labeled.

An automatic termination feature stops the program upon satisfaction of any Fortran expression involving any of the circuit elements. For example, the statement

TERMINATE IF(-IR7 GT.10.1.AND.R9 LT.12.2)

will terminate the run when the reverse current through R_7 is greater than 10.1 milliamperes, and the voltage across R_9 is less than 12.1 volts.

Sceptre uses the state-variable principle as its mathematical basis. Capacitor branch voltages and inductor link currents are the state variables chosen to form a network of first-order, nonlinear, differential equations. This method is very efficient since computation time relates only to the number of state variables and not the number of elements.



2. Sceptre models. High-frequency model (a) of flip-flop includes transistor speed-up capacitors and lead resistance. These circuit elements, however, severely slow up solutions at low frequencies because Sceptre must take thousands of steps to arrive at answer. Changing to model shown in (b) speeds solution. Increasing frequency of forcing function and decreasing its amplitude also helps.

Ebers-Moll pnp transistor model

There are usually two circuit equations associated with the Ebers-Moll transistor model: one for the collector current, I_C, and the other for the emitter current, I_E.

The collector current is:

$$I_C = I_{CS}(e^{\theta_I V_{B'C'}} - 1)$$

where I_{CS} is the base-collector saturation current with the base-emitter shorted, and θ_I the slope of the natural log of I_C versus $V_{B'C'}$.

This equation can also be written as:

$$I_C = I_{CO}(e^{\theta_I V_{B'C'}} - 1)/(1 - \alpha_I\alpha_N)$$

where I_{CO} is the base-collector saturation current with the base-emitter open, α_I the inverted common-base current gain, and α_N the normal common-base current gain. For computer program listing, the collector current becomes:

I_C = DIODE EQUATION (θ_I, $V_{B'C'}$)

Similarly, the expression for the emitter current can be written as:

$$I_E = I_{ES}(e^{\theta_N V_{B'E}} - 1)$$

where I_{ES} is the base-emitter saturation current with the base-collector shorted, and θ_N the slope of the natural log of I_E versus $V_{B'E}$.

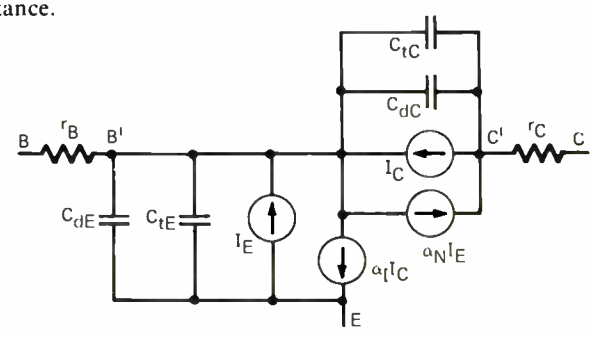
Another version of the equation is:

$$I_E = I_{EO}(e^{\theta_N V_{B'E}} - 1)/(1 - \alpha_I\alpha_N)$$

where I_{EO} is the base-emitter saturation current with the base-collector open. The program listing for I_E becomes:

I_E = DIODE EQUATION (θ_N, $V_{B'E}$)

The model's circuit elements are defined as: r_B, the base-spreading resistance; r_C, the series collector resistance; C_{dC}, the collector diffusion capacitance; C_{tC}, the collector junction transition capacitance; C_{dE}, the emitter diffusion capacitance; and C_{tE}, the emitter junction transition capacitance.



The first step in preparing a problem for analysis with Sceptre is to draw an equivalent circuit using resistors, inductors, capacitors, transformers, sources, and any necessary stored models. Circuit elements may be linear or nonlinear, and defined by a numerical constant, tabular list, or Fortran expression.

Next, name or number all nodes and name each circuit element. Then choose current flow direction in each passive element and source. Assign circuit values in a constant set of parameter units. (For high speed, a good set is kilohms, picofarads, microhenries, milliamperes, volts, and nanoseconds.)

Circuit elements can now be easily combined to form an Ebers-Moll large-signal transistor equivalent circuit (see "Ebers-Moll pnp transistor model," p. 74). The emitter current, I_E, and the collector current, I_C, are entered as DIODE EQUATION (θ,V) or DIODE TABLE XY to achieve numerical convergence for the initial condition solution.

An example will illustrate how to use Sceptre and how to implement model changes in order to achieve a successful run. The circuit hysteresis of the flip-flop in Fig 1 is to be predicted by the computer. The diagram uses a labeling scheme that is convenient for calling out circuit elements in a program. Besides the usual numerical differentiation between components, the letters L and R distinguish between elements on the left side and right side of the circuit.

The Sceptre model of the flip-flop in Fig. 2(a) uses a slightly modified version of the Ebers-Moll transistor equivalent shown on p. 74. Since the flip-flop's transistors never saturate, current source $\alpha_I I_C$ can be omitted. Diode JCSL (or JCSR) replaces current source I_C, and diode JESL (or JESR) replaces source I_E. Both the diffusion and transition emitter capacitances are combined in capacitor CESL (or CESR), while the diffusion and transition collector capacitances become CCSL (or CCSR). Also, small speed-up capacitors (5 pF) and lead resistances (10 ohms) are included for better accuracy.

Because the flip-flop's hysteresis is reflected in the difference between the collector voltage of Q_1 and Q_2, resistor RO is added. Circuit hysteresis, which is a function of R1L (and R1R) and R3L (and R3R), can be predicted by computing the voltage across RO.

Operating frequency range for the flip-flop is 1 kilohertz to 10 megahertz. Therefore, a forcing function with a frequency of 1 kHz is a reasonable choice for the excitation voltage. To guarantee that the flip-flop will trigger, the amplitude of the forcing function will be 5 v. Let the forcing function, then, be $E_s = -5\cos 2\pi 1000t$, where t is time.

Fail-safe. For the model of Fig. 2a, Sceptre will correctly solve the dc case but will fail to give a transient solution. The reason for the failure will be indicated as SMALLER MINIMUM STEP SIZE REQUIRED.

This type of failure, which is sometimes called the Eigenvalue problem, is caused by a conflict in circuit time constants that will incapacitate any nonlinear analysis, computer or otherwise. The flip-flop has natural frequency modes caused by short time constants that require very small time steps for accurate analysis. Because of the long running time to complete the solution, Sceptre will decline to solve the problem.

There are several elements aggravating the flip-flop's time-constant problem. Speed-up capacitors, header capacitances, and transistor lead resistance do not affect a low-frequency solution, but they do complicate solution processes and increase program time.

Step size is determined by the specified problem duration (stop time) and by the smallest time constant of the circuit. The initial step size chosen by Sceptre is 10 times the stop time. This step size is tested by the inte-

gration routine for accuracy, and if that size is found to be erroneous, a new step size that is half the previous value is attempted.

The test process is repeated until a small enough step size is found or until the step size is smaller than 10^{-5} times the stop time. If the step size required is less than this value, the run is terminated because a smaller minimum step size is required.

A successful run can be achieved without changing the low-frequency hysteresis by removing all speed-up capacitors and all lead resistances as shown in Fig. 2(b). It is also helpful to decrease the magnitude and period of the forcing voltage, E_s, to speed up the integration.

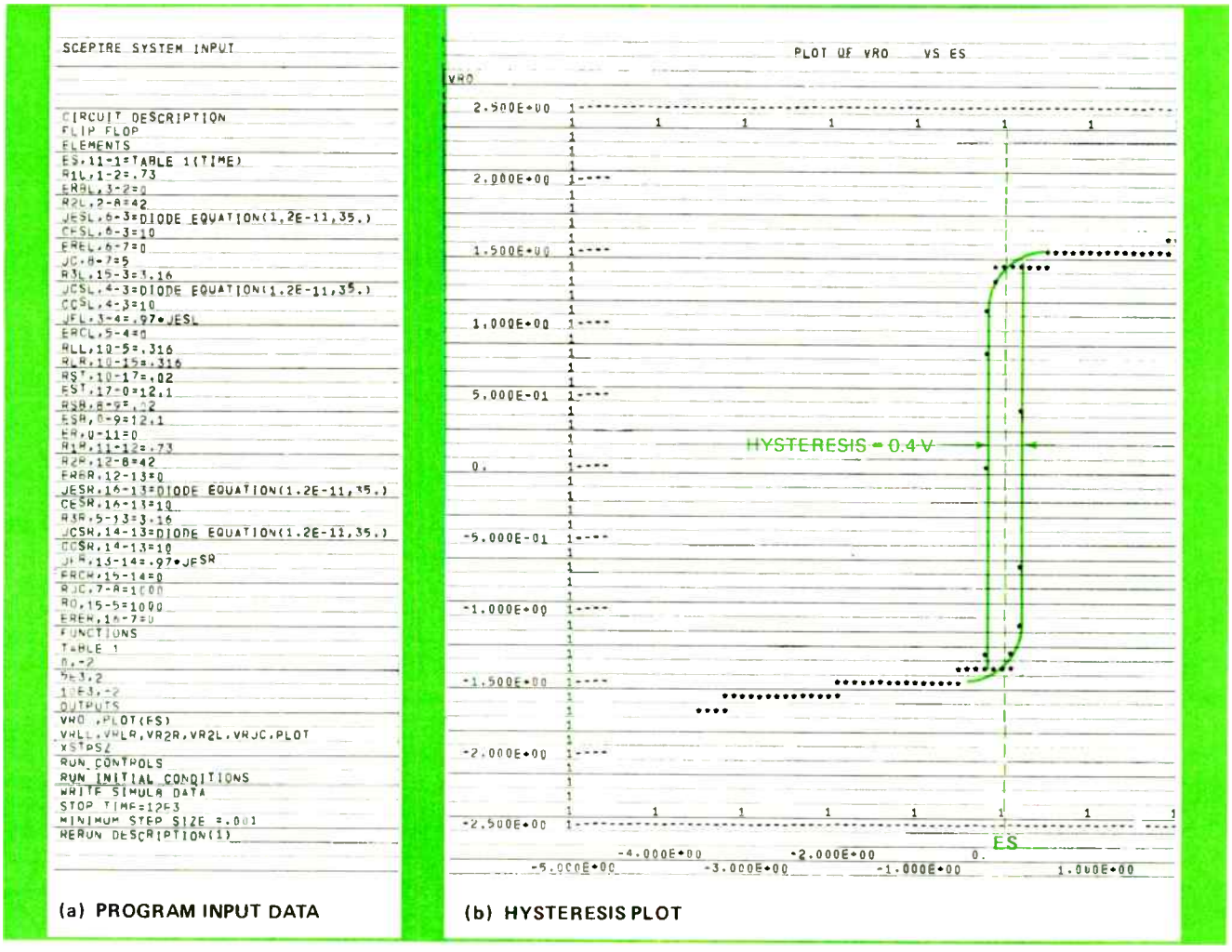
Actually measuring circuit hysteresis helps to determine how to modify E_s. A measurement will show that the hysteresis is about 0.5 v at 1 kHz as well as at 100 kHz; therefore, changing the frequency of E_s from 1 kHz to 100 kHz will speed the solution without affecting accuracy. Reducing the amplitude of E_s from 5 to 2 v also aids the solution without impairing the triggering of the flip-flop. Switching from a cosine wave to a triangle wave is another simplification. To see the change in hysteresis at high frequencies, another run could be made at 10 megahertz with the original model and original E_s.

Figure 3 reproduces the successful run of the program input data and the hysteresis plot. The forcing function, E_s, is entered as a table; all diodes are represented by the exponential diode equation. The program requests a plotted output of VRO, the voltage across resistor RO, versus E_s. The plot correlates fact with theory—computed hysteresis is 0.4 v; the measured is 0.5 v.

A brief look at cost considerations is also essential. Because Sceptre is a large program that requires expensive Fortran compilation, a good deal of its cost tends to be a fixed overhead. The flip-flop problem, for example, can be run with identical numerical results on an IBM 360-65 or a Univac 1108, using a conversational, remote, job entry teletypewriter. The price of the IBM run will be approximately $90, 80% of which is overhead, while the Univac solution costs $30 with 20% overhead.

Defined parameters. Another example will serve to illustrate the flexibility of Sceptre through the use of its special defined parameters section. Suppose the problem is to solve a set of first-order, simultaneous, differential equations that may be entirely independent of any electrical network:

$$X'(t) = -6X(t) + 5Y(t) + 10$$



3. Computer printout. Program listing (a) shows set of Fortran instructions needed to predict flip-flop hysteresis. A graph of the hysteresis (b) is obtained by requesting a plot of the collector difference voltage (between Q_1 and Q_2), represented by VRO, versus the forcing function, E_s. Distance between colored lines is predicted hysteresis voltage, which is 0.4 volt compared with measured value of 0.5 V.

Modified pnp Ebers-Moll model

A few minor modifications of the conventional Ebers-Moll transistor model improves its speed without adversely affecting its accuracy. Eliminating extraneous resistances and carefully combining diffusion and transition capacitances implements the change.

The equation for transistor collector current, I_C, can be written as:

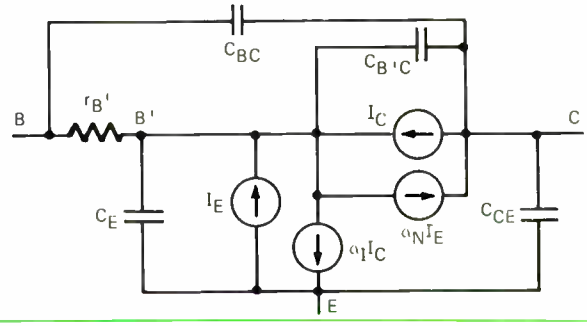
$$I_C = I_{CO}(e^{\eta V_{B'C}} - 1)$$

while the expression for transistor emitter current, I_E, becomes:

$$I_E = I_{EO}(e^{\eta V_{B'E}} - 1)$$

All modified circuit elements are defined in terms of the original model:

$C_{BC} = 3C_{ob}/4$
$C_{B'C} = C_{ob}/4 + C_{dc}$
$C_E = C_{dE} + C_{jE}$
$C_C = C_{dC} + C_{jC} = C_{BC} + C_{B'C}$
C_{CE} = collector-emitter header capacitance
$r_{B'}$ = base-spreading resistance
$C_{dc} = \theta_I \tau_S I_C$
where τ_S is storage time
$C_{dE} = \theta_N \tau_F I_E$
where τ_F is the minority carrier transit time
$\tau_F = 1/\omega_{Alpha} = 1/1.2\omega_T$
where ω_{Alpha} is the alpha cutoff frequency, and ω_T is the beta cutoff frequency
$C_{jC} = C_{obo} - C_{CE}$
where C_{obo} is the output capacitance with the emitter open
$C_{jE} = C_{ibo} - C_{CE}$
where C_{ibo} is the input capacitance with the collector open.



$Y'(t) = 5X(t) - 7Y(t)$

The initial conditions are $X(0) = 6$ and $Y(0) = 5$.

Each of the derivatives may be entered under the program listing DEFINED PARAMETERS in explicit form. A proper sequence would be:

```
CIRCUIT DESCRIPTION
DIFFERENTIAL EQUATION EXAMPLE
(Enter data, for instance, as in Fig. 3(a).)
DEFINE PARAMETERS
DPX = EQUATION 1 (PX,PY)
DPY = EQUATION 2 (PX,PY)
PX = 6
PY = 5
OUTPUTS
PX(X), PY(Y), XSTPSZ, PLOT
FUNCTIONS
(Define equations X'(t) = -6X(t) + 5Y(t) + 10 and
Y'(t) = 5X(t) - 7Y(t) by using dummy variables A
and B for X and Y, respectively.)
EQUATION 1 (A,B,) = (-6.*A+5.*B+10.)
EQUATION 2 (A,B) = (5.*A-7.*B+2.)
RUN CONTROLS
INTEGRATION ROUTINE = TRAP
STOP TIME = 100
END
```

Since the derivatives of PX and PY (DPX and DPY, respectively) are entered in the program, the functions of PX and PY must be updated at each integration step.

It should be noted that the initial values of the variables X and Y are entered as PX = 6 and PY = 5; the differential equations themselves are entered under DEFINED PARAMETERS. Since the quantities X and Y are treated like the state variables of a general transient problem, they are subject to the same step-size limitations in whatever Sceptre integration routine is used.

When the defined parameters feature is used, it should be remembered that Sceptre can only solve nonlinear, first-order, differential equations. Higher-order equations must be reduced to a set of first-order ones.

Limitations. There are several important factors to keep in mind when using Sceptre. The first one is to know the application. Sceptre can solve very complicated nonlinear problems; if the problem is linear, use ECAP. It is often worthwhile to simplify the problem by using different models at different frequencies.

Another consideration is computer models. For most nonlinear applications, transistors can satisfactorily be handled by Sceptre with the Ebers-Moll model shown in "Modified pnp Ebers-Moll model," above. It offers a good compromise between speed and accuracy. Always remember that the simplest satisfactory circuit model has the best chance of running.

Sceptre is limited to two types of active dependent circuit elements for accurate dc (initial condition) analysis. These are a current source that depends on a current and a nonlinear element, like the diode. The diode must be entered as a diode equation or a diode table. Any other active dependent circuit elements (such as voltage-dependent current sources, passive elements that depend on either voltages or currents, and tables for zener diodes, tunnel diodes, or any device whose characteristic curve does not monotonically increase) may cause convergence difficulties in the dc solution.

However, these elements present no difficulty for the transient solution portion of Sceptre. They even offer an alternate method of obtaining a circuit's initial condition when the dc method fails.

To approximate a dc steady-state solution, some initial conditions can be assumed and a transient solution run (with the forcing function set to zero and all capacitors given equal values) for a duration of five constants. Using the steady-state values obtained in this way as initial conditions, a transient run with a proper forcing function can be made. This technique should only be used after unsuccessful attempts to solve the dc case. Finding initial conditions by transient response will al-

ways require two runs to achieve a final solution.

Another difficulty often encountered is the Eigenvalue or small-time-constant problem. First, it should be determined whether the elements causing the trouble are necessary to get the desired solution. About 90% of the time, they are superfluous and only serve to bog down the program.

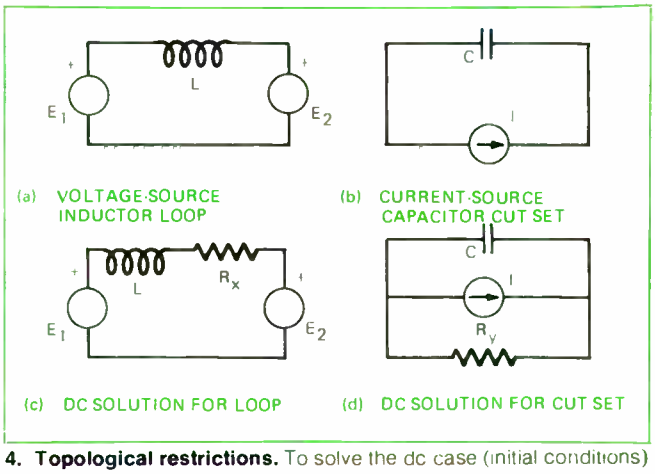
One method of solution is to use a simple model at low frequencies and a complex one at high frequencies, where the forcing-function frequency and the Eigenvalues are compatible. A good low-frequency model is one that has no capacitances except large diode shunt capacitors and that uses E_s at the highest possible frequency without appreciably changing the dc solution.

An appropriate, but not overly complex, model should be used for a second run at higher frequencies. This two-model technique will probably be more satisfying and less expensive than using the same model for high and low frequencies, as can be done with ECAP.

Even if the problem involves conflicting Eigenvalues and all attempts at separate solution are unsatisfactory, there is yet another approach. The user can allow Sceptre to take a smaller step size than the normal 10^{-4} times the stop time. A specific minimum step size (for example, MINIMUM STEP SIZE = 0.00001) is called out as a RUN CONTROLS instruction. Sceptre follows the same process to determine step size—starting with 10^{-4} times the stop time and dividing by two each integration pass until the specified limit is reached.

It is also useful to call out a maximum step size (like MAXIMUM STEP SIZE = 100) that is about 1% of the stop time. The program can then take large steps in time toward the solution when the derivative of the state variables are changing slowly. For example, a circuit problem may require very small step sizes in the beginning, but it could correctly take large steps later, near the steady-state condition.

Excessive computer time is not a concern when a very small step size is specified. A built-in counter logs integration passes and automatically terminates the run when the number of passes exceeds 20,000. When step size is varied, it is a good idea to call for XSTPSZ, PLOT under the OUTPUTS instruction so that step size is plotted as a function of time.



4. Topological restrictions. To solve the dc case (initial conditions) for a voltage-source inductor loop (a) or a current-source capacitor cut set (b), Sceptre requires the addition of a resistance—in series for the loop (c) and shunting for the cut set (d).

Nonlinear computer programs

At present, there are four computer-aided design programs for solving nonlinear circuit problems: Sceptre, NET-1, Circus and TRAC. Each one has its own special application and, when properly matched to a problem, will minimize both time and cost. Generally, Sceptre is considered the most powerful, flexible, and expensive of the four; it can solve many problems beyond the reach of the others.

NET-1 (network analysis program) employs predetermined stored Ebers-Moll models of junction diodes and bipolar transistors for a good compromise between speed and accuracy. But the program's flexibility is limited. NET-1 does not allow the user to account for such things as junction breakdown, base narrowing or conductive modulation.

Circus (circuit simulator) employs a somewhat awkward charge-control model that is mathematically equivalent to the Ebers-Moll model. Program restrictions include acceptance of only pulse or sine inputs, limited element library, and no tables or analytical expressions.

TRAC (transient radiation analysis by computer) cannot handle stored elements, tables, or analytical expressions. However, a problem that can be solved with TRAC will be done more economically and faster than with Sceptre.

Sceptre has three integration routines: TRAP, XPO, and RUK, which (in this order) are increasingly accurate, time consuming, and costly. For most applications, XPO, which gives a 2.5-term approximation of the Taylor series, offers optimum speed and accuracy.

Although Sceptre can handle up to 300 circuit branches, it is advisable to limit the number of branches to 70. The Fortran compiler cannot handle more than 70 branches at once, and large programs become difficult to run.

There are several reasonable topological restrictions imposed by Sceptre for dc solutions. Two are shown in Fig. 4—a voltage-source inductor loop and a current-source capacitor cut set (dual of a loop, connecting one node to another node). The dc case for these problems is solved by adding a small resistor, R_x, to the loop and a large resistor, R_y, to the cut set. The resistors should be eliminated for the transient run since cut sets and loops are acceptable for the integration routine. It should be noted that a diode, instead of a resistor, can be used to prevent the formation of a cut set, as it does in the Ebers-Moll model.

Very small and very large passive element values should be avoided in Sceptre because of the time constant problem. Also, zero values of resistance, inductance, or capacitance will cause a run to terminate in Fortran. Because Sceptre can plot the current through voltage sources and the voltage across current sources, a zero-impedance element can be represented by a zero-value voltage source, and a zero-value current generator makes an ideal infinite-impedance element. Moreover, the diode capacitances in the Ebers-Moll model should not be neglected since their exclusion would cause solution errors. □

Designer's casebook

Resistance change alters filter's output function

by Frank Vitaljic
Bellingham, Wash.

A variable-function filter can be made with an active RC network by simply changing the value of a single resistor. For specific values of a feedback resistor, R_f in circuit (a), either all-pass, bandpass, or notch filter functions can be implemented.

Network filtering function is variable since the circuit's two zeros are movable, while its two poles remain fixed. Values of R_f that lie between the points where the filtering function changes cause a linear variation in the circuit's voltage amplitude ratio at the center frequency, ω_0.

If R_f is some high value, a pole-zero plot (b) shows that the zeros are located on the positive and negative imaginary axes, resulting in a notch filter. As R_f is decreased, the zeros travel on a circular path towards each other. When they are diametrically opposite the network poles, an all-pass filter is realized.

Further decreasing R_f causes the zeros to coincide on the real axis, where they split and then travel in opposite directions—one towards the origin, and the other towards infinity. When R_f is reduced to zero, a bandpass filter results with one zero at the origin and the second at infinity.

Examining the network's transfer function will illustrate circuit action. The basic circuit (a) has an all-pass transfer function:

$E_2/E_1 = k\, D(-s)/D(s)$

where k is a constant, s the Laplace transform variable, and:

$D(s) = s^2 + \omega_0 s/Q + \omega_0^2$

and $D(-s) = s^2 - \omega_0 s/Q + \omega_0^2$

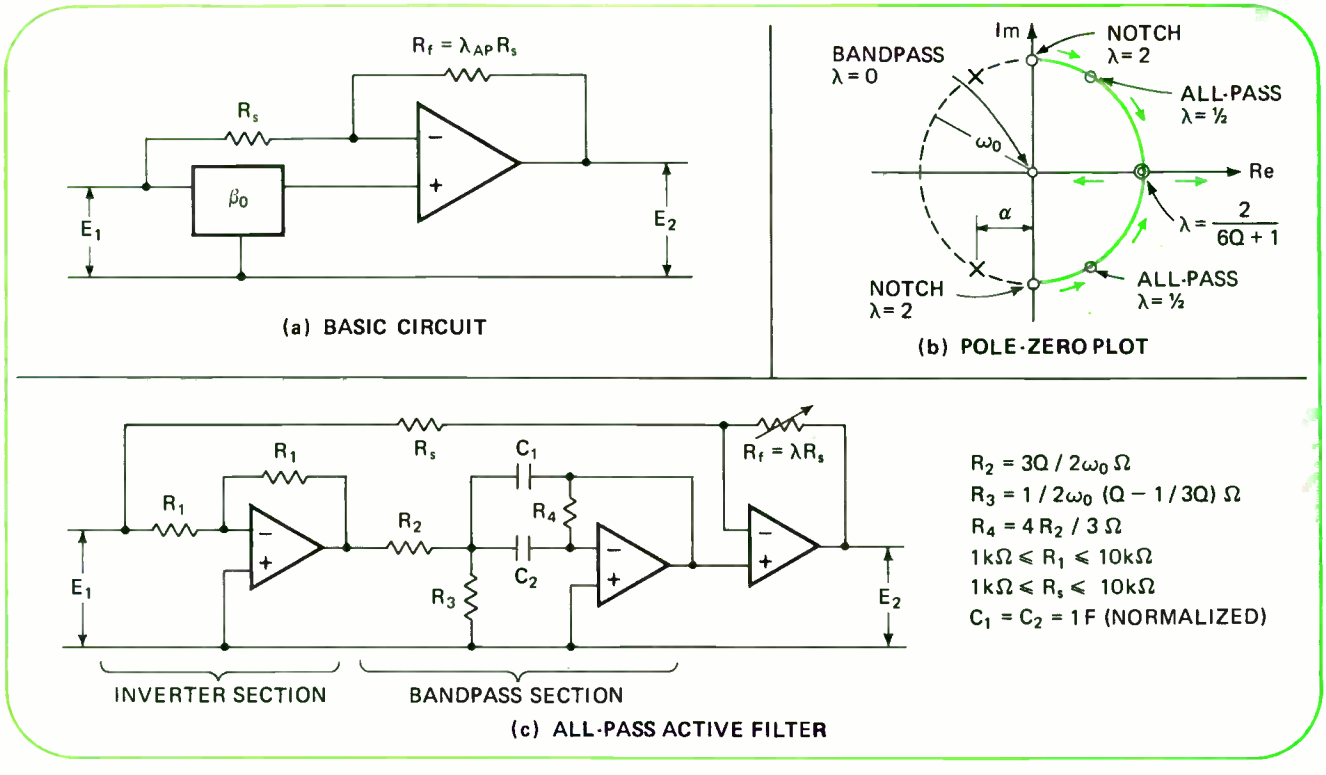
where $Q = \omega_0/2\alpha$

and α is the real part of the complex pole pair (as shown in the diagram).

The network represented by $\beta^{\Sigma \neq 0}$ is actually a bandpass filter. The value of R_f needed to realize an all-pass function is denoted by $\lambda_{AP}R_s$. If $k \neq \pm 1$, then either bandpass or notch filters can be implemented by adjusting λ.

For example, when $k = -\lambda^{\Sigma \neq \lambda P}$, the $\beta^{\Sigma \neq 0}$ network is a bandpass filter:

Variable active filter. Decreasing the resistance of feedback resistor, R_f, changes filtering action of basic active circuit (a) from notch to all-pass to bandpass network. As shown in (b), poles of transfer function are fixed, but zeros move toward real axis, where they meet and then split. When R_f is zero, one zero is at the origin, the other is at infinity. Actual all-pass filter (c) requires three differential amplifiers.



$$\beta_o = \frac{\lambda_{AP}}{1+\lambda_{AP}}\left[\frac{D(s)-D(-s)}{D(s)}\right]$$

$$\beta_o = \frac{2\omega_o\lambda_{AP}}{Q(1+\lambda_{AP})}\left[\frac{s}{s^2+\omega_o s/Q+\omega_o^2}\right]$$

The overall circuit transfer function becomes:

$$\frac{E_2}{E_1} = \frac{\lambda_{AP}}{1+\lambda_{AP}}\left[\frac{\lambda_{AP}-\lambda}{\lambda_{AP}} - \frac{(1+\lambda)D(-s)}{D(s)}\right]$$

An all-pass filter results when $\lambda = \lambda^{\Sigma\alpha_{AP}}$:

$$\frac{E_2}{E_1} = \frac{\lambda_{AP}}{1+\lambda_{AP}}\left[\frac{\lambda_{AP}-\lambda_{AP}}{\lambda_{AP}} - \frac{(1+\lambda_{AP})D(-s)}{D(s)}\right]$$

$$\frac{E_2}{E_1} = \lambda_{AP}\left[-\frac{D(-s)}{D(s)}\right]$$

Since $k = -\lambda^{\Sigma\alpha_{AP}}$, then:

$E_2/E_1 = k\,D(-s)/D(s)$

which is the original all-pass circuit transfer function.

Similarly, when $\lambda = 0$, a bandpass filter is realized:

$$\frac{E_2}{E_1} = \frac{\lambda_{AP}}{1+\lambda_{AP}}\left[\frac{\lambda_{AP}}{\lambda_{AP}} - \frac{D(-s)}{D(s)}\right]$$

$$\frac{E_2}{E_1} = \frac{\lambda_{AP}}{1+\lambda_{AP}}\left[\frac{D(s)-D(-s)}{D(s)}\right]$$

And when $\lambda = 2\lambda^{\Sigma\alpha_{AP}}/(1-\lambda^{\Sigma\alpha_{AP}})$, the circuit is a notch filter:

$$\frac{E_2}{E_1} = \frac{\lambda_{AP}}{1+\lambda_{AP}}\left[\frac{\lambda_{AP}-2\lambda_{AP}/(1-\lambda_{AP})}{\lambda_{AP}} - \left(\frac{1+2\lambda_{AP}}{1-\lambda_{AP}}\right)\frac{D(-s)}{D(s)}\right]$$

$$\frac{E_2}{E_1} = \frac{\lambda_{AP}}{1+\lambda_{AP}}\left[\frac{(1-\lambda_{AP})D(s)-2D(s)-(1+\lambda_{AP})D(-s)}{(1-\lambda_{AP})D(s)}\right]$$

An actual all-pass circuit is shown in (c) for $\lambda^{\Sigma\alpha_{AP}} = -k = \frac{1}{2}$. The resistor values are scaled with respect to the capacitors.

Triggered sweep generator responds to 100-ns spike

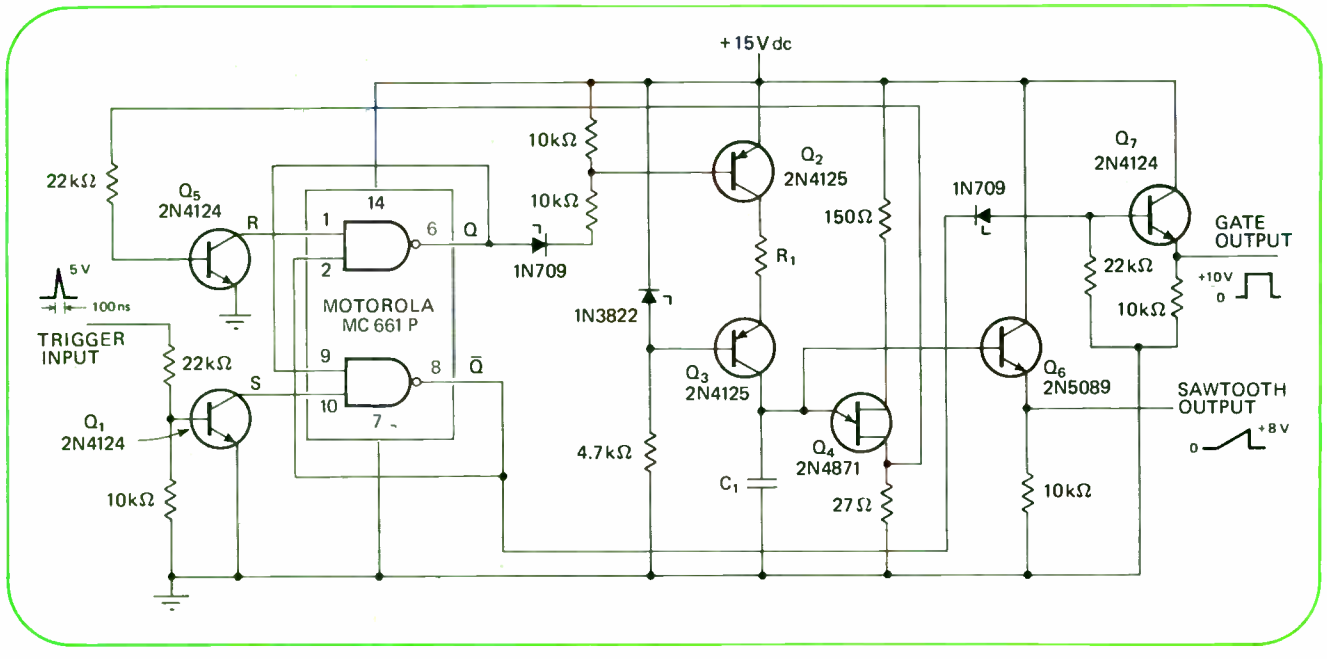
by Lawrence Sperling
Monroeville, Pa.

Connecting a dual high-threshold-logic (HTL) NAND gate as a set-reset flip-flop gives a triggered sweep generator that provides a 2%-linear ramp when triggered with a 5-volt 100-nanosecond pulse. Sweep speeds for the circuit range from 10 seconds down to 10 microseconds. Moreover, duty cycle for a second output, a gating pulse, can be as high as 95%.

When the flip-flop is set with a trigger pulse through transistor Q_1, its Q output goes low, allowing transistor Q_2 to saturate. Since Q_2 is conducting, transistors Q_3 and Q_4 generate a ramp output, the timing of which is controlled by capacitor C_1.

A constant current, determined by resistor R_1 and the voltage across it, charges capacitor C_1. The resistor's voltage (V_{R1}) for the sawtooth output shown is approxi-

Flip-flop trigger. Bistable formed by dual NAND gate accepts high-speed trigger pulse for sweep generator circuit. Input spike sets bistable, its Q output goes low, Q_2 saturates, and C_1 charges. When voltage across C_1 reaches threshold of UJT Q_1, the transistor fires, discharging C_1, which applies a pulse to Q that resets the bistable. The sweep generator is now ready to be triggered again.



mately 3 v for the generator in the diagram.

Capacitor C_1 charges until the voltage across it reaches the triggering point of unijunction transistor Q_1. When Q_1 turns on, C_1 discharges and a positive pulse is applied to the base of Q_3. This resets the flip-flop to its normal state, with the Q output high. The sweep generator can now accept a new trigger pulse.

Output sweep voltage is buffered through Q_2 so that a load will have a negligible effect on sweep length. This emitter-follower introduces a slight output delay, for which the circuit can be compensated. In addition to providing a sawtooth output, the circuit offers a gate output, which is taken from the flip-flop's Q output and buffered through transistor Q_3.

It is simple to find the timing for sweep speed:

$$t = C_1V_o/I_{R1}$$

where V_o is the maximum output sweep voltage, and I_{R1} the current through R_1. Since $I_{R1} = V_{R1}/R_1$, then:

$$t = R_1C_1V_o/V_{R1}$$

Output voltage, V_o, is determined by the product of Q_1's intrinsic stand-off ratio (η) and its interbase voltage (V_{BB}). For this particular UJT, ηV_{BB}, equals 8 v. Therefore:

$$t = 8R_1C_1/V_{R1}$$

Values for resistor R_1 should range between 100 ohms and 100 kilohms. Values for capacitor C_1 depend primarily on the resistance selected for R_1; the suggested low limit is 1,000 picofarads.

Broadband pulse generator uses small timing capacitance

by Ron Siebert
Signetics Corp., Sunnyvale, Calif.

An inexpensive, widerange pulse generator keeps capacitor values low, even at operating frequencies down to 0.3 hertz. Instead of large capacitances, the circuit uses a field effect transistor and a high-value variable timing resistor to give large time constants.

The generator, which operates from 0.3 Hz to more than 10 megahertz, consists of only one integrated circuit, a FET, two resistors, and one capacitor. It has no special power requirements, and operates over a supply range of 4 to 6 volts.

The FET performs as a source-follower; and because of its high input impedance, the timing resistor, R_1, can be quite large. This allows the timing capacitor, C_1, to become small for a particular output frequency.

Three TTL NAND gates provide the gain and regenerative feedback needed to sustain circuit oscillation. The generator's output is a pulse train the duty cycle of which can be adjusted with potentiometer R_2.

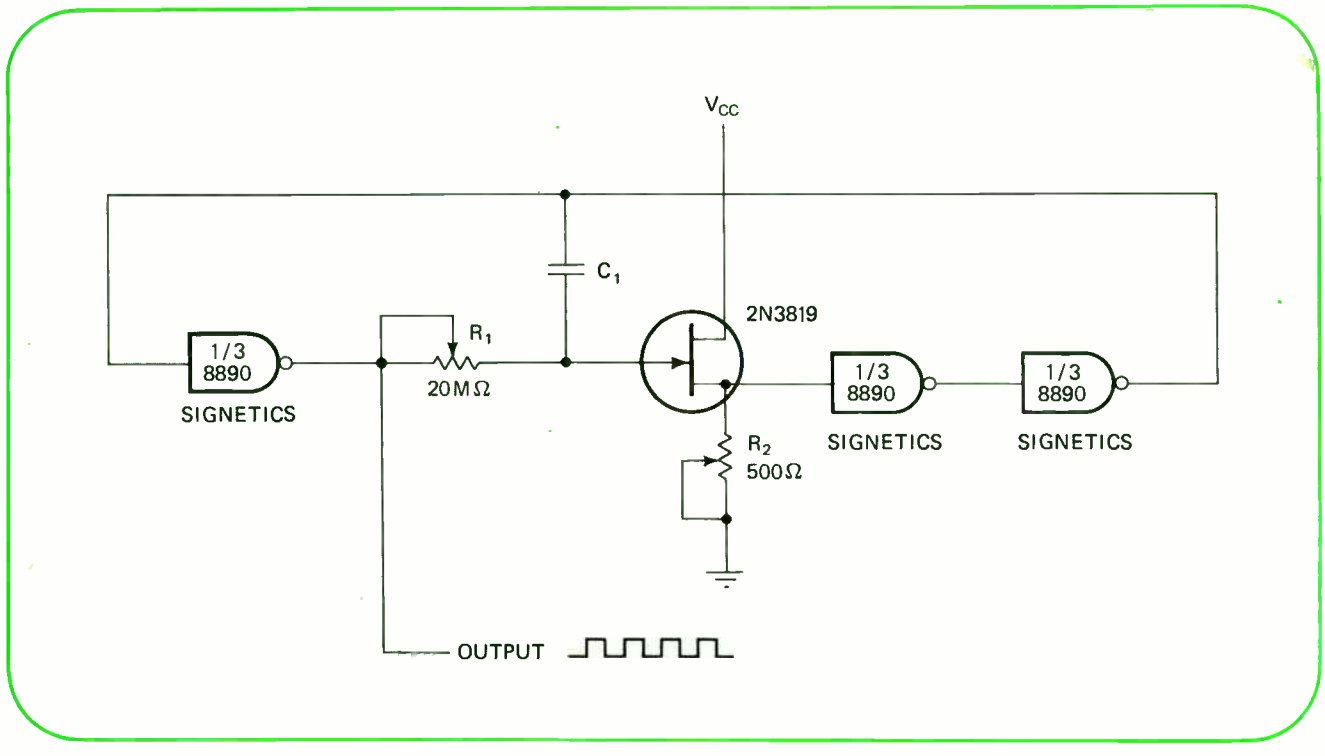
Frequencies as low as 0.3 Hz can be obtained when C_1 is as small as 0.1 microfarad. Timing resistor, R_1, may be varied from a few hundred ohms to 20 megohms, resulting in a frequency change for the output of over 50,000:1.

To calculate the output frequency (f_o) for specific values of R_1 and C_1, let:

$$f_o = \tfrac{1}{2}R_1C_1$$

High R, low C. Generator can deliver 0.3-hertz pulse output with timing capacitor as small as 0.1 microfarad. High input impedance of FET and large timing resistance keep time constant large.

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.



What's all this noise about noise?

Philips' 30-series high noise-immunity logic modules solve noise problems instantly, right on the circuit design.

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Latent image can provide chips with built-in control memories

Flip-flops on a memory chip spontaneously assume a specific on-off pattern when power is turned on; this latent image can be programed at little cost with control instructions immune to power failure

by Irving T. Ho and Gerald A. Maley, *IBM Corp., Hopewell Junction, N.Y.*

☐ In striving to improve the price/performance ratio of semiconductor memories, designers have so far copied the approach that was successful with core memories—they've reduced bit-cell size and power dissipation, shortened the cycle time, and improved fabrication techniques. By now, however, this approach to reducing semiconductor memory costs seems to be nearing its limit.

But there is another tack designers have largely ignored—exploiting certain features found in semiconductor arrays, but not in cores, that would add to the functions performed by semiconductor memories. Chips with these extra functions might cost more per bit, but they would also substantially improve the operation of the overall computer system.

One such potentially useful feature of alterable semiconductor memories is the latent image. This is the pattern of on and off positions assumed spontaneously by the flip-flops on a semiconductor chip every time power is turned on.

At the moment, so far as the systems designer is concerned, the latent image is just a nuisance. Yet it is capable of solving a problem that is already encountered in an acute form in control stores and that will be compounded as machines with semiconductor main and/or buffer memories come into more and more general use. The problem arises whenever a machine is turned on after any kind of power shutdown or after a "crash," when a small software bug causes the computer to behave erratically and unpredictably.

Once the machine is operating normally again, the first step is to clear the memory and restart the system from some known point in the program. This clear-and-restart procedure is necessary with most core memories, to correct for the errors that voltage transients may have introduced into the stored data. It's also necessary with semiconductor arrays, but for an entirely different reason—the latent images that emerge in these conditions are not at all like the patterns of stored data that existed beforehand.

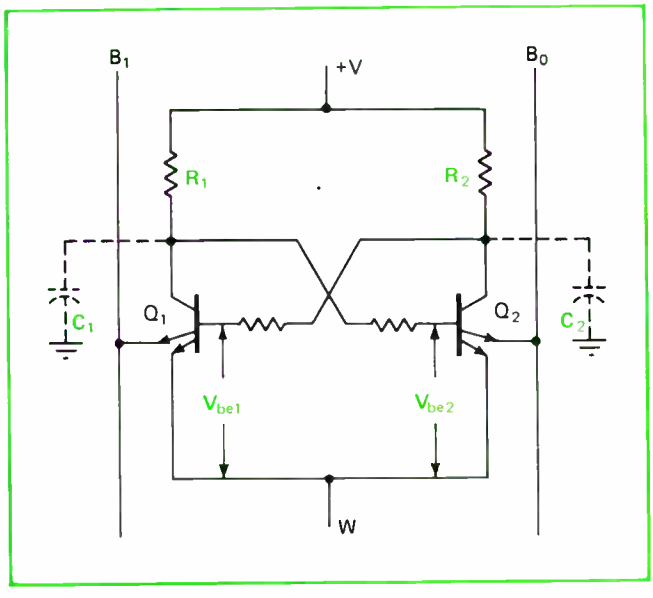
It is tempting, but wrong, to refer to the new patterns as "random." In fact they aren't random, because in any given semiconductor chip the pattern is always the same. If all the flip-flops on the chip were perfectly balanced, then the pattern would be different every time, and the data would indeed be random. But balancing all the flip-flops in a large array is impossible, especially in mass production. In general, each flip-flop has a bias that pulls it into the same state with every power restoration. Since unbalance is inevitable, it might as well be planned so that the latent image is meaningful.

A meaningless latent image makes it necessary to reload machines that have alterable semiconductor control stores—a problem which older machines circumvented by keeping control information in read-only memories. ROMs, however, required all data, even if seldom used, to be kept immediately available, and could be updated only by the physical replacement of a major part of the entire memory array. These difficulties are avoided with the reloadable control stores, at the cost of providing a means to reload them—in IBM equipment, for instance, a small magnetic disk.

A meaningful latent image, however, would provide a control store with built-in reloadability, eliminating costly extraneous hardware. The latent-image memory would thus combine the advantages of a read-only memory with those of an alterable memory.

Of course, personalizing the memory chips with the

1. Time constants. All three pairs of flip-flop parameters labeled in color are theoretically, but never actually, identical. By slanting any one of the three parameter pairs properly, it's possible to guarantee the condition of the circuit when power is turned on.



latent data, as read-only memory modules are personalized, adds to chip cost and also to inventory costs, since a single part is replaced by many almost identical parts. Offsetting that, the extra function created by the personalization will provide increased revenue for the memory manufacturer.

The personalization is achieved by imposing on the array of flip-flops a built-in bias, with a desired pattern, in place of the bias that appears inevitably and haphazardly in spite of attempts to avoid it. This intentional asymmetry can be either ac or dc, as the two diagrams in Figs. 1 and 2 show.

A typical ac asymmetry can be obtained by making the time constants on the two sides of the flip-flop slightly different, as shown in Fig. 1. These time constants are functions of the collector load resistance, the collector-to-ground capacitance, and the base-to-emitter voltage of the respective transistors. For instance, transistor Q_1 in the diagram will inevitably turn on when power is applied under any of the following three conditions:

(a) $R_1 = R_2$, $C_1 > C_2$, and $V_{be1} = V_{be2}$; or
(b) $R_1 > R_2$, $C_1 = C_2$, and $V_{be1} = V_{be2}$; or
(c) $R_1 = R_2$, $C_1 = C_2$, and $V_{be1} < V_{be2}$.

A typical dc asymmetry can be obtained by adding a Schottky barrier diode to one or the other side of each flip-flop, as shown in Fig. 2. This diode may be connected to the substrate of the memory chip through the p+ isolation wall, or, at some expense in chip area, to a separate reset line.

Usable with any cell. The two memory cells shown in Figs. 1 and 2 have been made different on purpose, to illustrate the fact that the latent image can be used in different kinds of bipolar memory cells. It also applies to MOS cells—to static field-effect transistor cells, and in principle also to dynamic FET cells, which store data in capacitances rather than in flip-flops.

As described so far, however, the latent-image memory concept suffers from a serious drawback. For if the latent image is obtained only when power is turned on, then to obtain the image under other than restart conditions requires power to be turned off and then on again—and this destroys the active data stored in the array on top of the latent image.

The drawback is easily circumvented by an extension of the basic concept: the latent image can be made to appear each time a pulse is applied to the unit, without the power being turned off and the active data being destroyed. One way of doing this is to add a diode to one side or the other of a conventional memory cell, as shown in Fig. 3. On one side, the diode creates the latent image of a binary 1 in that cell; on the other, it creates a latent 0 image.

During conventional operation the diode is biased negatively and does not affect the cell's normal operation. To read actively stored data, the word line W is given a positive pulse, in response to which another positive pulse appears on one of the two digit lines, B_0 and B_1, depending on which of the two transistors is conducting at that moment. Likewise, to write new data into the cell, the appropriate digit line is driven positively at the same time as the word line, forcing the opposite transistor into conduction. Neither of these operations is significantly affected by the presence of the diode.

But to read the latent image, a positive pulse is applied to the anode of the diode at the same time as a pulse is applied to the word line. The amplitude, V_L, of this pulse is related to the voltage drop V_D across the diode and to the nominal collector voltages of the memory cell, in this way:

$$V_L \approx V_D + \tfrac{1}{2}(V_{c1} + V_{c0})$$

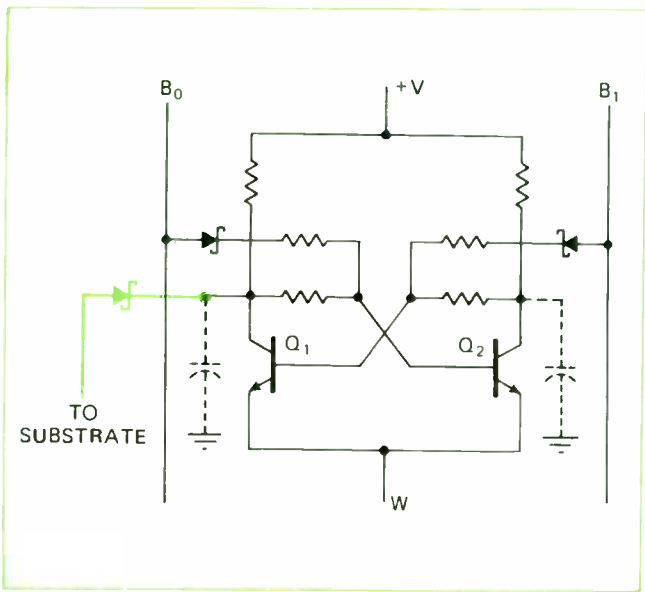
Typical values for the collector voltages V_{c1} and V_{c0} are 1.7 and 0.9 volt respectively; if the diode is a pn junction device, its V_D is about 0.75 v, and V_L should be in the neighborhood of 2 v. For a low-barrier Schottky diode, the V_D is 0.4 v, and V_L should be about 1.7 v. Under these conditions the latent image can be read from the cell without disturbing the active data.

Obviously the active data appears on the output lines too; the distinction between active and latent images is present only when the images themselves differ. External logic can perform the discrimination function.

Specifically, if the active and latent images in a particular cell are the same, that is, both 1 or both 0, then a signal appears on only one of the two digit lines. On the other hand, if the active and latent images are different, the active data will appear on one digit line and the latent data on the other. Suppose, when the word line potential rises, the B_0 line rises along with it. This implies that transistor Q_1 is off, so that the large swing characteristic of a readout can appear. Therefore Q_2 is saturated—the collector and one emitter of Q_2 are clamped within a fraction of a volt of one another.

Ordinarily, the word pulse is relatively wide, and the following pulse on the digit line is equally wide. But the diode pulse for reading out the latent image should be

2. Diode pullover. By applying a signal to the isolation barrier in the substrate when power comes on, the Schottky diode can force the flip-flop into its "on" state. Diode can also be connected on other side of circuit to force the flip-flop "off". This circuit is a Bell Laboratories design for high speed and low power.



Who needs latent-image memories?

by Wallace B. Riley, Computers Editor

Although the latent-memory concept, which *Electronics* first heard described at the International Solid State Circuits Conference last February, is an ingenious and intrinsically novel idea, we found that its real potential, like the latent data it carries, lies beneath the surface.

As the authors suggest on page 82, the latent-image concept would be most immediately useful in control memories. It permits reloadable versions of these memories to be built that could load seldom-used routines, such as diagnostics, only when needed, and be readily updated with minimal interference in system operation. Further, if a particular latent image becomes outdated, it still has the capability of automatically calling in information to update itself.

But when *Electronics* talked to systems programers about the latent image, this capability didn't appeal to them much at first glance.

We asked about things like initial program loading. Generally, if a computer is turned on when its memory is clean and empty, two or three instructions must be inserted into that vast expanse of nothing. These instructions call in two or three additional instructions, which in turn call for a program to be executed, set up the data, and so on, in what is sometimes called a "bootstrap" routine. Once upon a time that first word had to be inserted by hand; but today, with sophisticated monitors, operating systems, and advanced hardware design, the machine operator need only punch a button.

One observer felt that the latent image could not do much to improve this situation. "Since IBM's 360 and 370 operating system takes seven to 10 minutes from a 'cold start' to get underway, I can see a distinct advantage to putting a lot of the routine in a latent image," he said. "But most of that time is spent initializing disks and tapes and other input-output equipment, so the latent-image capability wouldn't accomplish very much." The same person pointed out that other less complicated hardware-software systems can be initially loaded from the "cold-start" condition in three seconds. And in any case, IBM's initial program-loading routine can be gotten off a disk pack in less than a second, and it's not used often enough for that time to make much difference.

Another programer, however, saw an advantage in storing in latent-image form those routines that would otherwise have to be called in from a disk pack many times a day—perhaps even every few minutes. Repeated disk accesses eat up a lot of time, and the capability of acquiring frequently needed interrupt routines quickly, without actually keeping them in main memory, could radically improve system throughput. The normal tradeoff is between retaining as much of the "housekeeping" software as possible in the main memory, leaving little room for a problem-solving program, and putting a lot of it out on a disk pack or a high-speed drum and making the user wait when it has to be called for. So here the latent image memory offers a compromise.

Some programers pointed out advantages of the latent-image concept in process-control computers, which are usually built in lots of 100 or more, often incorporated as part of other equipment, and used by persons unsophisticated in the ways of computers. This is particularly important because such machines often have only limited input-output equipment through which their control memory can be reloaded.

Knowledgeable observers, however, point out that the real wallop of the latent-image concept will come when IBM must reluctantly grant some of its customers access to its control programs—so far jealously guarded from tampering, and with excellent reason. Control programs in modern computers are responsible for guiding data bit by bit around the machine to achieve the results called for by external instructions. Where users write a source program in some language such as Fortran or Basic ("add quantity A to quantity B, multiply by C, square the result and store it away somewhere"), and where computers execute these instructions after compilation into a machine-language program ("add contents of memory location D to the accumulator"), the control program deals with the actual gut-level manipulation of data within the machine ("route the contents of registers E and F through the adder, and place the adder's output—the sum of the numbers in E and F—in register G"). At this level, the reversing of one critical bit in a control program, experimentally or accidentally, could introduce extremely serious "bugs" into a system, particularly the kind that might not become apparent for weeks and then persist in chewing up whole carloads of data.

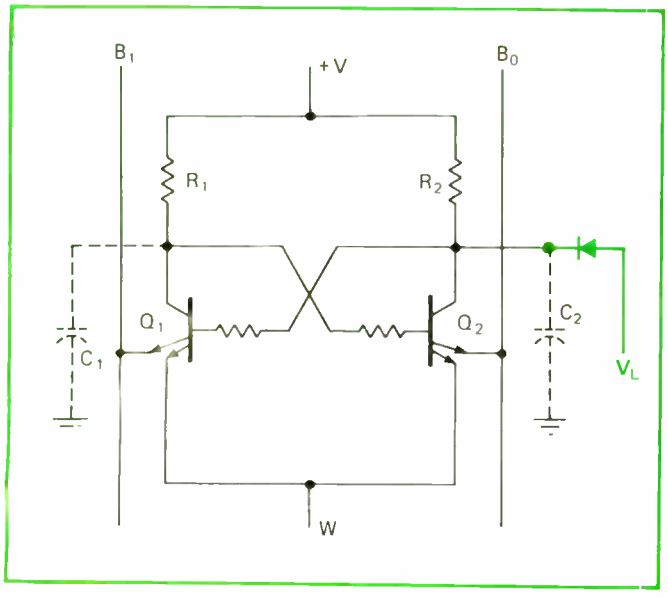
One reason IBM put its control programs in most of the early models of the 360 into read-only memory was to keep the sticky fingers of curious customers from gumming up the programs. In a few models, mostly the large ones, where read-only memories were not used, elaborate safeguards were incorporated in the hardware to prevent access by any but authorized persons—namely, IBM's own systems people.

Now, in some models of the 370, control programs are kept in a section of main memory, again with safeguards. But the means of updating the programs is a small magnetic disk made of flexible plastic and familiarly known as the "floppy disk." This is carefully designed so that it won't fit any kind of standard input-output disk unit that IBM's customers might be using, and it can be read only on a special console disk unit that comes with those machines that have a reloadable control storage unit. And there is, at present, no way to route the output of that disk unit to some other input-output device, which would permit inspection of its contents, and no way to write new data on the disk except at the IBM factory.

But IBM's customers are getting smarter. They're less likely to buy a system in a box without carefully evaluating several alternatives. Unlike a few years ago, when they order a system today, they're more likely to demand individually engineered features, based on what they've got and what they need.

Sooner or later somebody's going to demand his own special recipe on a floppy disk, and IBM will have to give it to him. (There are reports that at least one such request has already been made.) And sooner or later somebody will figure out how to write on his own floppy disks. Faced with the prospect of a great deal of such meddling, IBM will urgently need a way to get modified control programs, and control programs that it suspects have been modified, back on the track in the quickest, easiest, cheapest way.

What better way to do it than to keep the basic nucleus of the control program in a latent-image memory?

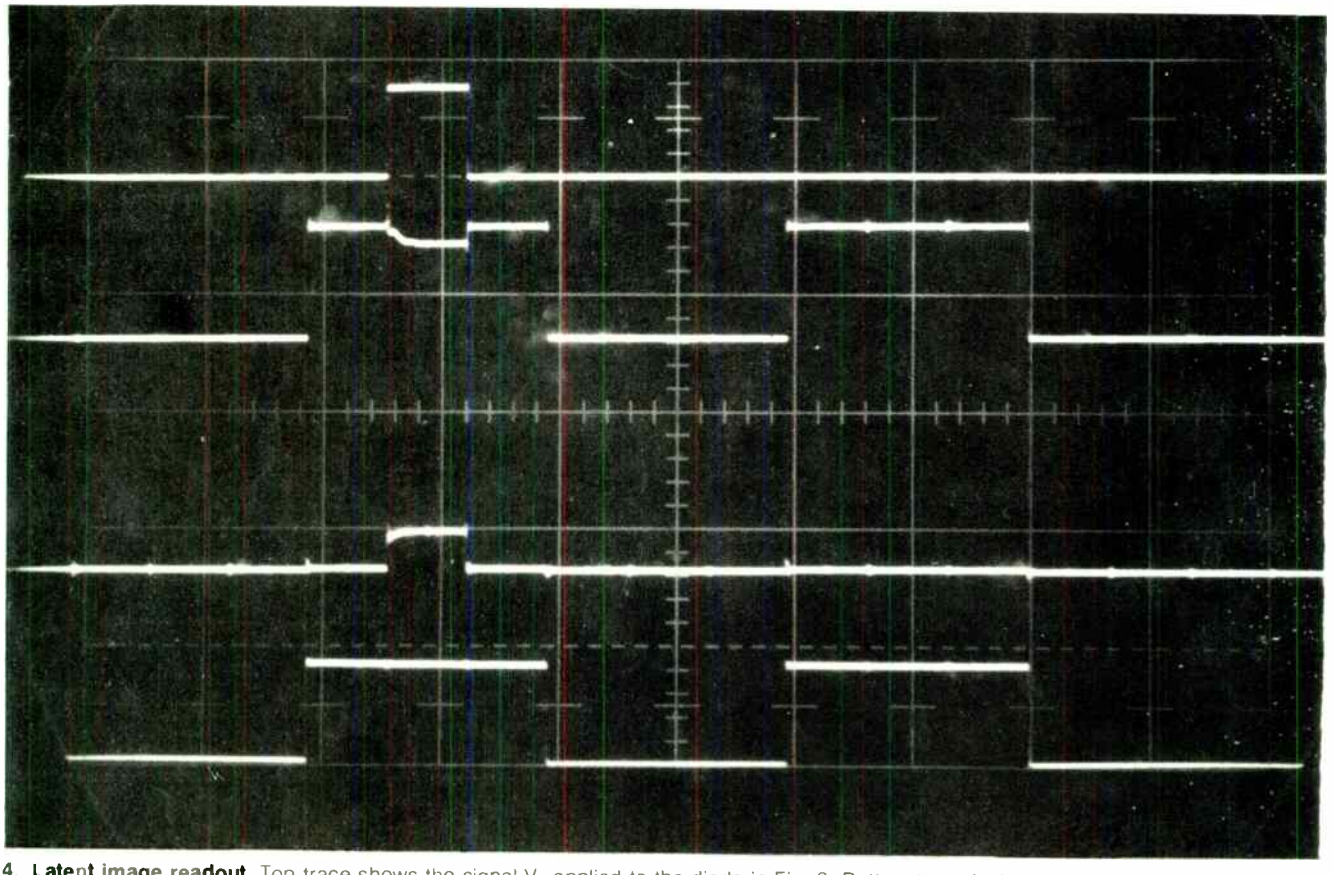


3. Nondestructive latent image. Pulse applied to diode (color) in this circuit provides a readout independent of the data stored in the flip-flop. No power off-on cycle is necessary.

narrower than these, as Fig. 4 shows. For so long as the pulse is present, the reverse bias is removed from the diode, letting current flow through the diode and through Q_1 to the digit line. In these circumstances the drop across the diode raises the collector voltage of Q_2 about 0.3v, and Q_2 therefore starts desaturating. But even at this higher level, the collector of Q_2 is still about 0.4 v lower than that of Q_1; the two would have to be within 0.1 v to endanger the state of the flip-flop.

But that minute departure from saturation has two effects: it creates a small, narrow output pulse about 0.2 v high in B_1, and it makes a little notch about 0.1 v deep in the top of the pulse on B_0. In this kind of circuit the signal voltages on W, B_0 and B_1 run 0.8 to 1.5 v, the diode pulse as mentioned previously is about 1.7 v, and the latent-image output is about 0.2 v. In duration the normal data output pulses would have widths measured in hundreds of nanoseconds, and the latent-image output would be tens of nanoseconds, the exact figures depending, again, on the particular details of the circuit being used.

The latent-image concept can be expanded in another direction, since two or more latent images can be placed in a single cell or a single array. In fact, a latent image can be stored for each parameter that can vary between the two halves of a flip-flop, without seriously affecting the flip-flop's normal operation. The problem, of course, is to make these different variations independently available. In the two examples cited thus far, the two parasitic capacitances can store one image, and an external diode can be connected to each cell to store another. By extension, any number of diodes and lines could be used to provide as many latent images as desired. The only limit is set by the "real estate" available on the chip and by the number of connections that can be made to the outside world. □



4. Latent image readout. Top trace shows the signal V_L applied to the diode in Fig. 3. Bottom trace is the word line that reads out active data. When latent and active data differ, the latent image appears on one bit line while the active image appears on the other (third and second traces respectively). This does not affect active data, as readout at right shows. Horizontal divisions are 4 μs.

Position sensor combines low cost with high accuracy and reliability

A three-terminal capacitive transducer overcomes fringing effects that caused errors in earlier devices; also, accuracy is unaffected by cable or stray capacitance

by E.V. Hardway, Jr., *Spearhead Inc., Houston, Texas*

☐ Though capacitive transducers for measuring angular or linear position have always been more attractive than other electromechanical types, their popularity has been limited because only expensive versions were capable of accuracies above 1%. The major source of inaccuracy was the capacitive fringing effects, and in a recently developed transducer these are greatly reduced by an improved capacitor plate design.

The device is also free from wiper friction and noise, and consequently converts angular or linear displacements to a linear voltage with an inherent accuracy of 0.1%. Yet it can be built inexpensively and reproducibly. High-grade ceramics and temperature-stable metals can be used for extreme environments, and low-cost plastics for less exacting conditions.

In addition, the transducer is relatively insensitive to motion other than the displacement being measured, and changes in its configuration are all that are necessary to tailor it for different applications.

The basic design comprises two fixed parallel plates separated by a movable shield. Since this shield is the only moving part, the sources of friction are minimized. And because it is also grounded, errors caused by its unwanted axial motion are about a tenth of what they would be if it were used as an active element.

To cope with the fringing effects, the active area of the receptor plate is surrounded by an inactive or guard area that's considerably wider than the distance between plate and shield. This active area is returned to virtual ground, so that it is in effect at the same potential as the guard area, shield, and transducer housing. Since the edge effects now occur only in the unused portion of the capacitor, the electric field over the active region is essentially parallel, and the transducer output is insensitive to internal as well as external stray capacitances.

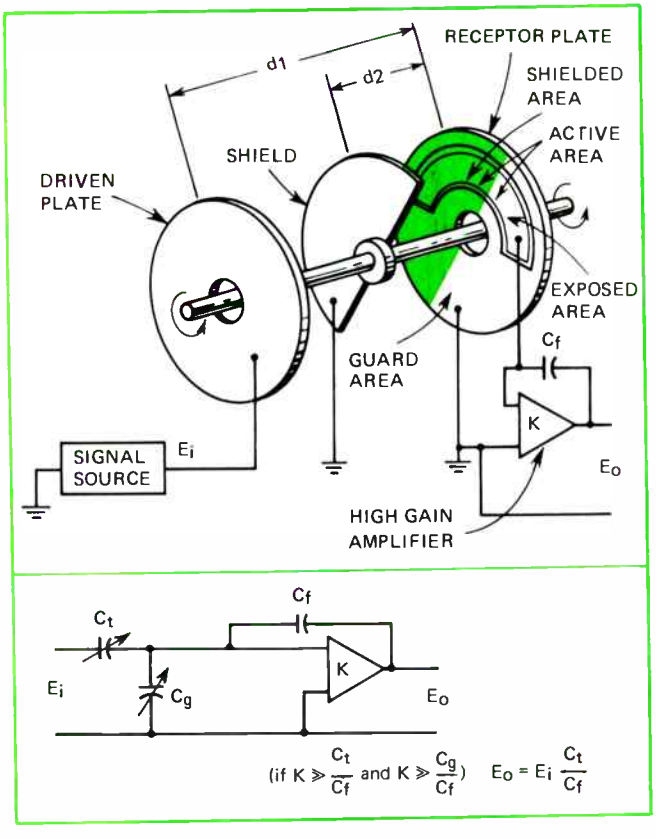
For an angular transducer with a linear output, the configuration shown in Fig. 1 is used. The spacings d_1 and d_2 between the fixed circular plates and the movable, semicircular shield are kept small relative to the plate areas so as to minimize fringing effects. Typically, for a transducer with plates 2 to 3 inches in diameter, d_1 might be in the neighborhood of 0.05–0.10 in. and d_2 about 0.005–0.010 in. Both the receptor and the driven plate are positioned in the transducer so that they remain parallel and separated by a fixed distance.

The plates are usually made of a dimensionally stable insulating material, such as glass-filled epoxy, which is completely coated on one side with a thin layer of copper. On the receptor plate, however, the active area is divided from the guard area by having its outline etched right through the copper.

Normally the active area will be configured as the segment of a ring. The length of the segment limits the range of rotation that will yield a voltage output. The width of the segment determines whether the output will be linear or nonlinear.

The device in Fig. 1 accordingly provides a linear output over 180° of angular rotation. Here, the active

1. Simple sensor. The output of the high-gain feedback amplifier is linearly proportional to the area of the receptor plate exposed to the driven plate. In the equivalent circuit, C_t represents the capacitance between driven plate and exposed active area, while C_g represents the capacitance between active and guard areas.



area is held at virtual ground by the high-gain amplifier with a capacitive feedback loop. The guard area is grounded, and the conductive driven plate is connected to an alternating voltage source. The signal source of level E_i establishes an alternating electric field between the driven plate and the unshielded portion of the receptor plate as well as between the driven plate and shield. With this arrangement the output is simply

$E_o = E_i C_t / C_f$

where C_t is the capacitance through the three-terminal transducer (the effective capacitance between the driven plate and the exposed active area on the receptor plate), C_f the feedback capacitance around the amplifier.

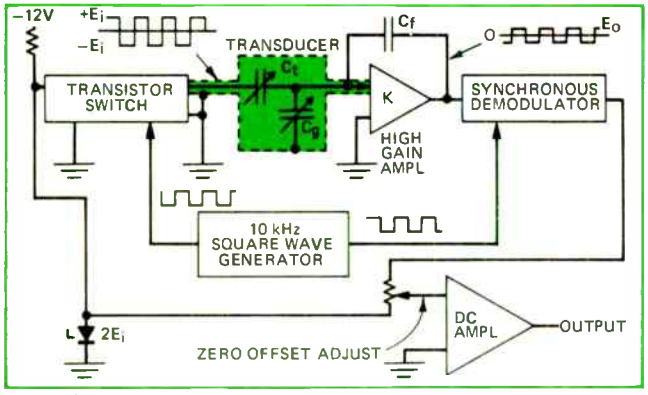
This formula derives directly from the complete expression for the ratio of the output/input voltage, which is

$$\frac{E_o}{E_i} = \frac{\frac{C_t}{C_f}}{1 - \frac{1}{K} + \frac{C_t}{KC_f} + \frac{C_g}{KC_f}}$$

where K is the gain of the amplifier, and C_g represents any cable capacitance to ground plus the changing capacitance between the active area and the grounded shield. With a gain of 10,000 or better, this expression is extremely linear so long as any changes in the transducer capacitance, C_t, or the capacity to ground, C_g, are small compared with KC_f. Also the effect of the cable capacitance between the amplifier input and ground, if small enough, is greatly reduced because it is in shunt with the much larger input capacitance of the amplifier.

Typically, the cable's capacitance is about 100 to 1,000 picofarads, depending on its length. The transducer capacitance, C_t, varies from about 0.1 to 4 pF, depending on the area of the plates and the distance between them. The changing capacitance between the active plate area and the grounded shield can be anywhere from 5 to 10 pF, and depends mainly on their separation distance. The feedback capacitance usually falls in the range of 100 to 1,000 pF: the higher the value of C_f, the less sensitive the circuit is to cable capacitance, but the smaller its output.

The capacitance between parallel plates of area A, in square inches, separated by an air gap of d inches, can be expressed in picofarads as:



2. For dc only. Transistor switch driven at 10-kHz rate provides necessary alternating field. Transducer output is boosted by the high-gain feedback amplifier, and is then demodulated synchronously. The resulting dc output level is also amplified.

$C = 0.225\varepsilon_0 A/d$

where ε_0 is the dielectric constant of air. This equation is accurate only when d is extremely small compared to plate area. With the larger values of d typical of most conventional transducers, fringing of the field around the outer boundaries causes appreciable errors, especially when the size and shape of the active area of the plate changes.

In the new transducer design, it's relatively easy to maintain 0.1% linearity for a total angular travel of up to about 160°. With a smaller air gap, d_2, and a thinner shield, this linearity can be extended to cover 170° of travel.

The feedback amplifier should have a relatively high input impedance so that all the current that flows into and out of C_t will also flow through C_f. The output and input voltage can be expressed in terms of this current:

$$E_i = \frac{1}{C_t}\int i\,dt$$

$$E_o = \frac{1}{C_f}\int i\,dt$$

Therefore, if the alternating current is the same in both equations, the ratio of the output to the input voltage is

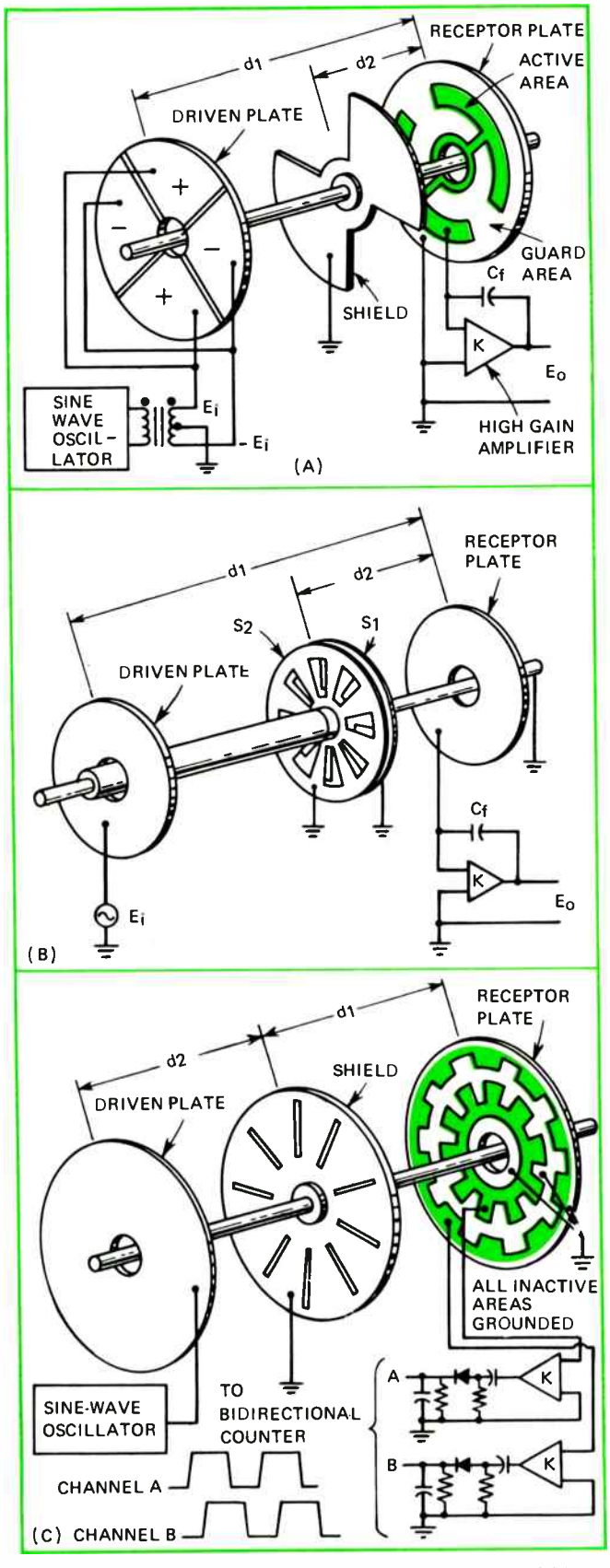
$E_o/E_i = C_t/C_f$

The basic capacitive position sensing transducer can be used as an ac potentiometer, since it lacks the large phase shifts and inaccuracies exhibited by wirewound potentiometers at frequencies above several kilohertz. However, for dc applications such as graphic recorders and industrial controls, a square wave may be used with a full-wave detector or synchronous demodulator to restore the dc at the output.

Figure 2 shows such a circuit. A transistor switch driven at a 10-kHz rate alternately switches the transducer input from a dc reference voltage of two times E_i to ground. A series capacitor in the switch shifts the level so that the input to the transducer is a square wave with an average value of zero and an instantaneous amplitude that varies from E_i to $-E_i$. (If necessary, the reference voltage can be regulated by a temperature-compensated zener diode.) Separate shielded cables connect the transducer input to the transistor switch and the transducer's output to the input of the high-gain amplifier. These two circuits must be separated or adequately shielded from each other, lest capacitive coupling from input to output cause a zero offset.

The synchronous demodulator then restores the dc level and cancels unrelated signals and noise. Since these transducers have residual capacitance at mechanical zero, there will always be some dc voltage present at the demodulator output. A zero offset adjustment can be provided to produce essentially zero output at any chosen shaft position. The dc amplifier provides a low output impedance, making output independent of load.

Actually, the transducer functions much like a sample-and-hold circuit. When it's driven by square waves, any measuring action occurs during the rise and fall times of the pulses. At other times the amplifier merely holds the voltage level. No extraneous capacitance between the input of the amplifier and ground,



3. Variations on a theme. By configuring the plate and shield patterns in different ways, the basic capacitive transducer circuit can be made to sense changes in (a) angular position, (b) torque, or (c) total distance travelled by a rotating shaft, regardless of how many times the direction of rotation is reversed.

unless very large, has any effect except to increase the rise and fall times, because any charge stored by the extra capacitance is released when the amplifier input returns to zero potential.

Variations of the basic plate and shield configurations will tailor these transducers for other applications. A capacitive, small-angle ($\pm 5°$) sensor or microsyn for accelerometers, for example, can be constructed by modifying the shield and both the plates, as shown in Fig. 3(a). The driven plate is divided into four sectors, each of which is isolated from the others. Two of these sectors are driven at one phase of the ac signal, and the other two are driven 180° out of phase. The output voltage of the amplifier is proportional to the difference between the active receptor area exposed to one phase of the input ac source and that area simultaneously exposed to the other phase.

If the inner and outer radii of the active area receptor pattern are r_1 and r_2, the ratio of output to input voltage is given by

$$\frac{E_o}{E_i} = 0.45 \frac{(r_2^2 - r_1^2)\epsilon}{d_1 C_f} \alpha$$

where d_1 is the plate separation, ϵ is the dielectric constant of the medium separating the plates, and α is the angle in degrees of the shield from a position of balance (that is, the point at which the shield covers equal portions of the active area). Since all torques on the shaft and shield cancel, the transducer is free of reaction torque, which makes it an ideal angle pickoff for gyros, pendulums, and torsion balances.

A torque sensor for rotating shafts that requires no slip rings may be constructed by reconfiguring the plates and shield as shown in Fig. 3(b). For this application two shields, s_1 and s_2, are placed between a circular driven plate and a conductive receptor plate. Shield s_1 turns with the shaft, while s_2 is fixed at a small distance away from s_1. Each is grounded and slotted.

The shields are initially positioned so that the slots do not overlap, and any relative motion between them exposes more or less of the receptor plate to the driven plate. Therefore, any twist of the shaft proportional to applied torque changes output voltage proportionally.

Another job well suited to the capacitive transducer is determining the total travel of a shaft from a fixed reference point, regardless of how often the direction is reversed. For this application, as Fig. 3(c) shows, the shield is slotted and placed between a simple circular driven plate and a circular receptor plate with an elaborate pattern of two sets of alternating lobes. With narrow slots in the shield, feedback around the amplifier isn't necessary because for this application only the presence or absence of the signal has to be determined.

The two active area patterns are offset from each other by the width of half a lobe. Each active area is surrounded by three grounded guard areas and connected to a separate amplifier and diode detector. As the shaft rotates, the capacitance between the slots in the shield and one or both of the active areas allows the oscillator signal to be coupled to the amplifier channels. For example, shield and receptor plate patterns of 36 slots and 36 lobes would provide a bidirectional shaft encoder capable of 144 counts per revolution. □

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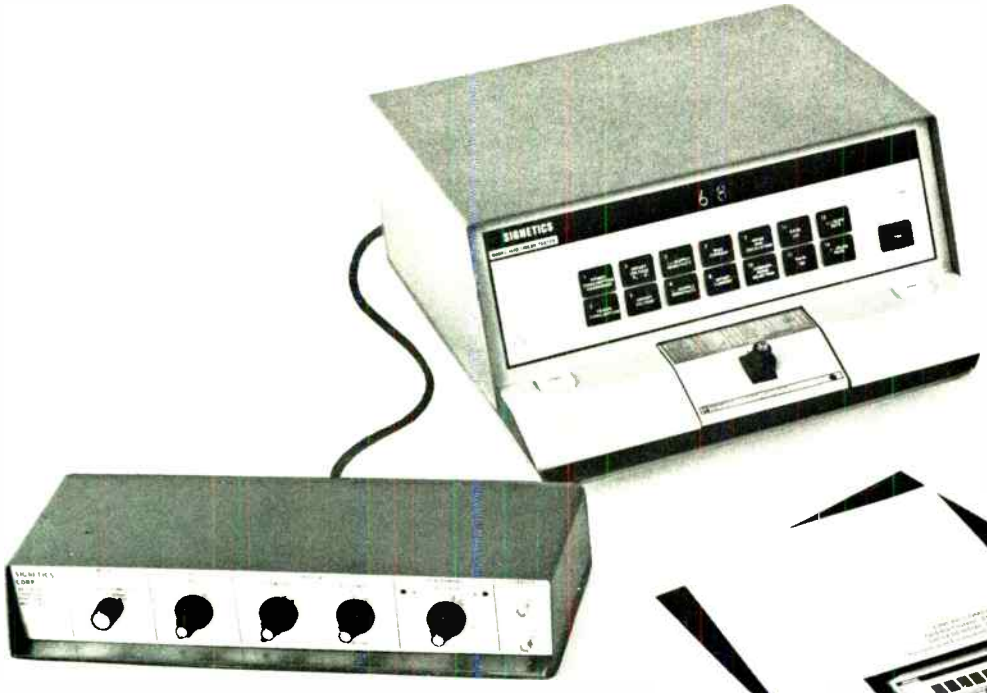

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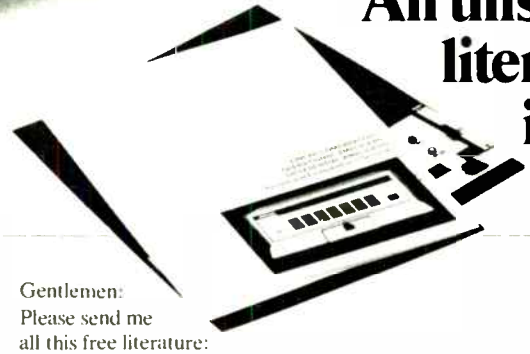

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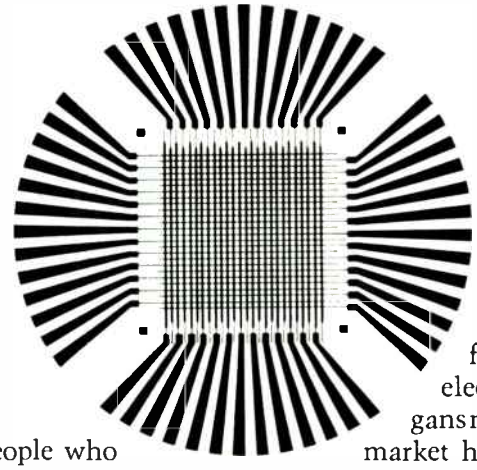

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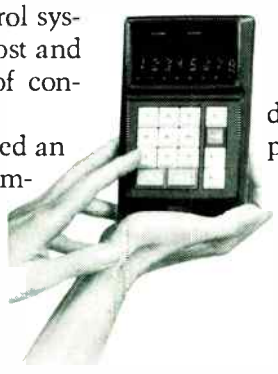

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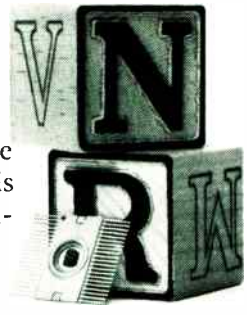
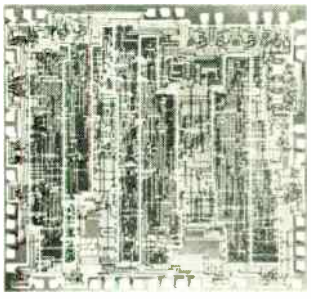
For our customers throughout the world we have designed hundreds and delivered millions of MOS/LSI circuits. Our deliveries have been on time and our reliability has been proven.



Building blocks that last for generations.

Because of our systems design capability, we're able to give our large-scale integrated (LSI) circuits building-block capabilities. When you have so many electronic functions available in a single circuit, it's good business to design so that the same circuits can be used in a number of different systems.

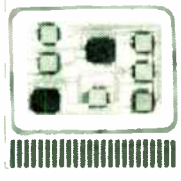
Our exclusive custom-layout, computer-aided design enables us



to provide more electronic functions on a smaller circuit with building-block capability. This minimizes cost—lower circuit cost and lower total systems cost.

These building-block systems perform data reduction functions for everything from simple calculators through business and accounting machines to programmable equipment. They also provide digital functions for data transmission and telecommunication systems.

Best of all, our building-block designs can be adapted and used in successive models of your product as well as in various current models. This permits minimum capital expenditure in developing new products and product lines. Cost per circuit is minimized—and reduced even more over large runs.



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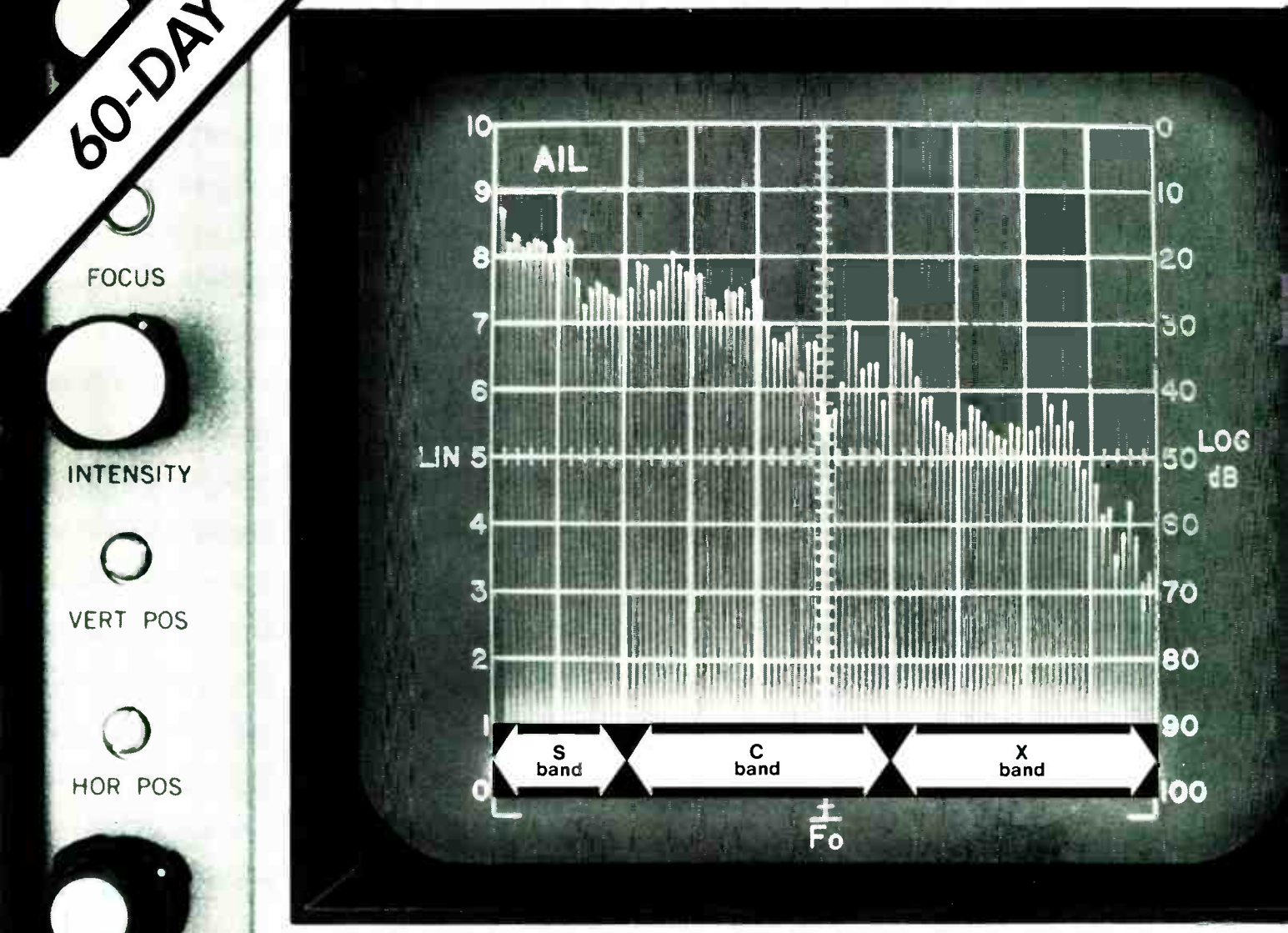

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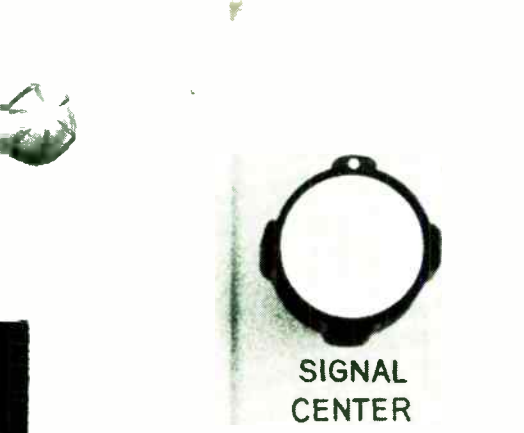

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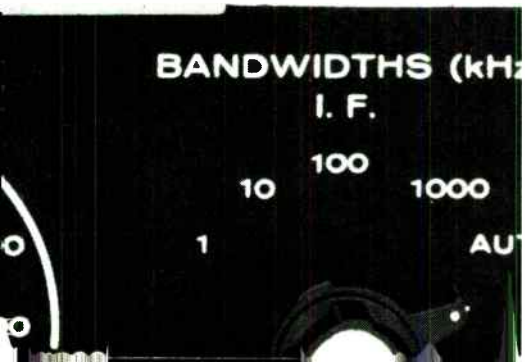

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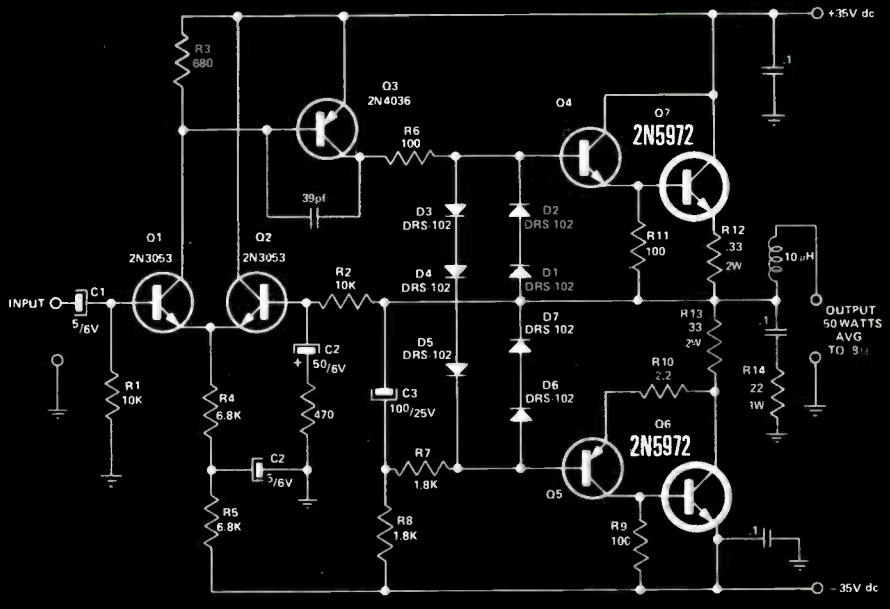

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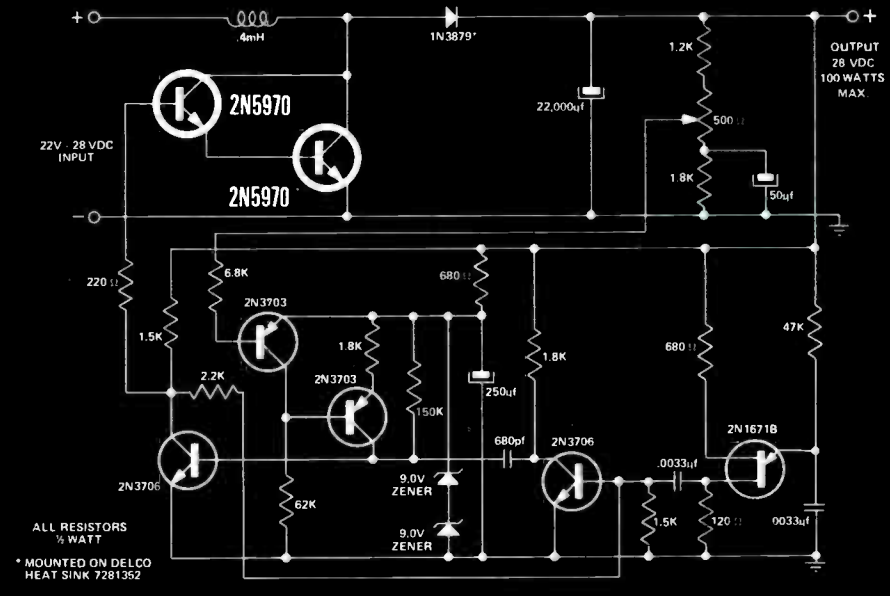

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2N5970	15	20	60	80	60	20	10	2.0
2N5971	15	20	60	80	60	50	20	1.5
2N5972	15	20	80	100	70	25	10	1.8
2N5973	15	20	100	120	80	25	10	1.8

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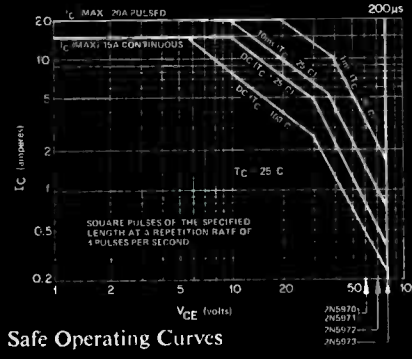

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Application Notes 42 and 43 provide the data on the circuits.

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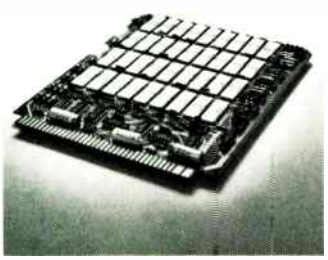

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The markets are still bottoming out

Consumer electronics, some instruments and minicomputers are the only rises in a flat midyear market; but a mild uptrend is expected in the second half

by Alfred Rosenblatt, New York bureau manager

Even if a product manager's sales are up these days, his optimism must be tinged with apprehension when a bellwether segment of the electronics industries—semiconductors—is expected to drop at least 10% this year. *Electronics*' midyear market survey shows that with the outstanding exception of consumer electronics—where color television sales are up 25% from last year's—and apart from strong action in minicomputers and certain instrument lines, the electronics industries will do well to maintain 1970 levels. They are not likely to better them.

Even where domestic sales have improved, total sales may still be off because the foreign market has been declining in the way U.S. sales did last year. This downward trend has been observed by companies as diverse as semiconductor maker Texas Instruments, electronic instrument manufacturer, Hewlett-Packard Co., process controls supplier Foxboro Co., and for the computer industry by analyst and market researcher Arthur D. Little Inc.

It appears then that the turnaround anticipated at the end of 1971's first quarter [*Electronics*, April 12, p. 103], may have settled into a long "bottoming out" period. And even though it's anticipated that second-half sales will outdo first-half, the overall business picture for 1971 will show little, if any, improvement over last year's. This current estimate is about the same as companies expected late last year. *Electronics*' market survey [Jan. 4, p. 35] forecast only a 2%, or $500 million, increase over 1970.

Semiconductors

Sales of semiconductors in the first half of 1971 are a crashing disappointment. Whereas last year major semiconductor manufacturers predicted a business turnaround starting in the second quarter of 1971, most markets are suffering further erosion. Sales in the first half were off about 15% from 1970 figures and seem likely to pick up only slightly in the second half.

Fairchild Semiconductor's director of business development Gene R. Selven sums up the whole sad story: "The industry-wide semiconductor market will be down by 10%—from $1.214 billion in 1970 to $1.1 billion—if the present rate projected for 1971 continues."

Major losers are digital bipolar ICs and discretes. However, digital metal-oxide semiconductor and linear devices are booming. Selven estimates 1971 industry sales of digital MOS devices at $90 million, up 50% from last year's $61 million. But as these segments make up only a small fraction of the total sales volume of the industry, they're unable to compensate for weaknesses elsewhere.

William A. Glazer, OEM sales manager for RCA's Solid State division, Somerville, N.J., also sees the semiconductor outlook as bleak: "No matter what statistics you want to compare, average pricing is down, volume is not up, and dollar sales are down." He says the biggest surprise in 1971 has been the lack of recovery generally. "It just didn't materialize as every one was predicting," he says. He looks for some improvement in the second half but "not enough to overcome the bad first half." And the year will wind up with a 15% drop in dollar volume from 1970, "maybe a little less," he adds hopefully.

Specifically, RCA's sales of linear

1971 Semiconductor market
(in millions of dollars)

	Estimates at end of 1970		Current forecast		
	1970*	1971**	Full year	First half	Second half
Digital Integrated Circuits, total	353.8	379.0	359.0	171.0	188.0
MOS	**68.0	102.0	91.0	42.0	49.0
Bipolar	**280.0	277.0	268.0	129.0	139.0
Linear Integrated Circuits	79.4	91.4	82.2	39.2	43.0
Discrete Devices					
Transistors, small signal	**191.4	186.5	143.3	72.3	71.0
Transistors, power	**78.7	73.8	100.0	52.0	58.0
Diodes, Silicon	77.3	97.6	44.7	21.6	23.1
Diodes, germanium	18.4	20.2	8.9	4.1	4.8
Zener Diodes	51.3	56.1	40.1	19.3	20.8
Thyristors (SCR's)	59.5	69.6	52.6	24.6	28.0

* Source: Electronic Industries Association
** Source: Electronics, Jan. 4, 1971, p. 63

devices for consumer products and its new C/MOS lines are up. But discrete power device sales are sluggish, with thyristors and rectifiers particularly soft. Likewise at the Semiconductor division, Westinghouse Electric Corp., Youngwood, Pa., "very-high-power products for capital equipment" were hardest hit, says marketing manager Maurice Sardi.

Most troublesome to semiconductor manufacturers is the state of the computer industry, which Fairchild's Selven characterizes as "a big disappointment to us."

The slow computer market is a continuing drag on IC memories and on digital bipolar IC sales, which were down to the tune of 27% through April, according to Selven, quoting EIA figures. And overseas, the computer market was down 30% in the first half of the year from the last half of 1970.

Despite the general decline, however, there have been successes in the semiconductor field, particularly at the smaller companies who were in the right place at the right time—and that means MOS. North American Rockwell Microelectronics of Anaheim, Calif., for one, had sales for the first half of 1971 which, although less than predicted, were still "about twice" those of the same period last year, says company president R. S. Carlson. And even some of the newer MOS makers are showing a profit—three-year-old Intel Corp. and Advanced Micro Devices Inc., both of Mountain View, Calif., are examples.

But no one can pinpoint where the business is coming from. It's a little here and a little there—orders are not coming in in the large quantities of the end of 1969 and the beginning of 1970.

Government electronics

For Government electronics contractors it is now 1972, a Federal fiscal year that began July 1. And for those who count on Defense Department outlays for revenue, it looks like a year with limited new opportunities at best. "There will be more money for research and more for development," says one major West Coast systems manufacturer's man in the capital, but precious little for big production programs. What there is of that, he adds, "usually has somebody's name on it"—an allusion to follow-on funds earmarked for one or two manufacturers already under contract.

But it is just such funds that are keeping sales up at some of the larger electronics firms. Kearfott division, Singer Co., in Little Falls, N.J., for example, had a "peak" year in 1970 and expects this level to hold this year. The reason: production contracts for inertial navigation systems aboard the SRAM missiles, signed early this year and, since late 1970, for the A-7D and A-7E aircraft. Lockheed Electronics, Plainfield, N.J. is running even in sales because of the Navy's Mark 86 gunfire control system. Litton Industries' electronics business is holding steady, and Hughes Aircraft says sales are 5% to 10% ahead of last year and will continue so "for the rest of the year."

So far, Secretary of Defense Melvin R. Laird has more than $13.91 billion in his hardware procurement budget. And for RDT&E he is ready to spend $7.96 billion, 12% more than was obligated last fiscal year.

Industry sources are optimistic for the future of R&D programs. "The rush to end the Vietnam war—and the economies that go with it—is making new R&D more attractive because there is less money involved in any single project, points out one industry observer.

Across the military board, the Pentagon's move to consolidate several communications satellite programs into a single tri-service effort promises new development opportunities in fiscal 1972. Dubbed Milsatcom within DOD, the project will reportedly supplant with a new generation of systems such programs as the defense satellite communications system and Taesatcom.

The Navy, with $2.46 billion, comes up on contractor lists as offering the broadest R&D opportunities. It got its enlarged budget at the same time as the House Armed Services Committee cut similar funds sought by the Army and other defense agencies and gave Air Force programs only a marginal increase.

For space, Congress is expected to give NASA $3.35 billion—$81 million more than the White House requested. Implicit in its action is permission to go ahead with two new programs—the High Energy Astronomical Observatory and the $1 billion Grand Tour to the outer planets—and to restart a once delayed program, the space agency's Viking orbiter/lander for Mars. However, NASA's potentially largest ongoing program, the $13 billion space shuttle, is being stretched out to postpone its peak costs beyond the middle of the decade.

Capitol Hill sources say that the Federal Aviation Administration should get about what it wants in both procurement and research and engineering categories—$250 million and $68.6 million, respectively, much more than last year.

And on the health side of the Federal Government, medical elec-

1971 Instruments market

(in millions of dollars)

	Estimates at end of 1970*		Current forecast		
	1970	1971	Full year	First half	Second half
Recording Instruments, Analog & Digital	70.1	74.0	66.0	31.3	34.7
Oscilloscopes	133.9	139.0	118.9	58.0	60.9
Panel Meters	45.9	47.4	40.5	19.1	21.4
Digital Voltmeters & Multimeters	28.1	29.2	23.0	10.2	12.8
Counters (time & frequency)	29.6	31.0	27.5	13.6	13.9
Signal Generators**	55.1	59.5	51.0	24.7	26.3
Component Testers	29.7	32.7	17.1	8.5	8.6

* Source: Electronics, Jan. 4, 1971, p. 63.
** Includes oscillators, synthesizers, function generators.

tronics firms can expect a little more money spent on equipment. Recent legislation allows the Department of Health, Education and Welfare to grant matching funds for equipment alone, instead of just for equipment involved with new construction.

Instruments

Although no one dramatic event has happened in the instruments business, declining sales curves have levelled and started upward. Many manufacturers are looking for at least modest increases in 1971, but *Electronics*' market survey finds estimated final sales for the year will still be down compared with last year.

The trend is upward at companies like Hewlett-Packard, Tektronix Inc., and John Fluke Manufacturing. Perhaps pacing the field is the industry giant, H-P, whose sales rose sharply during its second quarter ending in April—$90.3 million versus $81.2 million in the first quarter—and whose third-quarter sales probably remained close to the second quarter rate.

The improving situation "doesn't look temporary," says product line manager Tony Schiavo at Dana. The Irvine, Calif.,-based manufacturer of digital voltmeters and frequency counters had third-quarter sales ending June 30 "up considerably" across all product lines compared to sales for the past several quarters, according to Schiavo.

At Dana, as at most other DVM makers, sales of lower-priced units seem to be doing better than the more expensive models. This indicates that money may still be tight, and engineers are buying the minimum instrument to handle the job. United Systems Corp., for example, reports sales of 4½-digit instruments "slightly off" while sales of 3½-digit models are up almost 15%.

Since June, sales of oscilloscopes have picked up strongly at H-P's Colorado Springs, Colo., division.

Equally bright is the picture at the leading scope builder, Tektronix Inc., Beaverton, Ore. After bottoming out during the last half of 1970, sales have risen from a volume of $2.6 million weekly until recently they reached a record weekly rate of $3.3 million, according to vice pres-

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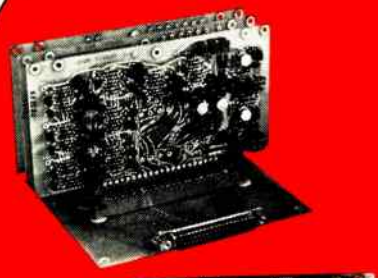

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At the signal source end of the instrumentation market, pulse generators are "definitely picking up," claims Larry L. Hahn, bench instruments marketing manager at E-H Research, Inc., Oakland, Calif. For the calendar year, the increase could be as much as 25% to 30% for his company, he predicts.

But the biggest expansion in signal source sales is likely to come in frequency synthesizers, now that their prices have dropped to under $2,500—about the price of a top-of-the-line oscillator.

Components

Strong sales of consumer electronics, plus expected stronger sales of computers, should push business at components houses into better shape as the second half of the year rolls along. Total sales in 1971, however, will be well below January's expectations. Far from riding an upturn, business in most of the traditional components categories, including resistors, capacitors, connectors and receiving tubes, will be down even compared with 1970's generally poor showing, according to *Electronics*' market survey.

Not fitting into this disheartening picture are the relatively new hybrid circuit components whose manufacturers predict sales increases ranging anywhere from 10% to 25%. Anticipating this trend, many old-line manufacturers have broadened their product lines to include hybrids of one kind or another.

But perhaps the broadest grins are to be found at suppliers to the home TV industry. Centralab's Electronics division in Milwaukee, for instance, anticipates a 20% to 30% growth in the $40 million in sales of last year. Doing very well is a ceramic disk unit earmarked for TV sets, reports William Fowler, vice president for marketing and engineering.

Although the resistor segment of the business is not nearly as bright, Allen-Bradley Co., Milwaukee, one of the largest resistor houses, has kept sales perking 10% above last year's rate by introducing a lot of new products—"20 in the last 11 months," says director of marketing Clayton Ryder. In addition, the company may sell twice or three times as many thick and thin film circuits this year, says Ryder, while sales for capacitors and fixed and variable filters have "improved" during the first half.

The situation will not be as rosy for components giant, Sprague Electric Co., North Adams, Mass. Its first-quarter loss was $2.4 million on sales which, projected over the year, are 13% below its 1970 level, when it grossed $127.48 million and lost $1.8 million. The company attributes its slump to a 10-week strike last year, whose effects are still being felt.

Hoping for the most modest of sales gain this year compared with the last are the connector manufacturers. At best, sales, should increase only a few percentage points. "The earliest business will pick up is the beginning of 1972," says Bud Howell, vice president of sales at AMP Inc., Harrisburg, Pa., tying a connector upturn to computer industry sales.

1971 Components market

(in millions of dollars)

	Estimates at end of 1970		Current forecast		
	1970*	1971**	Full year	First half	Second half
Capacitors					
Electrolytic, Total	182.8	199.0	159.9	76.7	83.2
Aluminum	81.8	96.7	74.2	36.0	38.2
Tantalum	101.0	102.3	85.7	40.7	45.0
Ceramic	74.5	68.3	70.9	34.6	36.3
Mica	20.0	23.4	21.2	9.9	11.2
Paper & Film	185.0	137.0	126.8	61.0	65.8
Variable	11.8	23.0	18.9	8.8	10.1
Connectors					
Coaxial	**44.3	47.4	37.5	17.9	19.6
Cylindrical	**93.6	96.2	74.5	43.5	44.0
Printed Circuit	**59.5	64.9	54.0	26.0	27.0
Rack & Panel	**76.2	78.9	72.6	35.4	37.2
Electron Tubes					
Backward Wave Tubes	–	–	11.3	5.6	5.7
Traveling Wave Tubes	–	–	48.2	24.8	23.4
Total	71.0	59.1	59.5	30.4	29.1
Klystrons	35.0	36.2	31.1	15.9	15.2
Magnetrons	38.0	30.7	27.3	13.9	13.4
Receiving Tubes	254.5	173.0	214.0	110.0	104.0
Relays, Total	**118.7	130.3	129.2	62.1	67.1
Electromagnetic	**101.6	109.9	112.9	54.7	58.2
Solid State	**17.1	20.4	16.3	7.4	8.9
Resistors, Total	314.1	335.9	306.0	152.6	143.4
Fixed	191.9	195.1	178.6	90.6	88.0
Variable	122.2	140.8	127.4	62.0	65.4

* Source: Electronic Industries Association ** Source: Electronics, Jan. 4, 1971, p. 63

Consumer electronics

Led by a comeback in color TV factory sales, consumer electronics business is humming along at mid-year levels ranging from 6% to 40% ahead of the same period in 1970. Only console phonographs, outplayed by a trend toward stereo components, have turned down. However, being well ahead of 1970, when everything was way off, is like Willie Stargell hitting a homer in a Little League ballpark—no big deal. In fact the 2.5 million color TV sets sold is what industry observers anticipated, that is, close to 1969 levels. (As expected, fm radio is doing better than in 1969 and 1970.)

For color television, marketing experts believe this year marks the beginning of continued annual growth of anywhere from 10% to

Probing the news

25%, with color receivers returning to a little over 5-million unit sales domestically.

The color TV recovery did not start in earnest until March, says Charles W. Kepler, director of product management for Motorola Consumer Products division, Chicago. By May and June the pace in sales at the factory had quickened to better than a 6-million-set-a-year rate, which would be about 12% ahead of last fall's projections.

The audio end of consumer electronics has also picked up steam. By the end of June, radio sales were up 17.4% over the same 1970 period, led by a 35% increase in fm and a-m/fm sales, according to EIA. Factory sales of portable and table phonos were 1.3 million units, 43% ahead of the year earlier, EIA reported. These figures are perhaps 10% better than expected early in the year, says one producer.

There's also been a lot of action on the audio tape front. Lawrence R. Pugh, marketing manager of Ampex Corp.'s consumer equipment division, expects consumers to buy about 11.6 million tape units in 1971, compared with only 6 million phonographs. This is a 10% increase in tape recorder unit sales over 1970, while cassette tape recorders and players for home, portable, and automobile use will have the largest growth, Pugh adds.

After a phenomenal burst in 1970 to an estimated 314,000 domestic and imported units, electronic calculators stepped up the pace with 122,000 units sold in the first quarter. Prices have tumbled, however, from an average price per unit, including costly programables, of around $1,200 in 1969 to $543 this year. And these figures don't adequately reflect the rapid slide in the price of hand-held minis—last fall $350-$400 was the lowest going rate, by spring the $200 level was broken, and there's now talk of mini models for just over $90 due this fall.

Robert W. Galland, national sales manager of the calculator group of SCM Corp., New York, predicts that this year electronic machines will get "more than half of the $350 million sales dollars and by 1974 will dominate a $500 million market."

Computers

"Mixed" is the best word for the computer market picture at mid-year. Of the large mainframe manufacturers, IBM admitted to a disappointing fiscal first half ending June 30 because sales did not increase by as much as expected. And chairman T. Vincent Learson warns that current economic trends may result in even "less favorable income comparisons for future 1971 reporting periods."

But in minicomputers, the picture is brighter: sales are way up, and researchers at Arthur D. Little, Boston, estimate a growth of about 36% in 1971 and 1970 dollar shipments.

Like IBM, Control Data Corp., Minneapolis, found business slow in the first half, but is apparently recovering now, though slowly.

The summary of a recent Little report on general purpose computers, termed "optimistic" by its authors, doesn't see the computer industry, with the European market turned "cautious," regaining the $5.5 billion heights of 1969 until sometime in 1972, when ADL estimates shipments in excess of $6 billion. This year the total will range between $4.9 billion and $5.1 billion.

Sales by minicomputer manufacturer Data General, Inc., on the other hand, set new records again this year. Third-quarter sales for the Dedham, Mass., manufacturer (for the period ending June 5) reached $1.89 million a year ago, but soared to $3.96 million in 1971. And sales at Digital Equipment Corp., Maynard, Mass., increased almost $8 million to $68.5 million in the first six months of fiscal 1971.

Companies in the peripherals business are also doing well. Tape transport manufacturer Potter Instrument Co., Plainview, N.Y., announced record orders for the fiscal year ending June 30. And sales of disk drives for minicomputers are up 100% since January at Iomec Inc., Santa Clara, Calif. Also extremely pleased is James Pyle, assistant to the president at California Computer Products Inc., Anaheim, Calif. He asserts that 1971 will be

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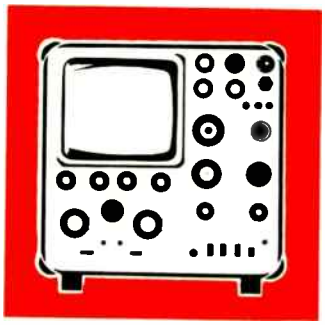

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the company's best in its 11-year history, with most growth coming from its IBM-compatible disk drives.

Production equipment

Suppliers of production equipment to the electronics industries are looking to 1972 for the pickup that last year they were expecting by mid-1971. The doldrums, apparently, have lasted from the second half of 1970 into the first six months of this year. But the next six months may improve. "We expect a recovery in the third or fourth quarter," says a spokesman at automatic test equipment manufacturer Teradyne Inc., Boston, Mass. "It depends on how fast the semiconductor industry's confidence goes up."

Teradyne, almost all of whose products serve the semiconductor field, had its first loss "in many years" during the first quarter. Though sales were up a bit in the second quarter, they were still down over last year.

One company whose business hasn't fallen off appreciably is Universal Instruments Corp., Binghamton, N.Y., makers of component insertion equipment and wire-wrapping machines. Gordon Mayo, Universal's marketing manager, attributes this to the fact that his company sells labor-saving equipment rather than replacement production equipment.

But for independent suppliers of printed circuitry, the dreadful decline experienced in 1970 continues in 1971. Sales last year were only $147 million, down from $179 million in 1969. And in the first two months of this year, sales were 45% below the comparable 1970 period, according to figures released by the Institute of Printed Circuits.

Industrial electronics

Suppliers of process control instrumentation are doing as they expected—"business is reasonably good," says a spokesman at Foxboro Co., Foxboro, Mass., modestly (his company grossed $78.9 million this last six months, up more than $11 million from the first half of a year ago). But for the machine tool industry hopes were not realized—shipments are down 31% for the first five months of 1971—and this poor performance is, of course, reflected in sales of numerical controls.

Altogether, process control companies seem less affected by the slowdown than many. Summing up the situation, John Rock, a market researcher at Quantum Science Corp., New York, says that this year the electronics complement in process installations should increase about 4% or 5% above the $357 million value of 1970.

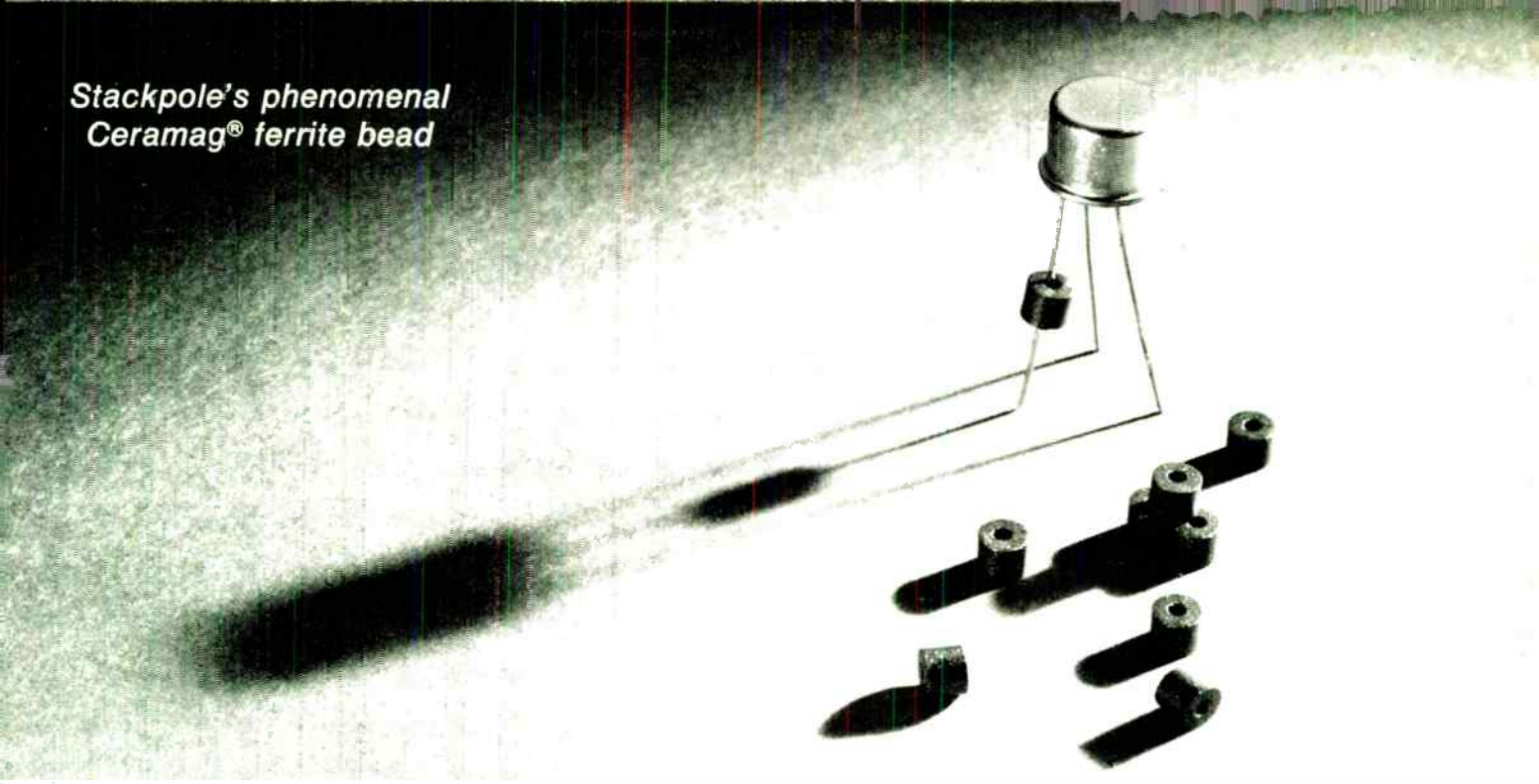
However, the spokesman from Foxboro, whose customers encompass the chemicals, oil refining, gas production, pulps and paper, and utilities industries, puts his finger on a cause for concern: although billings are up 18%, new orders are up only 6%. Sales in the United States are stronger than last year while sales in Europe have "softened."

Way ahead of this growth rate, however, are systems for computer-based materials handling and warehousing, a market that, according to the Industrial Control Systems division of Cutler-Hammer Corp., Milwaukee, is about to "boom."

Another profitable area is supervisory control systems for utilities and pipelines. Jack C. Davis, vice president for operations at Radiation Control division, Harris-Intertype Corp., pegs the year's growth here at 10% to 15%, with the total market in the $50 million to $70 million range.

A much bleaker view is held of the numerical control field by Peter Senkiw, president of both the Numerical Control Society and Applied Computer Systems, Dayton, O. "The first six months of 1971 have been pretty dismal," he says. And any real pickup won't come until the first quarter of 1972, according to James Childs, an Alexandria, Va., consultant.

Programable controllers also are not doing as well as expected. Donald Chace, manager of Industrial Control Products, Digital Equipment Corp., Maynard, Mass., revised downward the $10 million sales estimate he made at the beginning of 1971 [*Electronics*, Jan. 4, 1971, p. 59] Industry sales will fall somewhere between $6 million and



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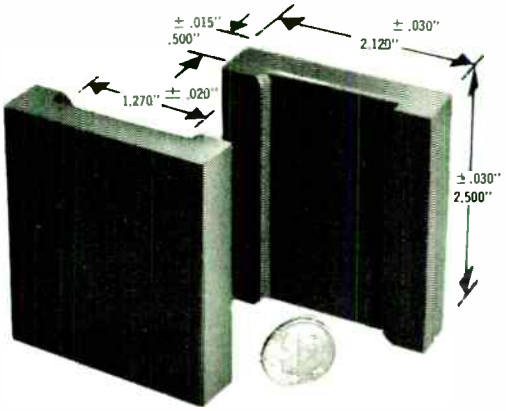

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Installation of Stackpole beads is easy. And inexpensive. Simply slip one (or several) over the appropriate conductor(s) for the desired noise suppression or high frequency isolation.

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	1.0×10^2	1.4×10^5	1.0×10^3	2.0×10^7
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.

STACKPOLE
ELECTRONIC COMPONENTS DIVISION

Probing the news

$10 million, he now says. His earlier forecast was made as a result of sales in November and December of 1970 which turned out to be merely an "upward fluctuation," rather than a continuing trend.

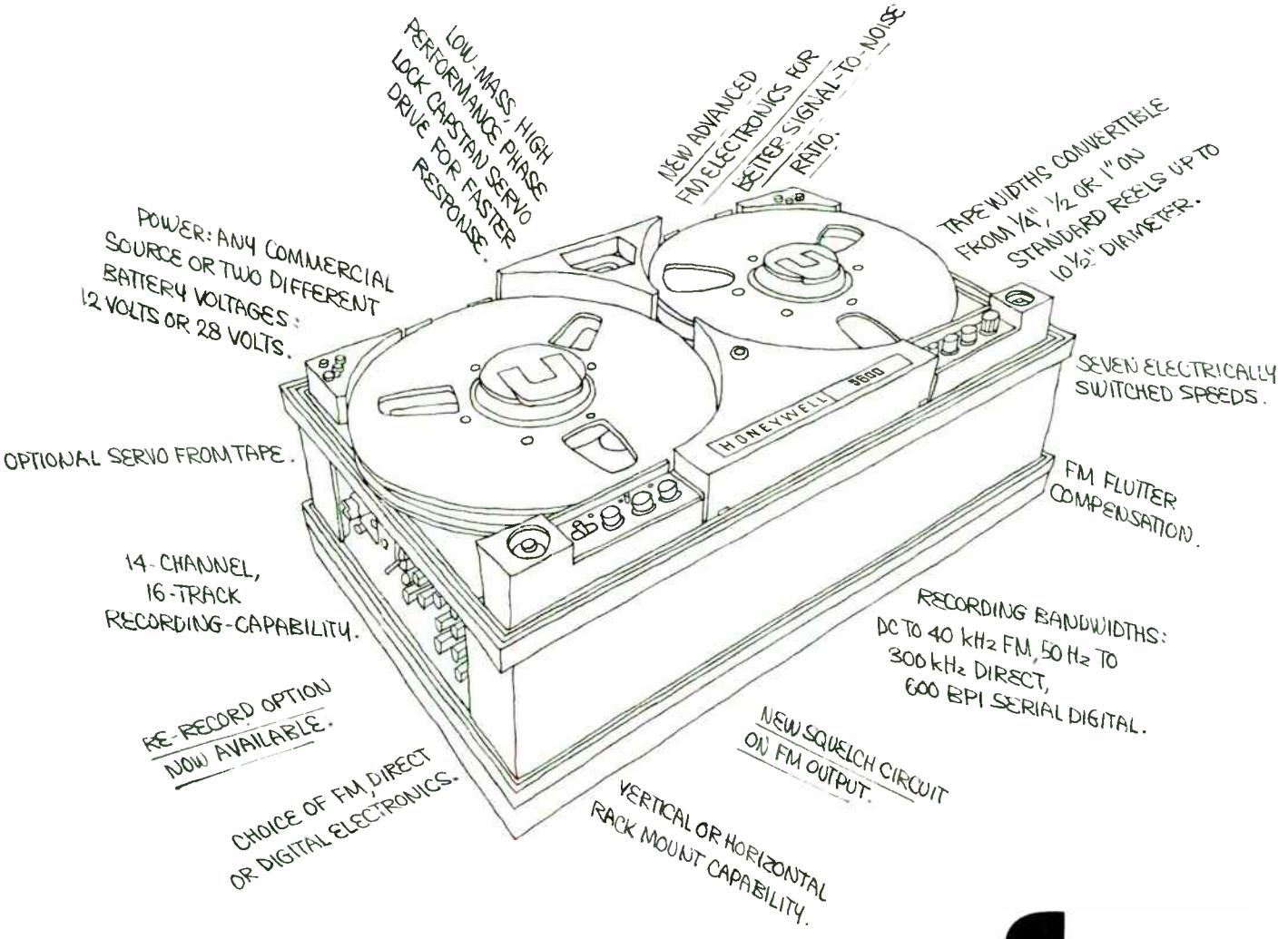
Communications

Communications electronics will do well to hold its own in 1971, its growth stunted by virtually no increase in last year's $500 million military business, by ever tighter space budgets, and by little of the predicted boom in cable television systems. And although the Federal Communications Commission in April finally gave the go-ahead for specialized common carriers to compete with old-line utilities, the market here for microwave and local distribution equipment won't show until the middle of 1972.

Market researchers who expected CATV systems to expand rapidly in 1971 were wrong, says Joseph D. Romosco, director of marketing at Jerrold Electronics Co., Philadelphia, one of the largest suppliers of CATV distribution gear. Apparently, the lack of a clear statement by the FCC on the areas that the CATV stations could serve and the programs they could transmit was a major deterrent to growth. The market for CATV equipment, which reached $97 million last year, is "flat," agrees John Lady, director of informational services at the National Cable Television Association in Washington, and he foresees no change for the rest of the year.

The year 1971 does see some growth areas in communications, however. Sales of land mobile equipment will continue their average 9% growth rate of the past five years, asserts Keith Elrod, director of marketing at General Electric's Mobile Radio division, Lynchburg, Va. Year's end should bring them to a $320 million level, he says. There's also considerable upswing in digital data transmission systems needed by the business community. Charlton W. Hunter, president of GTE Lenkurt, San Carlos, Calif., says his sales of PCM gear are increasing at a 15% to 20% rate. □

HONEYWELL'S PORTABLE 5600.



even more for your money.

The new, advanced portable magnetic tape recorder offers greater performance, more features and greater versatility than any other recorder in the same price category.

And that's just half the story. Let one of our representatives tell you the rest. Call your local Honeywell office for a demonstration. Contact C. S. Corbin, 303-771-4700 — X692. Or complete and mail the coupon. Today.

Honeywell E-7
The Automation Company

Yes! Have someone contact me with more information on the 5600.

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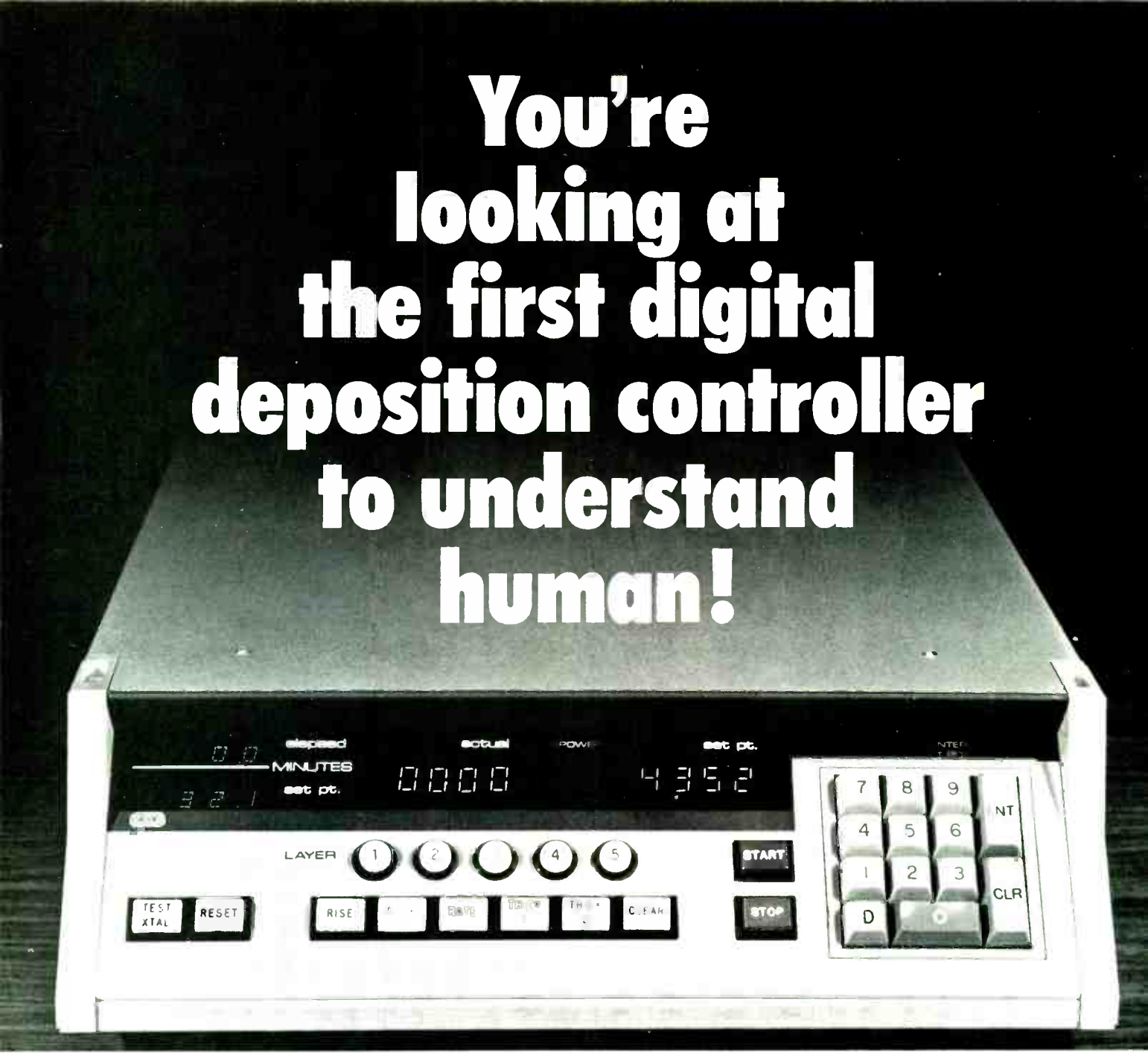
MAIL TO: Honeywell, Test Instruments Division, MS218, P. O. Box 5227, Denver, CO 80217.

You're looking at the first digital deposition controller to understand human!



Human error, forgetfulness, uncertainty

It forgives all. One of three new Digital Evaporation Masters that give uncompromising control but never forget you're human.

For example. It's inhuman to expect to tune a pot with the same repeatability as you can punch a key. Sloan systems have keyboard entry of all data.

We tend to forget what step should be programmed, what was programmed, where the deposition is, where it's going, how long it's taken. Sloan digital control will remind you.

To guarantee accuracy there's four digit thickness resolution from 0 to 999.9 thousand Angstroms. Rate control from 0 to 999 A per sec. Three digit time input for source degas cycle.

For ease there's automatic range changing. Direct reading of film thickness in Angstroms. Crystal life indication.

And when you're uncertain of initial power requirements a handheld analog power override lets you bypass the keyboard.

Units come in One Channel (single source), Five Channel and nifty little "thickness only" models. All priced below anything vaguely competitive.

Write: Sloan Technology Corporation, Santa Barbara, California 93103.

Or: Sloan Technology/Europe N.V., Schiphol Airport East, Amsterdam, The Netherlands.

sloan

International Offices: Amsterdam, The Netherlands; Stuttgart, Germany; Paris, France; Croydon, England; Tokyo, Japan; Stittsville, Canada.

Communications

CATV is on the march

Hardware makers push ahead with two-way systems despite unresolved Federal policy questions

by Ray Connolly, Washington bureau manager

An America wired for two-way, broadband, cable television has been a dream of technologists for more than half a decade. The dream has been filled with visions of subscribers calling up a host of services on request, ranging from community information and computer-aided instruction to shopping and banking at home, while the plugged-in household has its utility meters monitored automatically.

Now, that dream is being fleshed out in two ways. Two-way, interactive cable systems are operating on a trial basis in southern California; Overland Park, Kan.; and Reston, Va. [*Electronics*, July 19, p. 29]. And at least a dozen others are due to go on line this fall, with one system designed for a big city—Washington, D.C. By the end of the year, more than 20 CATV broadcasters will be evaluating two-way systems of one sort or another for merchandising, education, or security.

Also, FCC Chairman Dean Burch has disclosed to the National Cable Television Association that he and his colleagues are completing an order that will require a two-way capability for all new cable systems in major U.S. markets. It is, said Burch, "the key to many of cable's potential public services."

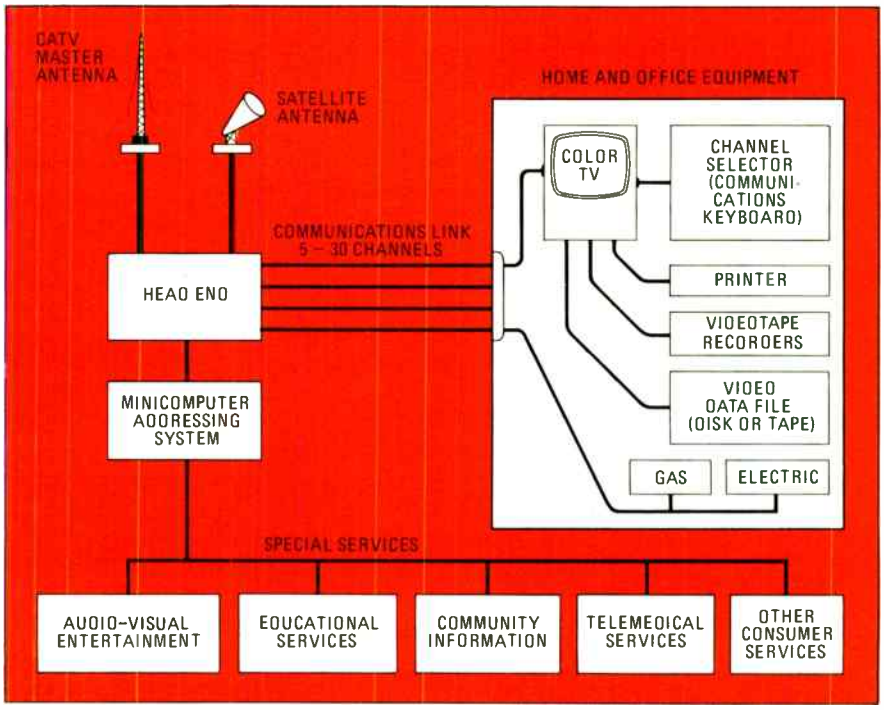
Back and forth. Forecasts are that two-way capability, which the addition of a digital or alphanumeric response will give subscribers, will make "remote-control living," in Burch's words, "more than just a pipe dream."

But Burch also challenged the cablecasters. He said: "Some cable operators are all 'get' and precious little 'give.' They're arguing that they must have distant signals now. But, as far as cable's unique nonbroadcast services are concerned—well, sometime later will be soon enough. We just can't buy that . . . Taking the minimal approach is selling cable short."

Interest in cable TV has been rising in Congress and the White House Office of Telecommunications Policy in the past year, but seems more of a reaction to the FCC chairman's increased activity in the field than agreement with his view that cable's time has come. The emergence of any finely honed Federal policy on CATV will still be subject to much negotiation between the FCC and cable's Congressional antagonists, led by Sen. John Pastore, (D.-R.I.), a friend of over-the-air broadcast interests. Some ask whether a blessing for free competition in broadcasting may not take, say, another 12 years and another 38 of the actions by commissions and courts that have marked the industry's path since the FCC first looked at the issue.

"I doubt it very much," says one FCC counselor. Pausing, he adds, "It may seem that long though, and please don't quote me."

Sen. John McClellan, Arkansas Democrat and a proponent of cable, makes a similar point more subtly. Recalling NCTA's recent mail promotion of forget-me-not seed packages imprinted with the line, "Plant



Wired world. Two-way CATV's potential for a variety of home and office peripherals includes one or more color receivers tied by as many as 30 channels to head-end equipment for distribution of signals from master antennas, domestic satellites, and special cable services.

a flower in the vast wasteland. Let cable TV grow," Sen. McClellan told the story of the French gardener who opposed planting a tree that would take 100 years to mature. "In that case," said McClellan quoting the gardener's master, "there is no time to lose; plant it this afternoon."

But if cable TV operators expand from the 5- to 12-channel, one-way systems that marked early, largely rural systems to 30- to 40-channel, two-way urban systems, will big cable television, forced to be competitive, wind up making the "vast wasteland" merely vaster? The answer of the National Academy of Engineering's new and comprehensive study of cable in an urban environment, is a very strong "No!" But the 218-page study by the NAE Committee on Telecommunications does more than concur with the widely accepted image of America as a wired nation—it proposes a series of specific pilot projects to be undertaken with cities to determine the degree of user interest and precise system costs. "Technology is available" for such two-way cable demonstrations, the NAE group concludes. "Still in question are consumer demand and economic justification," questions that the pilot projects would attempt to answer.

That more sophisticated tech-

Link. For a CATV system test, technician adjusts 12-channel transmitter mounted on four-foot parabolic antenna

nology for two-way CATV is available than the industry can use, pending a firm Federal policy, was demonstrated at the recent NCTA convention in Washington. Equipment makers displayed a variety of hardware with which they hope to mine the cable bonanza, from master antenna and headend distribution systems down to subscriber equipment. Ultimately they see subscribers as owning one or more color receivers with "frame grabbers" to hold and refresh a single image, such as a supermarket price list; a service selector keyboard, probably starting out as a pushbutton telephone; a high-speed printer or facsimile receiver; a video-tape cassette for recording and playback, plus a data file for storage. In the NAE view, "innovative combinations of these home terminals," coupled to a headend computer, will lead to a spectrum of services limited only by "the system designer's imagination and the cost."

Fertile ground. "Whether it's one-way systems today or two-way tomorrow, this market is golden," remarked one marketing man from Theta-Com, the Hughes subsidiary for CATV equipment in Los Angeles. "With two-way there will be more equipment, of course, including minicomputers" at the headend to direct subscriber traffic requests, monitor viewing habits, handle polling, and record charges. "But even without all that," he went on, "there is good business in existing one-way systems here and now."

NCTA's statistics document the "here-and-now" market as consisting of more than 2,750 operating systems with approximately 59 million subscribers—an estimated 50% saturation of those areas where cable service is available. Still pending are about 2,400 more community systems already authorized but not yet built—a figure that leads NCTA to predict 25 million to 30 million homes with cable by 1980, as major urban markets open for two-way systems.

Until urban markets open on a large scale, however, equipment makers are straddling the controversy between single, bidirectional coaxial cable as the means of handling subscriber feedback in a two-way system and the more costly

Probing the news

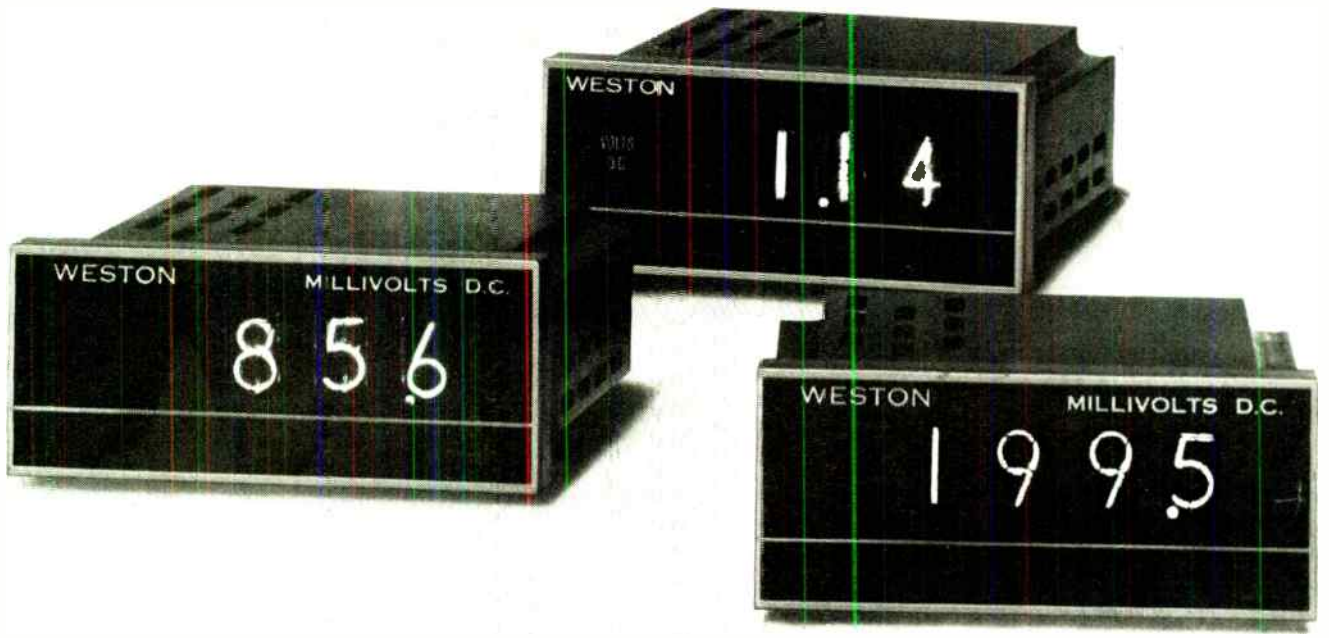
but also more flexible two-wire system. (The FCC supports two-wire systems for the 30- to 40-channel urban systems offering educational and other services requiring heavy subscriber interaction.) Manufacturers are continuing to offer the 5- to 12-channel, single cable system and push-pull amplifiers to upgrade existing one-way equipment with a two-way capability, using a 25-megahertz feedback to the headend. But broadband, two-way equipment is now also available, one of the most elaborate designs being the Subscriber Response System developed by Hughes Aircraft Co., Culver City, Calif., for marketing by Theta-Com.

Planning for subscribers. This system features a modular approach to allow service expansion as subscribers are added. In the Hughes plant, communications between the subscriber terminal and the processing center are transmitted back from a communication modem—either over the same cable network with suitable amplifiers and filter networks to bypass the existing transmitting amplifiers, or over a separate cable. The computer-to-subscriber signals occupy a 4 MHz bandwidth from 108 to 112 MHz, and the terminal-to-computer signals occupy one from 21 to 25 MHz.

Another bidirectional system ready for market is Tocom, consisting of a central data terminal, a bidirectional coaxial amplifier system, and a network of remote transmitter-receiver units. Available from Cas Manufacturing Co., Dallas, this system is capable of interrogating seven words of information, each word containing 16 bits, at any remote transmitter-receiver location. In the present system, the seven words are coded to return certain specific information, such as status of the TV set.

The cost of these and similar systems varies considerably depending on the type of terminal and the capacity of the computer center as well as the number of subscribers in the system and the services being performed. Terminals, for example, range in price from about $20 to about $150. □

Someday you'll be able to buy panel meters this good for under $100.



Is today soon enough?

Here are three of the finest digitals around, all designed to fit the industry's most compact front-panel-removable chassis. All for under $100. Two of them you've seen before—the 2½-digit Model 1260 and the 3-digit Model 1261. The 3½-digit Model 1291 is brand new. It features full 100% overrange capability with input impedance as high as 10 megohms per volt.

All three are better on the inside than the usual "economy" models, because they utilize dual slope* circuitry techniques developed by Weston, repairable (non-potted) circuit boards, and top-rated components throughout. Standard options include BCD output and remotely positioned decimal point.

But the best news of all is that Weston has broken the $100 price barrier on the world's foremost DPM line. Choose the ranges and the digits you need—2½, 3, or 3½. Model 1260 costs you only $79.50, Model 1261 is priced at $98.00, and our new Model 1291 at $99.75 in OEM quantities. How's that for value in these days of tight budgets?

*U.S. Pat. #3,051,939

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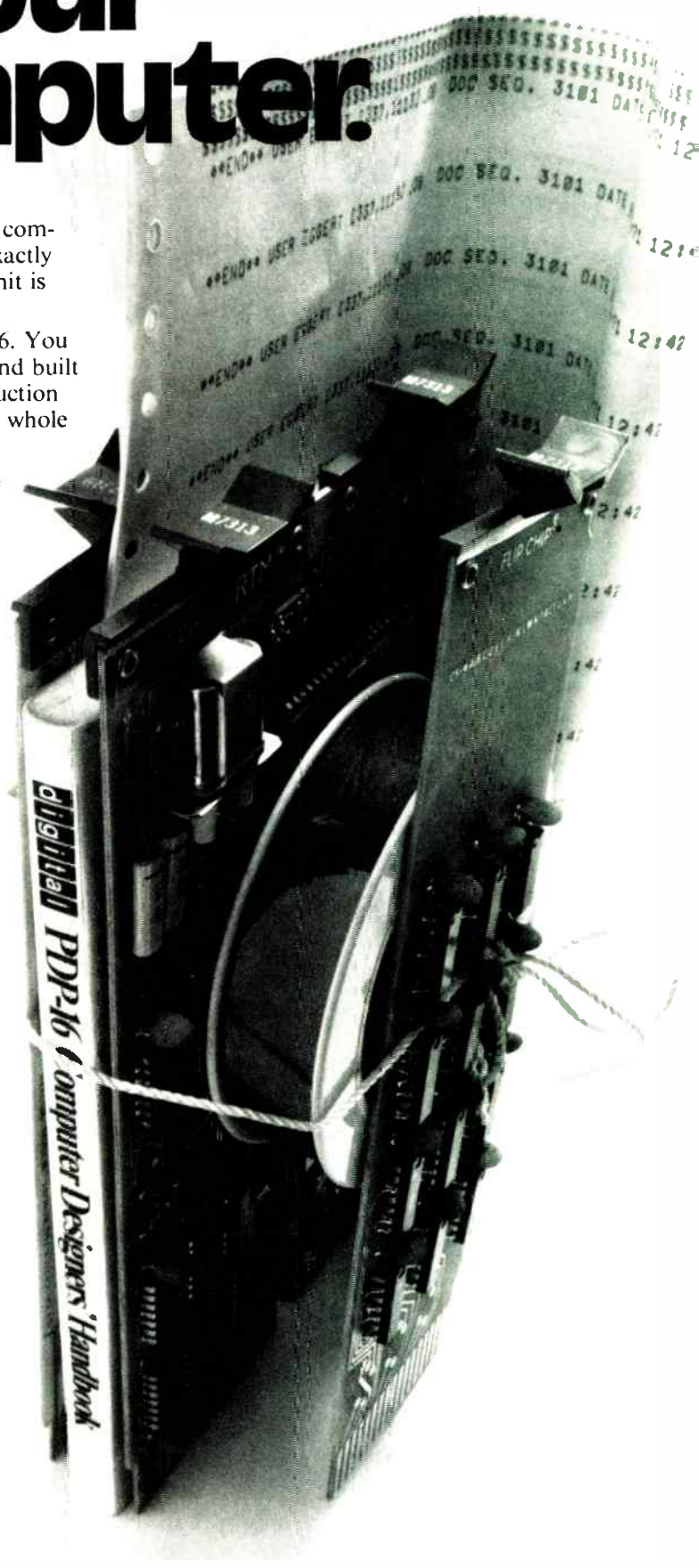
Design your own computer.



And have it working in two weeks.

The PDP-16 is the world's first completely functional computer. Each configuration is custom-designed to do exactly the job you want done. No extras. So the price per unit is remarkably low.

Until now, you had to come to us to get your PDP-16. You told us what you wanted it to do, then we designed and built a prototype. Thanks to the PDP-16's modular construction and Chartware, our computerized design method, the whole operation took only two weeks.

And you can still get your PDP-16 that way, for considerably less than you'd pay for a stripped mini. No software development, either.

But now, if you want, you can have a PDP-16 at an even lower price. Just how much lower depends on how involved you want to get in the design of your PDP-16.

For instance, you can have us design the PDP-16 you need, then you can build it yourself with our hardware.

Or you can design your own PDP-16 using Chartware, then build it yourself, too.

Or you can even take care of everything all by yourself—just disappear into your back room with the hardware and our new PDP-16 Computer Designers' Handbook. It'll take you only a few days to design and build your PDP-16.

How do you find out which way is best for you?

Well, if you're going to be at Wescon, stop by our booth. We'll have a full explanation (with prices) of the PDP-16 and how it's put together. And we'll give you a free PDP-16 Computer Designers' Handbook that'll tell you all about the PDP-16.

If you're not going to Wescon, give us a call or drop us a line, and we'll send you a handbook, absolutely free.

Digital Equipment Corporation, Main Street, Maynard, Mass. 01754, (617) 897-5111.

digital

Wescon focus: zoom in on '72

Wait till next year, the cry that rekindles the home-team spirit of baseball fans, will also echo through San Francisco's Brooks Hall/Civic Auditorium during the Western Electronic Show and Convention.

In the West, as elsewhere, 1971 has been a disappointing year. But many marketing managers see signs of an upswing in 1972, and the products they will introduce at Wescon 71 point up promising areas: ICs, particularly MOS; semiconductor memories; computer peripherals; and production and test equipment for complex digital modules.

In the pages that follow are some of the more significant products that will be presented at Wescon from Aug. 24 through 27.

Tester quickly pinpoints fault on complex pc card

The problem of effectively testing printed circuit cards looms larger as the number and complexity of the circuits increases. MSI and LSI circuits require multilayers of board interconnections, and this means denser boards with a greater probability of a solder bridge or a component failure.

According to Donald P. Allen, vice president and director of marketing at Trendar Automation Corp., a new West Coast company, "it can take upwards of 20 hours to find a fault" on one of the denser pc cards. A computer-controlled automatic pc card tester costs from $50,000 to $500,000, takes many days to program, and doesn't always cut the test time, he says. Dedicated test fixtures for specific cards can also cost $200,000 to $300,000 to build and, says Allen, don't shorten fault location time much more than the computer approach.

Trendar champions the general-purpose test station that employs the comparator method. The company's first product, the model 2000, offers typical fault location times of one to 15 minutes, and the system price ranges from $24,000 to about $45,000.

The comparator method is not new, but Trendar's coding scheme for fault detection is, Allen says. The 2000 employs a set of four pattern generators that are capable of exercising almost any type of logic

Across the board. Using the comparator technique and a new coding scheme, tester exercises a printed circuit board for go/no-go check and can also perform troubleshooting job.

← Circle 114 on reader service card

or memory function. Allen says that the "best way to test a circuit is a functional test since that is what is performed in end use. And the best way to simulate this is by applying every conceivable input pattern and sequence of patterns to both a known good circuit and the circuit under test, and then comparing the response." If a fault occurs, the test sequence stops in that logic condition. If production—go/no-go—testing is being performed, the operator just removes the card and goes on to the next. But if the operator is also performing troubleshooting, the exact location and nature of the failure can be traced.

For exercising the boards, the Trendar 2000 provides up to 128 signal sources—32 each of the four types: pseudo-gray code, binary code, 1-of-n generator, and the Trendar generator, which is the key development that enables the 2000 to test rapidly and thoroughly.

The Trendar generator produces an extremely diverse array of patterns and sequences suitable for driving combinatorial and clocked sequential logic. It is equally suitable for data or control, memory or logic functions.

The test procedure for any circuit consists of selecting the test rate and number of test. The voltages for marginal testing and current limit are usually set for a group of circuits. The test station automatically initializes all circuits—that is, it brings their internal states to the same condition. Up to 10 million tests are repeated in three sequences with voltages that are high, normal and low. Any output failing to correspond to the reference circuit is displayed with its reference (pin) number.

When a fault is detected, the test station fixes inputs in the fault-detected state. The operator notes the displayed fault's output pin number and traces the circuit paths of the test and reference modules with a display test probe. An optional built-in IC test capability speeds this process even further. Checking voltages at corresponding points, the operator notes the circuit states indicated by the probe. A component flow diagram simplifies circuit tracking.

When differences between modules' circuit states are detected, the operator traces back from that point to a point where the states are again identical. The fault lies between the two points, and can quickly be identified as a mechanical, component, or assembly defect.

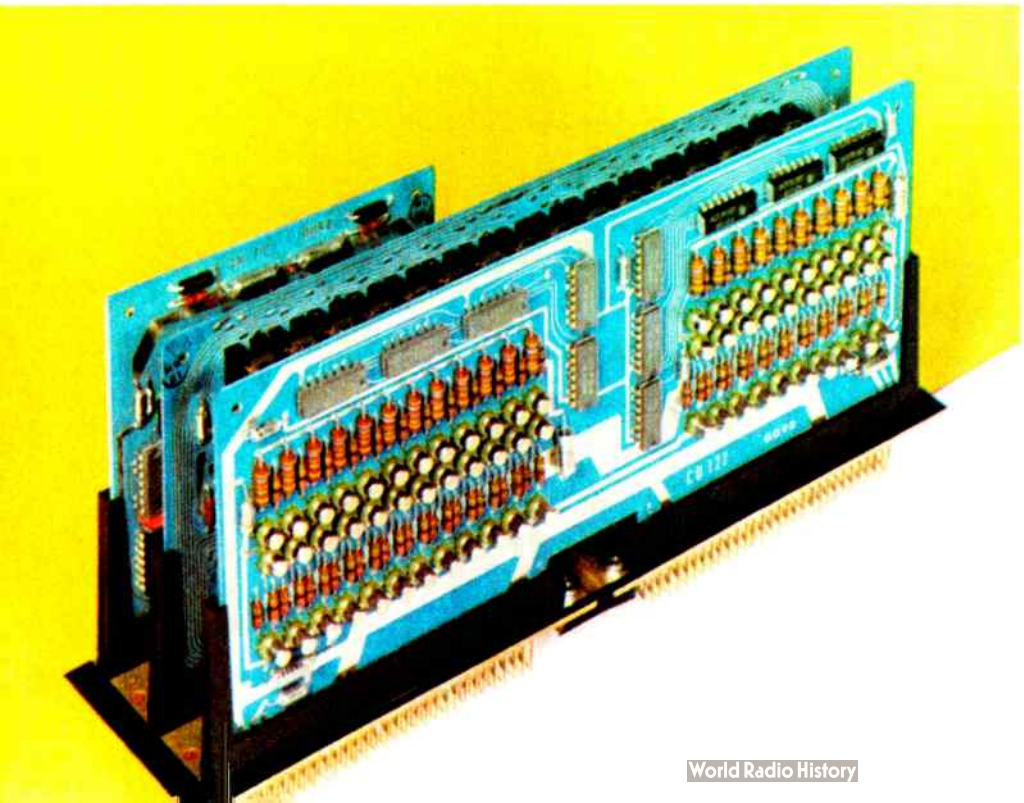
Trendar Automation Corp., 2560 Wyandotte St., Mountain View, Calif. 94040 [338]

RAM module permits 'off-shelf' systems

"In the memory systems supermarket business, you have to offer fast delivery as well as a good price," observes Bruce L. Billington, vice president of Standard Logic Inc. With cores, this means stocking a variety of stacks or planes. With semiconductors, it can be done by designing a basic module that is easily word-and bit-expandable.

Standard Logic's building block is the RAMM 4096, a random access MOS memory with 4,096 8-bit words, a cycle time of 550 nanoseconds and access time of 450 ns. The input/output section is structured like that of a core memory and has nondestructive readout. The refresh logic provides for automatic operation from the memory or from an external control source. The modular device uses three pc card types: (1) a timing and control, (2) a clock driver, and (3) a data board. The data board has a maximum capacity of 32,768 bits. The addition of data boards builds whatever size memory the customer wants—4k x 16, 4k x 32, and larger.

Memory building block. MOS random access memory systems can be built to desired word-bit configuration by adding data boards to 4,096-word, 8-bit module shown below.

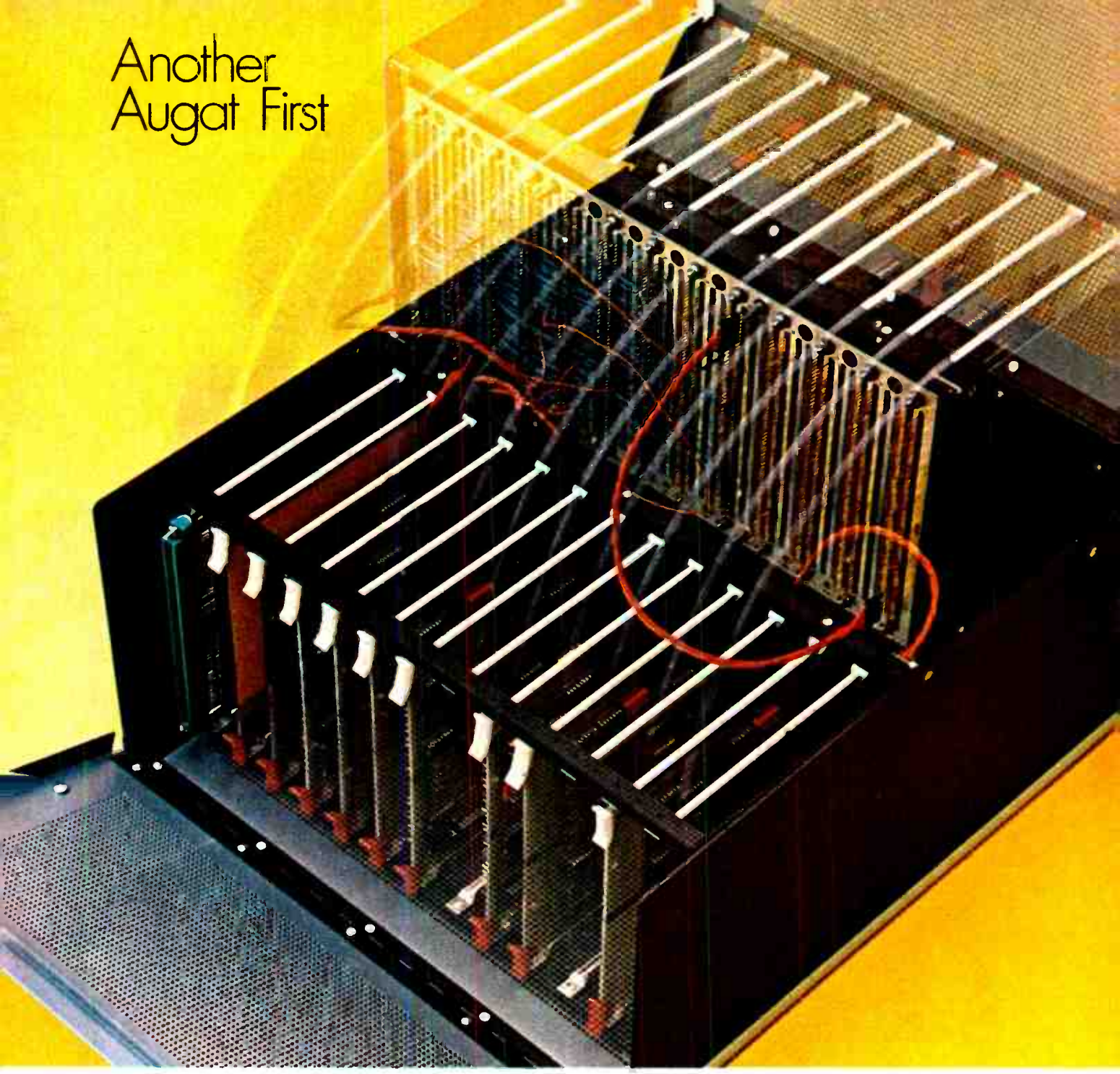


Approximate volume is 125 cu in. for a 4k x 16 RAMM, whereas a comparable core memory is 200 $in.^3$ Each memory size has a different power consumption, but a 4k x 8 RAMM requires 17 watts as opposed to 30-40 watts for a typical core memory.

The 4096 series connector backpanels are built on punched plates that are wire-wrapped on numerical control wiring machines, and the desired configuration can be obtained with the applicable tape.

Typical applications of the series

Another Augat First



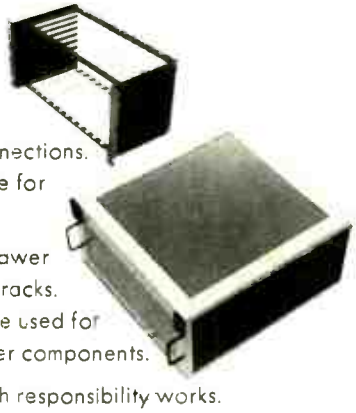
Booths 1632-1633 WESCON

Over and out!

Unique flip action of the rack in this new Augat enclosure permits direct and easy access to back plane. What's more, back panel can be quickly removed and adapted for automatic wrapping purposes. Rack assembly can be quickly removed . . . can be ordered separately.

It's the latest Augat development in high density IC packaging. New off-the-shelf standard rack assemblies and enclosures for our R Series panels. Another way you can save design time, space and money by ordering wire wrapped panels and mounting facilities from a single source.

Voltage and ground pins on back panel located for any desired inter connection. Large solder lug terminals provide for primary voltage and ground connections. New jumper assemblies available for connector pin take-offs.



Enclosure can be made into a drawer assembly for standard 19" relay racks. Rear portion of enclosure may be used for power supplies, blowers, or other components.

Let us show you how our in-depth responsibility works. Call us, (617) 222-2202 or write for new catalog 266. Augat, Inc. 30 Perry Avenue, Attleboro, Mass. 02703.

AUGAT INC.

lie in input/output data rate compensators such as disk memory buffers, data acquisition and logging systems, and display systems. The company is also aiming at medical instrumentation data storage, special purpose processors, and automatic test equipment.

Unit price for the 4k x 8 RAMM is $1,116; in 100-lots, $800. The 4k x 36 sells for $4,226; in 100-lots, $3,100. Delivery time for all models is 4-6 weeks.

Standard Logic Inc., 1630 S. Lyon St., Santa Ana, Calif., 92705 [339]

Graphics converter saves computer time

Busy. Converter includes multiplication function and saves computer power in graphic display applications.

Most graphic display terminals depend on an associated mainframe computer to generate, point by point, the lines that appear on their CRTs. Each point has specific X- and Y-axis coordinates, and curves are series of short straight lines. In displays with high resolution, the number of dots even in short lines can reach into the hundreds, straining mainframe and display-refresh memory capacity in the system.

A new digital-to-analog converter that is aimed squarely at the graphics market promises to cut computation time and memory usage. Hybrid Systems Corp., maker of the model 310-12, claims it is the first 12-bit d-a converter to combine submicrosecond settling time and multiplication in a single package.

Conventional converters use a fixed, often internal, voltage reference and vary their output in response to digital command. The length of the "word" is a measure of the converter's resolution—it's 12 bits with the 310-12. But the 310-12 also includes a multiplier which can accept varying voltages (from 0 to +6.2 volts) from external signal sources such as ramps, square waves, and sine waves. If a sawtooth wave is applied to the 310-12's external reference input, the unit's output is also a sawtooth, but attenuated to a level determined by the digital input word.

The unit thus uses two voltage references, one fixed and operating as an internal reference in pegging the X-Y position of the beginning of the line, and an external reference—from a ramp generator in most displays—for slope and length.

This relieves the mainframe of all tasks except the generation of the gross characteristics of the line to be drawn: into slope, length, and one end point. The elimination of point-by-point drawing means less has to be stored in refresh electronics.

Since the 310-12 includes the multiplication function, analog settling time is specified. It's less than 5 microseconds full scale. A faster version settles in 500 nanoseconds. Settling to 0.05% in the digital circuitry of the device takes 750 ns worst-case.

Full scale output current is 2 milliamps, and up to +1.25 volts is available at the output, making an amplifier unnecessary in many applications. Linearity is better than 0.0125% and drift with temperature is about 15 parts per million per degree centigrade.

Price of the model 310-12 in lots of one to nine is $150; delivery is from stock.

Hybrid Systems Corp., 95 Terrace Hall Ave., Burlington, Mass. 01803 [340]

Digital multimeter has liquid crystal display

MOS circuitry and a liquid crystal display reduce the price and power requirement for a digital multimeter developed by the North American Rockwell Corp.'s Electronics Group. The 3½-digit meter is believed to be the first instrument on the market to use a liquid crystal readout. The design includes digital techniques that eliminate precision components and permit most functions to be incorporated in a single MOS chip.

NR intends to sell the meter, not to end users, but to instrument manufacturers, either as a complete multimeter or as a meter movement.

The demonstration models use 21 dual in-line packages that will be replaced by an MOS chip in production models. NR plans to have its first MOS unit available in September or October, at a price well under $300. North American Microelectronics Co. makes the MOS chips and will market the meter. It will also market the liquid crystals.

The multimeter uses only 100 milliwatts. Included in the price estimate are a battery, binary-coded decimal output for an external printer, and automatic ranging. Ranges are: ac or dc from 1 to 1,000 volts full scale, 1,000 ohms to 1 megohm full scale, and dc current 1 milliamp to 1 amp full scale. Accuracies are: dc 0.1%, ac 0.1%, ohms 0.15%, and dc current 0.1%, all of full scale.

NR uses the dual slope integration approach in combination with digital servo feedback techniques. The unknown current and the reference

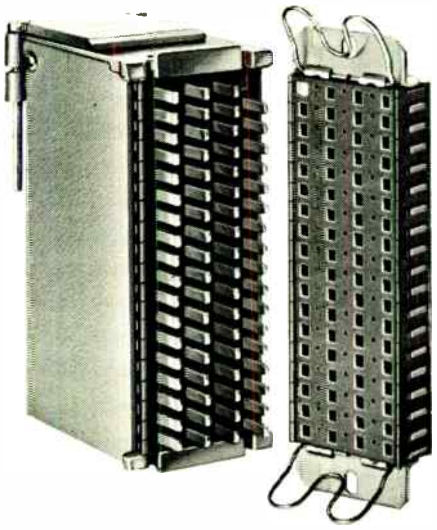
Plessey invites you to trade in a big pain for a little pleasure

Male, female, covered, uncovered, side cable entry, top cable entry, with locks, without locks, covers on male plugs, or covers on female sockets. Stocking up on all the varieties of rack and panel connectors that are necessary can give any company a real pain. The combinations begin to sound like chess possibilities.

It can be a real headache.

Well, as any "with it" up-to-date company knows, commonality in design, multiple use and miniaturization are the most efficient and successful methods of designing anything. And that is just what Plessey has done with their 159 series Rack and Panel Connectors.

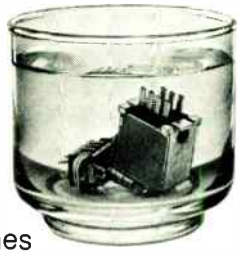
In less than the space that other companies have placed 33 contacts, Plessey has fit 71. And Plessey has 10 more sizes ranging downwards from 59, 55, 47, 35, 31, 23, 19, 15, and 11 to a tiny little 7/8" x 1 1/8" x 1 3/8" 7 contact connector. All much smaller than anyone else's equivalent connectors. Since smaller means less material used in manufacturing, these units are less expensive than others of similar capacity and elaboration.



Not satisfied just with this accomplishment, Plessey went on to design "commonality" into this series . . . creating a cover that can be used on plugs as well as sockets and can convert to either top or side cable entry. Where you formerly had to stock all types, you now only need one. Plessey covers can be ordered on male or female connectors or on both for a cable connection with no chassis mount at all. The covers are of rugged metal, PVC coated in and out, "short" resistant inside and "shock" resistant outside.

The 159 series can be ordered with or without their unique and very positive snap-on lock retainers, at less than the cost of other retaining devices. This retainer is a savings in labor over manually screwed together retainers while being more vibration-proof than spring clip retainers (which require a special notched cover and are even more stock to store).

To sum up, Plessey has a better made, smaller, lighter, more durable and more positive locking series of connectors than anyone else. And less expensive all up and down the line, with extras or without.



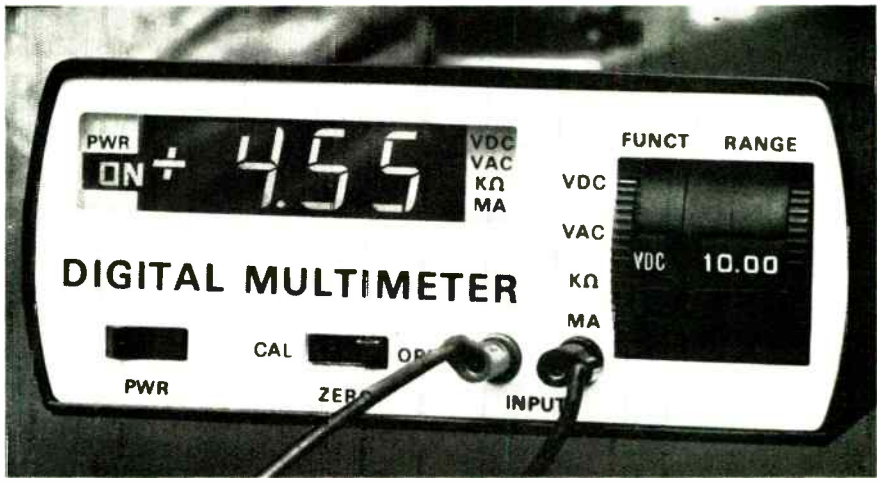
So the next time you feel one of those "stock up time" headaches coming on, reach for a Plessey series 159. For fast relief.

Further information and literature regarding these and other Plessey products may be obtained by contacting one of the representatives listed below.

PLESSEY INCORPORATED/CONNECTOR DIVISION
400 MORELAND ROAD/COMMACK, NEW YORK 11725
TELEPHONE: **(516) 543-5000** • TWX: **510-226-3744**

REPRESENTATIVES: *EASTERN*, PAUL D. AARON, Phone: (516) 767-2600 • B. and W. ASSOCIATES, Phone: (617) 275-9177 • BOWSER and SAPECKY, Phone: (716) 839-4170 JACK ONORE, Phone: (201) 355-0474 • WIRE-CONN CORP. Phone: (609) 234-0569 • *SOUTHERN*, KIRKWOOD ASSOCIATES, Phone: (813) 894-8240 • MURPHY and COTA, Phone: (919) 723-1001 *WESTERN*, RAY OVER SALES, Phone: (206) 454-4551 • ED LANOA CO. Phone: (213) 879-0770 • W. W. POSEY CO. Phone: (415) 948-7771 • *MIDWESTERN*, INLAND ASSOCIATES, Phone: (913) 362-2366 • R. C. NORDSTROM and CO. Phone: (313) 353-0210 • LGS ELECTRONICS CORP. Phone: (312) 622-8183 • S.A.R.G.E. INC. Phones: (312) 237-9525 • *SOUTHWESTERN*, AIO ELECTRONICS Phone: (214) 638-8015 • *CANADA*, BEN MANIS ASSOCIATES, Phone: (514) 336-4500 • WEBER SEMAD ELECTRONICS, LTD. Phone: (416) 635-9880

New products



New inside and out. In addition to use of a liquid crystal readout, digital multimeter includes design techniques that help to reduce both power requirements and price.

current are fed into either end of a 200-picofarad capacitor across a FET-input operational amplifier. The two currents are nulled by means of digital servo circuitry that adjusts the duty factor or pulse width of the known current, rather than the current amplitude. The fixed integration period of 3.4 milliseconds is determined by the fact that the MOS chip is operated at 1 megahertz. The reference current is fed in for the time necessary to obtain a null balance, while the unknown current goes in continuously. The ratio of on-off time for the known current is directly proportional to the unknown current.

The accumulated voltage in the capacitor represents the difference between the known and unknown currents. When discharged, it is compared with the voltage on the same phase in the previous period. Very small differences between the reference and unknown currents may be accumulated in the capacitor, making the meter more sensitive to differences.

North American Rockwell Electronics Group, 3370 Miraloma Ave., Anaheim, Calif., 92803 [487]

Artwork generator is fast, precise

Sales of integrated circuits are not exactly soaring in 1971, but California Computer Products senses an upturn. That's why it's aiming its new model 738 general-purpose flatbed plotter squarely at IC makers. The MOS outlook is particularly hopeful, says Dennis Bress, product manager for flatbed plotters at CalComp, and many small companies are getting into the business because it doesn't involve as heavy an investment as bipolar technology.

Ready for IC work. Flatbed plotter is shown equipped with an optical head for putting artwork directly on photographic film. It can be used to cut strippable film for ICs

From RCA... RF Tube/Cavity Combination for 1 kW VHF-TV Translator Service

The RCA-8792 Cermolox® Tube/Y1167 Cavity combination is available now from RCA—the industry's leading source for any RF tube/cavity combination from 1 to 25 kW!

8792/Y1167 provides 12 dB of gain with a third order intermodulation distortion product of greater than —50 dB at 1000 watts in VHF-TV translator service. Designed especially for such service, this compact combination can introduce as much as a 4-to-1 savings in plate dissipation alone. Think of the lowered operating costs per hour!

RCA-8792 is a tetrode that has surpassed the stringent linearity requirements while operating with less than the rated 1500 watts of plate dissipation—a performance unmatched by any equivalent tube on the market. The tube is equipped with an efficient, forced-air-cooled radiator which reduces blower noise problems and increases system efficiency. Its sturdy matrix cathode increases system reliability, too—a feature that is ideal for unattended locations.

Y1167 is a cathode-driven, double-tuned, coaxial cavity designed especially for use with the 8792. In translator service, the module amplifies both visual and aural signals.

For more information on RCA tube/cavity combinations, see your local RCA Representative or your RCA Industrial Tube Distributor. For technical data, write: RCA, Commercial Engineering, Section 70H16/ZR6, Harrison, N. J. 07029. International: RCA, Sunbury-on-Thames, U. K., or 2-4 rue du Lièvre, 1227 Geneva, Switzerland, or P. O. Box 112, Hong Kong.

RCA

New products

IC work requires precision and speed, and the company is guaranteeing the accuracy of the 738 at 0.004 inch anywhere over the 48-by-72-in. drafting area, plus repeatability at plus or minus 0.002 in. The plotter is calibrated by a laser interferometer, and in its service contract the company offers to recalibrate the machine to its original specification every six months. Maximum speed is 571 in. per minute, which CalComp says is 20% faster than that of the nearest competitor.

In IC work, the plotter may be equipped with a strippable film cutter to make masks, or—with an optical head—may plot artwork directly onto photographic film. It may also be used to plot printed circuits at 1× (actual scale at which the pc board will be manufactured). The same tape that is used to make a mask can be used with CalComp's model 937 magnetic tape unit to produce an ink drawing against which the mask may be checked.

The 738 has a more advanced mechanical design than the company's 718 and 728 models, making it faster and more accurate.

"As companies put more and more active elements on an IC mask, they will need greater and greater accuracy", says Bress. CalComp's model 745, introduced several months ago, operates at a maximum speed of only 180 in./min, but has guaranteed accuracy of plus or minus 0.001-in. over a 4-by-5-ft drafting area.

The model 738 sells for a base price of $58,600. The top price is $94,300, including $17,500 for a model 937 magnetic tape unit and $18,200 for the model 900 controller (a minicomputer). Software is included. The equipment may also be leased for from one to four years, the cost per month ranging from approximately 5% down to 2.75% of the base price.

The plotter will be in operation at Wescon at the beginning of an IC production line in which CalComp is participating with other companies as part of an educational program.

California Computer Products, 2411 W. La Palma Ave., Anaheim, Calif. 92801 [486]

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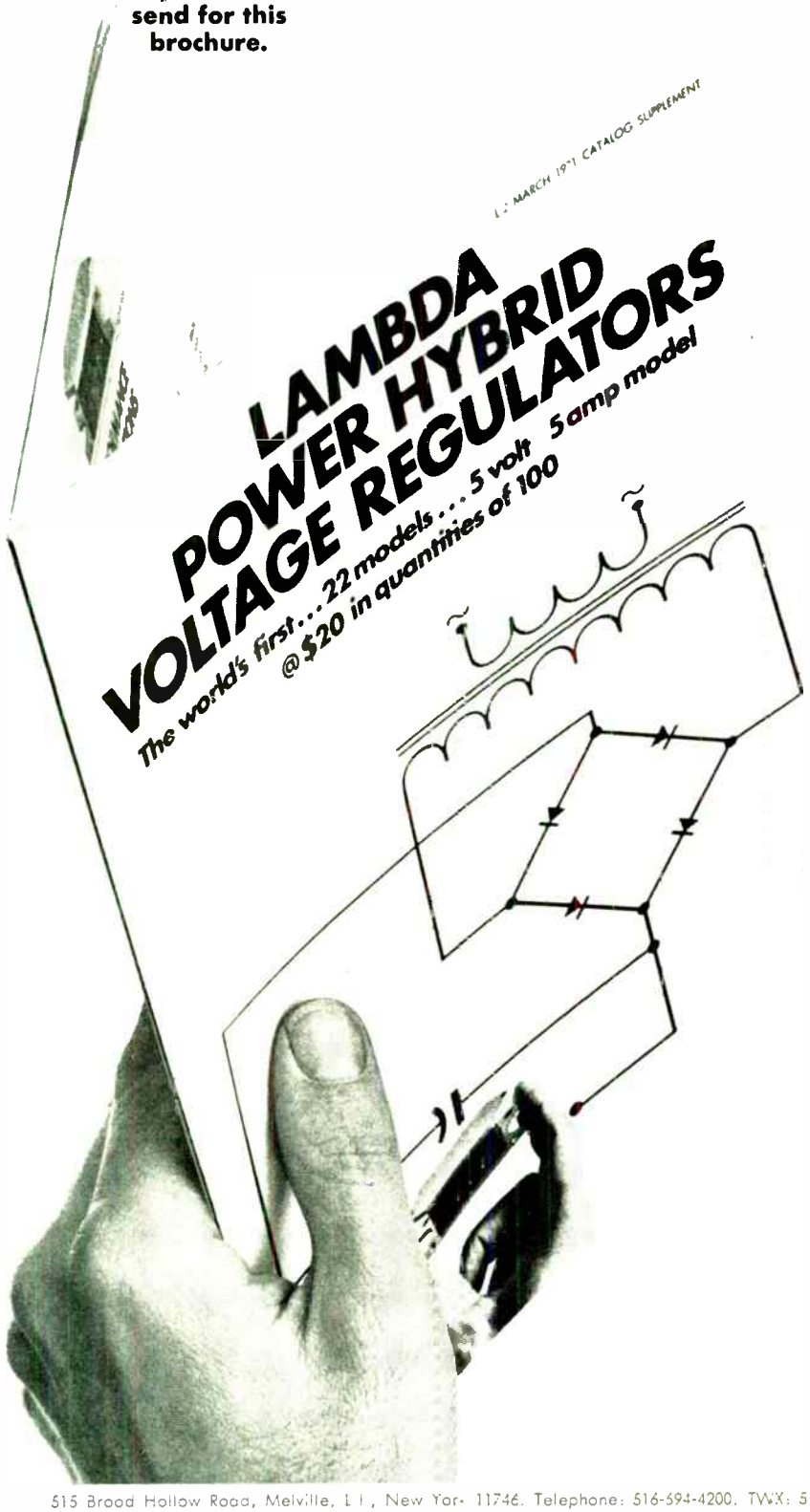

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Instruments

Heat sensing made precise

Curve-fit technique in digital thermometer widens range and gives high accuracy

Trading accuracy for range is standard operating procedure in the design of thermocouple readouts. But Newport Laboratories says it has achieved both high accuracy and wide range in its series 2600 digital

thermometers. The key development is a 58-segment approximation of a thermocouple's response curve provided by the instrument. Not only does this linearization give a high accuracy over the full range of a thermocouple but, because it is a digital method involving no drift, it adds to measurement stability.

The 58 line-segments on the approximation curve are "three times as many as are generally used," says Peter A. Turnquist, marketing vice president of Newport Laboratories. "With one model of the series, you can read the entire range of a thermocouple. You don't have to choose between buying several and degrading the accuracy of a single one." Price of the basic models in the series is $750, which Turnquist says "compares with a usual $1,800 to $2,200." In 100-lot quantities, the price is under $600.

The 2600 series accommodates standard types of thermocouples including J, K, T, S, R, and E. Each instrument is intended for a specific thermocouple type, and handles the entire useful range of that type. Changing the instrument for other ranges and types involves switching a few components.

Accuracy of the reading depends primarily on the thermocouple that is used. With a J-type, typical system accuracy is 0.5°C. Temperatures as high as 3,800°C are displayed, and changes as small as 0.1°C can be resolved.

The 2600s have a built-in technique for nulling junction errors and therefore enhancing accuracy. A thermistor circuit senses temperature at the junction box—where thermocouple wires are joined to the copper wires of the instrument input—and the instrument compensates for the thermocouple-like voltages induced there.

For reading the outputs of remote thermocouples, the junction box can be detached. One model 2600 can be shared by many thermocouples.

Noise attenuation is more than 10,000 to 1. The instrument is protected from overvoltages as high as 200 volts, and it has isolated BCD outputs. Power consumption is less than 20 watts.

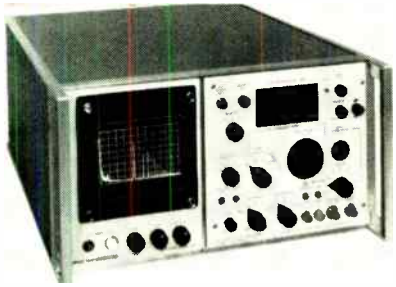
Newport Laboratories Inc., 630 E. Young St., Santa Ana, Calif. 92705 [359]

Mainframe rounds out line of spectrum analyzer plug-ins

Until now, Nelson-Ross Electronics has been content with turning oscilloscopes into spectrum analyzers. The company makes plug-ins that transform Tektronix and H-P scopes into complete analyzers.

Now the company, a division of Polarad, has decided to make the total instrument. "Although plug-ins permit a 50% to 75% savings," explains Polarad vice president for marketing Edward Feldman, "the biggest market still involves the complete package."

Nelson-Ross's analyzer is actually



a mainframe, the MF-9, which can take any of the company's 14 plug-ins. The MF-9 contains a cathode ray tube along with power supplies and controls. Price is $1,000.

Feldman points at the low prices for an MF-9 plus plug-in to justify his confidence in the company's ability to compete. The 235, which is the mainframe plus a PSA-235 plug-in, has a range of 1 kilohertz to 25 megahertz and sells for $2,600. Similar units, states Feldman, sell for over $4,000.

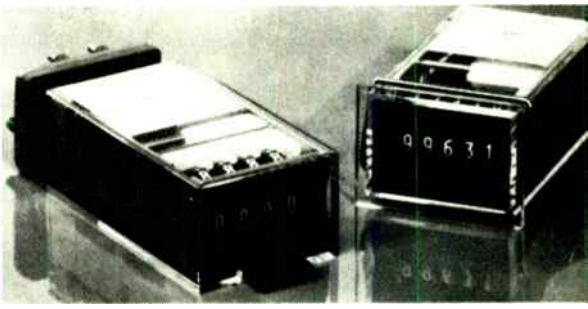
Prices are low, says Feldman, primarily because the plug-ins have been designed for specific applications: "If an engineer is doing vibration work, telemetry, or single-sideband design, he doesn't have to pay for a lot of extras."

The 14 Nelson-Ross analyzers cover a range from 10 hertz to 6.5 GHz. Prices go from $1,800, for each of three low-frequency units, to $4,200 for a telemetry unit.

Nelson-Ross Electronics Division, Polarad Electronics Corp., 5 Delaware Drive, Lake Success, N.Y. 11040 [360]

Instrument briefs

Impulse counters. Series of type RG devices with four or five digits have an operating life of 200 million counts and are rated for continuous



duty at 35 impulses per second. Three mounting styles are available: pc board, rapid spring-mount plug-in, and base mount. Price is $9 to $11 depending on quantity. Sodeco, a division of Landis and Gyr Inc., 4 Westchester Plaza, Elmsford, N.Y. 10523 [352]

Pulse generator. Model 360 has over 31 kW peak power at 1.5% duty factor. Output is continuously variable to 2,500 V. Applications include

New products

semiconductor testing, modulating microwave tubes, pulse testing magnetic devices, and ultrasonic experimentation. The unit is regulated for constant output independent of line voltage or duty factor changes. Current pulses are up to 750 A or voltage pulses up to 30 kV. Price is $4,990. Velonex, 560 Robert Ave., Santa Clara, Calif. 95050 [351]

Correlator. Real-time, 400-point probability analyzer model SAI-42 operates in three modes: correlation, probability, and signal enhancement. Incremental lag values in the auto-cross correlation mode

range from 1 μs to 1 s, providing time delays from 100 μs to 100 s. Price of the instrument is $7,800. Signal Analysis Industries Corp., 595 Old Willets Path, Hauppauge, N.Y. 11787 [354]

Voltage booster. Protection of equipment from malfunction or damage due to low line-voltage is provided by the Auto-Boost. When line voltage drops 7% or more, the unit automatically boosts it 10%. Price is $300 to $750 depending on rating. Microtran Inc., 145 E. Mineola Ave., Valley Stream, N.Y. 11582 [355]

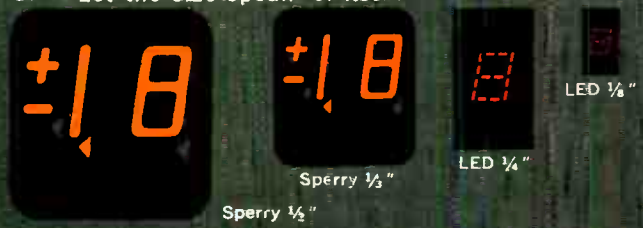
Sperry explodes the LED myth

There has been a lot said in recent months about LED's representing the most significant advance in display technology and how they are destined to dominate the digital display market. We feel it's time to explode the myth and set the record straight. So, here's a direct, point-by-point, comparison of Sperry seven segment gas discharge planar displays† vs LED displays.

COST

For the price of a single ¼" LED digit you can buy three ½" or three ⅓" Sperry display digits*. And, in the future, the Sperry displays should continue to be less expensive than LED displays. Gives you something to think about, doesn't it?

SIZE Let the size speak for itself.



READABILITY

Have you tried to read a ⅛" or even a ¼" LED display at 20'? On the other hand, the Sperry ⅓" display is easy to read at that distance and the ½" model can be read at up to 40'. See the difference?

COLOR

With LED's, you have the choice of red, red or red. Not so with Sperry. They come in an eye appealing orange — with amber and red available with filters. If you like red, why pay more for a LED?

APPEARANCE

Which do you prefer — looking at individual red dots on LED devices or at continuous unbroken Sperry figures. The choice is yours.

BRIGHTNESS

Sure you can read LED's indoors, but how about in bright light or direct sunlight? LED's fade fast while Sperry displays stay clearly legible with no appreciable loss in brightness. And, Sperry devices won't poop out when it gets hot!

Sperry advantages don't stop here either. The small Sperry package is only a shade larger than a LED and nearly as thin. Sperry power dissipation is also significantly lower. And, Sperry reliability is so good that they have proven fail-safe in stringent, high performance aircraft applications including the Boeing 747. There are no wire bonds to go bad, either. Don't just take our word for it. Arrange for a comparison demonstration and see for yourself what the difference will mean to your particular application.

For complete technical information on Sperry displays, use this publication's reader service card or phone or write:
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INFORMATION DISPLAYS

It's a whole new ball game in display devices!

† Patents pending

*based on 1,000 digit quantity, and above. Sperry displays are available in 3 digit, 2 digit, and 1½ (7 segment character and a 1 with + and −) digit models in both ⅓" and ½" sizes.

SPERRY RAND

Circle 127 on reader service card

Data handling

Vidicon stores data 15 minutes

Pickup tube accepts optical images or electrical input; delay length is variable

Millions of families could see the Apollo 15 astronauts walking and riding on the surface of the moon because—among many other electronic components—NASA Mission Control had imaging tubes that con-

verted the slow scan of the astronauts' camera to the U.S. and European broadcast rates.

A new tube developed by General Electrodynamics Corp. can perform this type of conversion, plus a few other operations that make it one of the most versatile pickup tubes on the market.

Called the Omnicon to indicate the variety of its applications, the nondestructive-readout, charge-storage tube can accept optical images or electrical signals and store them for 15 minutes or more. F.D. Jackson, director of marketing, points out that the Omnicon can stop motion and hold an image for transmission by slow scan TV, as over the telephone lines with their limited bandwidth. It can also capture transient phenomena, such as nonrepetitive scope traces, and hold them for analysis on a conventional TV or for recording on videotape.

The Omnicon's electrical input, which makes it useful for conversion from one scanning rate to another, can also provide variable-length delay for data applications. Another use is storage of alphanumeric or other data, to reduce the frequency at which it is necessary to update or refresh a remote computer display. If not scanned, the image can be held indefinitely by the tube.

Writing speed of the Omnicon depends on the light level, which is about half a foot-candle per second maximum. The tube performs integration so it can improve contrast in a static scene. Erasure takes about 0.5 s.

Two versions are available. The 2-inch TD1314-010 is similar externally to a standard 2-inch vidicon, and the 1-inch TD1362 is much like a conventional 1-inch vidicon. Both use standard magnetic focusing and deflection.

Even internally, the Omnicon is much like a conventional vidicon, except in the region just behind the target or collector. As the charge-storage layer, a photoconductor enables the Omnicon to accept optical and/or electrical input.

The storage layer is deposited on a mesh that is parallel to the field mesh and between the field mesh and the faceplate. The faceplate, which is coated on the inside with a transparent conductive layer, serves as the collector.

On reaching the photoconductor, the charge pattern, whether optical image or electrical signal, modulates the electron beam in proportion to the charge. The signal is taken off the target ring, or flange, as in a standard vidicon. Since the charge-storage layer is not a collector but only modulates the beam, the readout is nondestructive. The storage time achieved is determined by the operating potentials, with the limit set by the accumulation of dark current.

This accumulation can be partially offset by gradually decreasing the storage mesh voltage during the period of viewing, resulting in viewing times as long as 15 minutes.

The TD1362 is priced at $1,550 in unit quantity, and is available with 30-day delivery. The 1314 sells for $3,850. GEC also offers complete cameras using the Omnicons at $6,255 and $9,295, with deliveries of 90 days.

General Electrodynamics Corp., 4430 Forest Lane, Garland, Texas 75040 [369]

Data handling briefs

Graphic output system. Model 900 controller with up to 32,000 bytes of programable memory, model 937 magnetic tape unit, and model 1136 digital incremental drum plotter comprise a system that plots on a wide range of paper sizes. Several

inks and line widths are available. System can generate any alphanumeric character, line, or curve, and special fonts can also be produced. California Computer Products Inc., 2411 W. LaPalma Ave., Anaheim, Calif. 92801 [361]

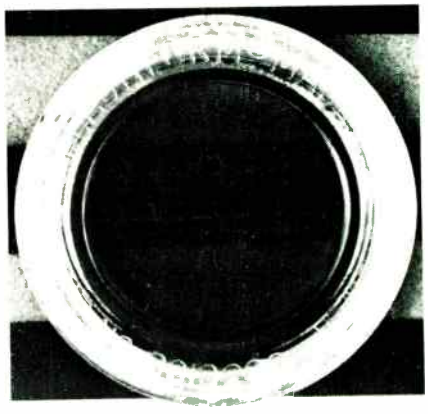
Terminals. Series called Tycom 35/37 consists of a Selectric typewriter equipped with a Tycom 150 baseplate, a logic translator, a data set or acoustic coupler, and an optional paper tape punch/reader. Models include keyboard and automatic send-receive, console send-receive. Price of keyboard send-re-

ceive model is $3,200. Terminal Equipment Corp., 750 Hamburg Turnpike, Pompton Lakes, N.J. 07442 [363]

Tape inspector. Observation of recorded signals without use of chemicals is made possible by a magnetic tape viewer called Plastiform. Oper-

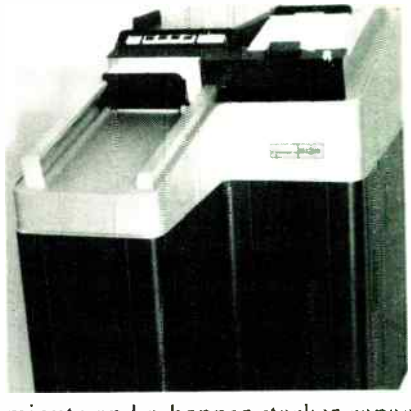
New products

ator can observe head alignment, track placement, pulse definition, interblock spacing, and dropout areas in computer and instrumentation applications. Plastiform can



also help determine, record, and reproduce problems in malfunctioning systems. Dielectric Materials and Systems Div., 3M Co., St. Paul, Minn. 55101 [365]

Card reader. Model M1200 for 80-column cards is designed for volume data input requirements, offers a reading speed of 1,000 cards per



minute and a hopper-stacker capacity of about 2,250 cards. Price is $7,800. Documation Inc., 841 E. New Haven Ave., Melbourne, Fla. 32901 [364]

Punch/reader. Portable model MSD 300 for paper tape offers switch-selectable speeds and editing capability, can be used with virtually any terminal for on-line transmission, off-line data preparation, and file storage. Send and receive speeds of 10, 15, and 30 characters per second are available to operator, with full-

Output Limit Indicator Light,
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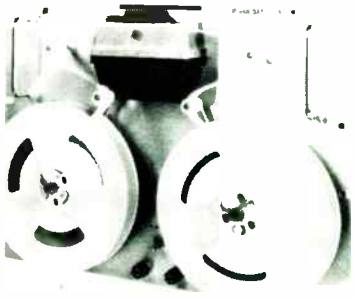
655443, 655419

Circle 131 on reader service card 131

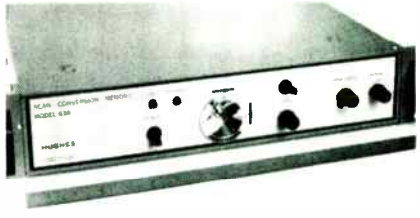
New products

and half-duplex modes. Automatic control using ASCII keyboard codes is optional. Mark-Space Devices Inc., 17835 Sky Park Circle, Irvine, Calif. 92664 [362]

Paper tape reader. Model N101 interfaces to Nova computers, operates at 50 characters/s. Price is $1,545 mounted on a customer-supplied interface board and $1,675 mounted on the company's board. Pivan Data Systems Inc., 6955 N. Hamlin Ave., Lincolnwood, Ill. [367]



Memory unit. Package, model 639, performs input/output signal conditioning control, scan conversion, and storage functions. It has its own circuitry, power supplies. Price is $4,000. OEM discounts available. Hughes Display Systems, Oceanside, Calif. 92054 [366]



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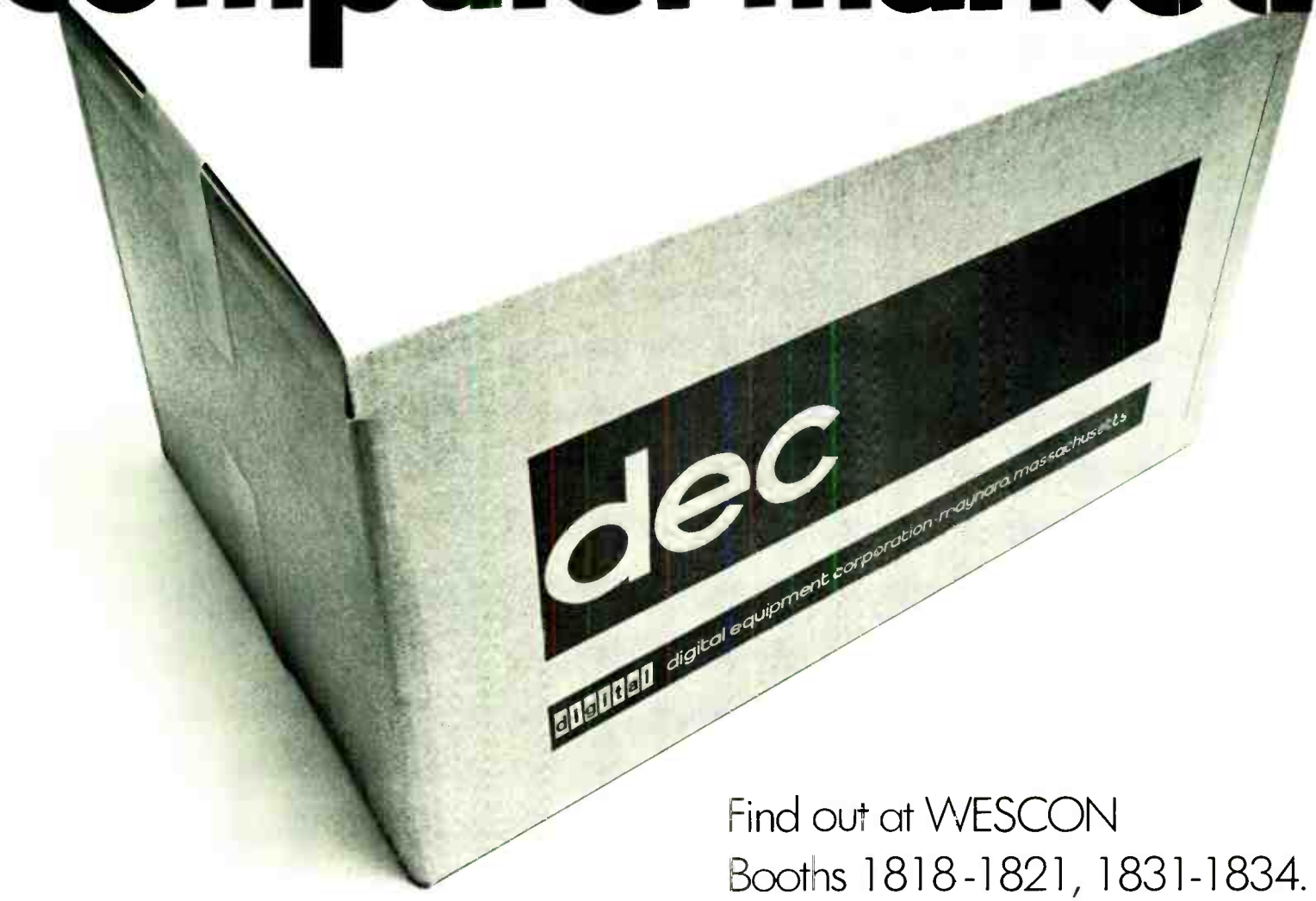
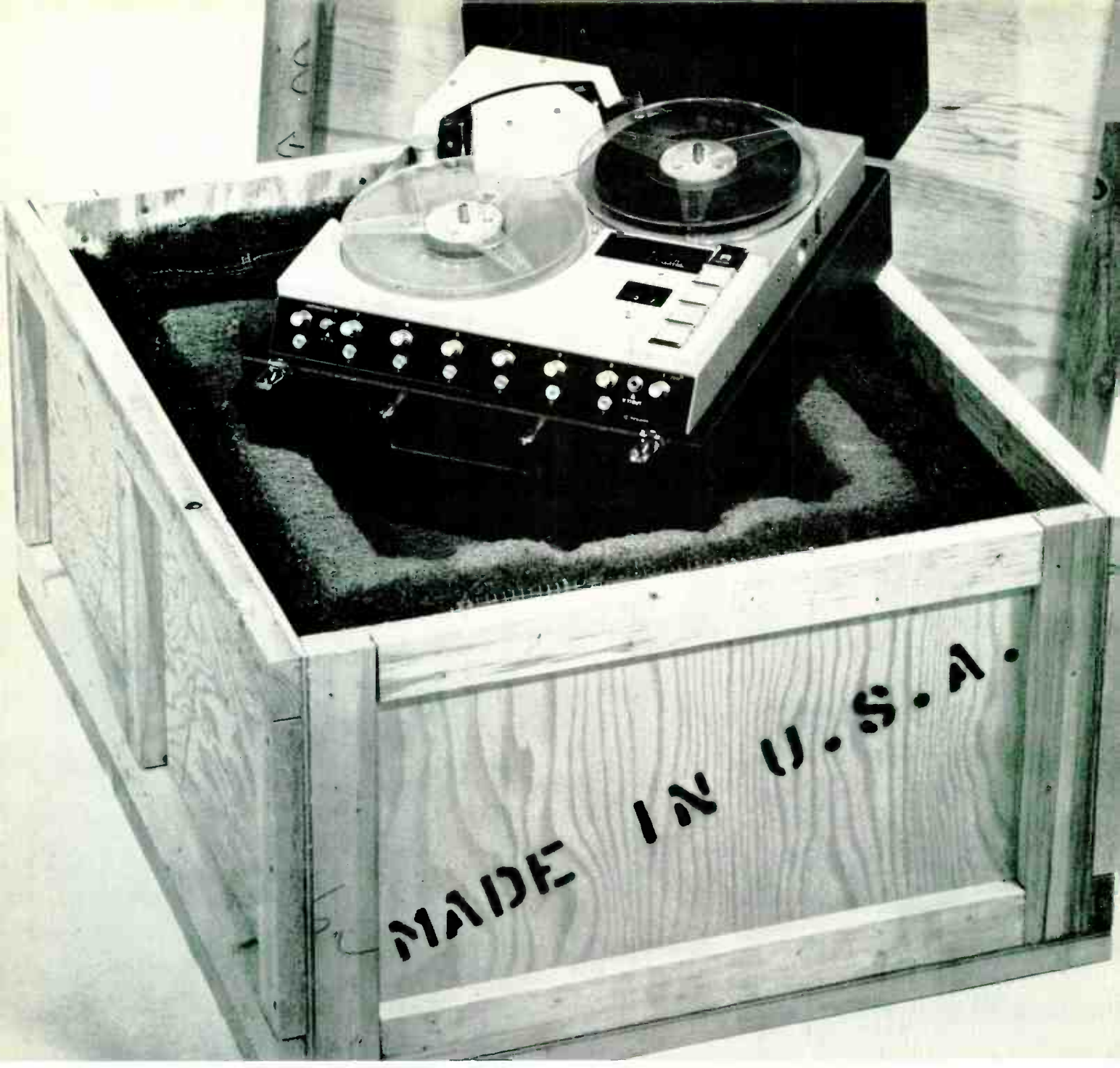


Find out at WESCON
Booths 1818-1821, 1831-1834.

Circle 133 on reader service card



The best data recorders in Japan.

They come from Lockheed.

Apparently the Japanese figure nobody makes data recorders that measure up to ours. Not even the Japanese.

Take the Lockheed 417 recorders used for precision data recording.

They're the only ones light enough to carry in one hand (28 lbs.), small enough to fit under an airplane seat (17" x 15" x 7"), and rugged enough to work under vibration and in any position. Yet they're as accurate as large, ungainly rack machines.

The 417s come in intermediate or wideband models. And they record on up to 7 channels simultaneously, IRIG compatible. Direct frequency response ranges from 100 Hz to 375 KHz. FM frequency response is DC to 100 KHz at 30 ips.

For power (normally 13w) a 417 can use its self-contained battery. Or, with accessories, it can use any power: 12 to 28v DC, 110 to 220v AC, 50 to 400 Hz.

The Japanese also picked one of our many custom-designed precision recorders to ride in their ionosphere research satellite. This particular recorder stores data at 565 bits per inch on 5 tracks, then plays it back at 26 times normal speed. Yet it weighs only 10 lbs. and gets by on 1/20 the power of a home tape recorder.

But for more down-to-earth uses, 417s are the answer. And back in the U.S.A. they go for as little as $7,000.

For more specs on any of our family of data recorders, write Bob Mei, Dept. 413-10, Lockheed Electronics Company, Plainfield, New Jersey 07061. Or call him at (201) 757-1600.

Lockheed Electronics

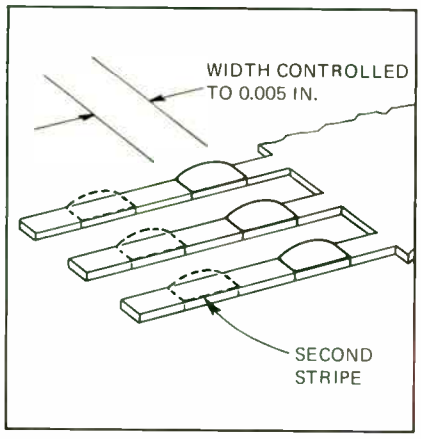
A Subsidiary of Lockheed Aircraft Corporation

Circle 134 on reader service card

Packaging and production

Solder process is selective

Production-line technique deposits stripe on wiring tail before terminals are shipped



Putting a deposit of solder on a wiring tail in order to hold it in a plated-through hole is not new—but doing it precisely and economically in volume production is. And that's what engineers at Amp Inc., have accomplished with a new process.

The solder, they say, gives a good bond between tail and pc board without interfering with the sharp corners needed on the tail for wrapped wire or for Amp's own Termi-Point connections. The tails, which can be produced with any type socket or connector terminal on the other end, will each cost from three- to four-tenths of a cent more than comparable tails without the solder, or about $3 to $4 more per thousand.

The thickness of the solder deposition can be controlled to within 1 mil, and the width can be controlled to within 5 mils.

The terminals are installed on a board by being taken off the strip in which they are shipped, inserted in the plated-through holes, and then held straight with a template. To reflow the solder and form the bond, the assembly is dipped in hot liquid (polyethylene glycol, which is water soluble, easy to clean, and said to work well). The terminals could also be reflowed with infrared or hot air, but the company says the liquid-dip method has worked best up to now. The new method is also claimed to be much faster and cheaper than hand soldering of posts. Solder preforms, another alternative, can cause later difficulties if they don't wick up into the plated-through hole to complete the bond.

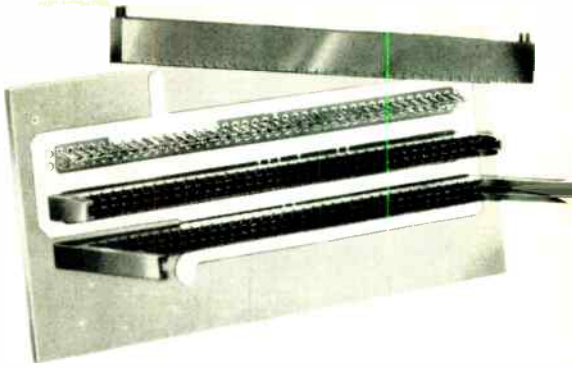
Amp can supply the deposit on any of the terminals they now commonly sell in strip form. The other end of the tails, for example, might have contacts to form edge-board connectors, or small spring sockets for dual in-line package insertion. The deposits made on the spring sockets are a good example of the degree of control of the placement of the solder band: the solder just about touches the socket but doesn't flow beyond a certain point and interfere with the movable member of the socket.

More than one stripe of solder can be deposited on a tail. This would be useful in back-plane wiring, where the first stripe would hold the terminal in the board. Then, once a group of wires wrapped to the tails were fixed in design, the group could be converted to a second pc board, and another stripe of solder added to the tail to hold this second board. In this way, the back-plane wiring would be converted to pc board format in stages, stacking up the boards on the tails, rather than in one single step. This would free designers from having to wait till all back-plane wiring was debugged before switching from point-to-point wiring to the more economical pc board.

Amp Inc., Harrisburg, Pa. 17105 [399]

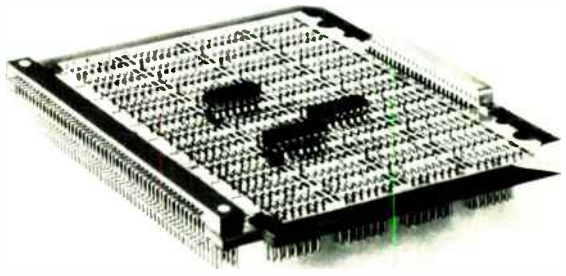
Production briefs

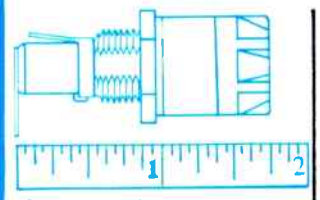
Card edge connector. The model 6317 requires no soldering; it press-fits into plated-through holes on pc card back panels. Contacts are connected to the printed wiring on the panel and have solderless wrap tails, so wire wrapping can accommodate additional connections. Other features include 0.125 by 0.125 in. contact spacing, working current of 5 A, and contact resistances of 7 milliohms between card and back panel and of 5 milliohms between contact and back panel. Elco Corp., Maryland Rd. & Computer Ave., Willow Grove, Pa. 19090 [391]



Heat sink chassis. Series 3000 reduces the cost in power supply design by eliminating sheet metal work. The three-sided unit requires fabrication of end and top plates only. Facing sides are slotted for housing pc cards. WEI Corp., 2140 S. Santa Fe St., P.O. Box 10577, Santa Ana, Calif. 92711 [393]

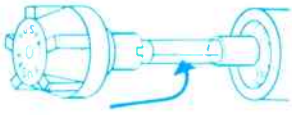
Socket contact. High packaging density and quick connect/disconnect are featured in unit that has a height of 0.025 in. above the pc board. Contact design allows short IC lead lengths to 0.035 in. below the device, and it contacts on about 60% of lead perimeters. One-piece contact/terminal is made of





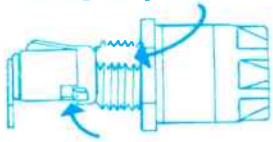
Space-saving size: projects only one inch behind panel, only 1-25/32 inches overall length

Easy-grip bayonet-type knob—sturdy compression spring assures good contact

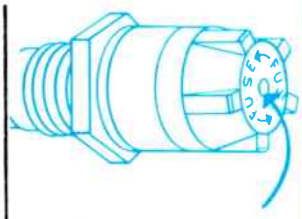


Knob grips fuse so that fuse is withdrawn when knob is removed

Made for installation in D-hole to prevent turning in panel



Terminals are mechanically secured in holder as well as soldered



Knob has break-out hole to allow use of test probe

BUSS HTA FUSEHOLDER

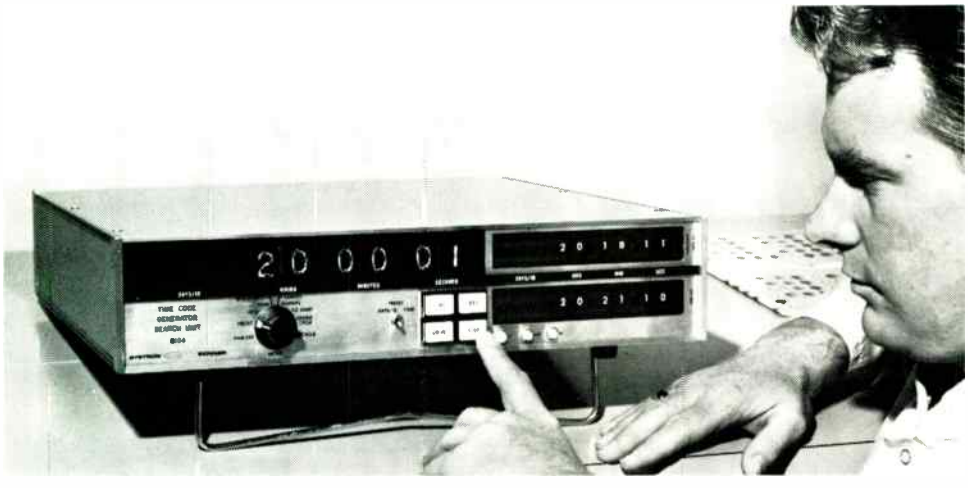
FOR ¼ x 1¼ INCH FUSES

Rated for 15 amps at any voltage up to 250. Dielectrically capable of withstanding 1500 volts A.C. between terminals and between terminal and panel.

Space Saver!

only a BUSS fuseholder could have....

Is it a time code generator? Reader? Tape search unit?



No. It's all three!

Systron-Donner's new Model 8154 is a **complete** time code generator and tape search system, compactly combined into one 3½" high instrument. Savings in packaging costs—without sacrifice of desirable features—results in a delightfully low price of $3,500 complete. Now, what will the Model 8154 do?

As a time code **generator,** the standard Model 8154 generates a modified IRIG B format in BCD hours, minutes and seconds. As a time code **reader,** the unit decodes the incoming code during data playback in both forward and reverse directions. Used for tape **search** and **control,** Model 8154 accepts a serial time code input, searches the recorded data, and controls the tape transport during a preset time interval.

The 8154's wide range input makes it compatible with almost any analog-recording equipment. Options include: parallel BCD outputs; 11-position bandpass filters for both playback and search speeds; slow code rates for graphic recording or visual display; and switch selectable IRIG A or B codes.

For full details contact: Concord Instruments Division, 888 Galindo St., Concord, CA 94520. Phone (415) 682-6161.

SYSTRON DONNER

See us at Wescon Booths 1005-08 and 1050-53.

Circle 162 on reader service card

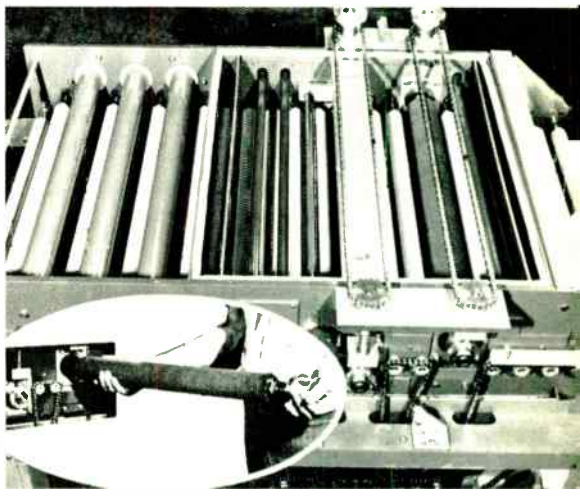
beryllium copper with 0.0001 in. nickel under gold plate. Robinson Nugent Inc., 800 E. 8th St., New Albany, Indiana 47150 [394]

Deposition fixtures. Step coverage of substrates by vacuum deposition is provided by a satellite and sweep planet system. The satellite handles 27 2-inch substrates in an 18-in. bell jar or 45 2-in. substrates in a 24-in. bell jar. Unit operates at 40 or 60°F. It is interchangeable with standard planets and can be used on the same 18- or 24-in. planetary workholder. E.T. Equipments Inc., 2 Alfred Lane, Kings Park, N.Y. 11754 [392]

Connectors. Rf coaxial units designated Kwik-Konnect feature a lock ring that lets the connectors lock when they are pushed together. Mated connectors are disengaged by pulling on their knurled collars, instead of on associated cabling. VSWR is 1.20:1 from dc to 12.4 GHz, 1.30:1 from 12 GHz to 18.0 GHz. Impedance is 50 ohms. Voltage rating is 400 v rms at sea level. Prices range from $2 to $7 each. Sealectro Corp., Mamaroneck, N.Y. [396]

Components insertion system. Computer controlled unit called Dyna/Pert model DIP-A/K1 is designed to place intermixed 14- and 16-lead dual in-line packages into printed circuit boards. It can select any of 20 different types of DIPs, position the board to receive the components, straighten the leads, insert the DIP, and clinch the leads at a rate of up to 4,000 components an hour. USM Corp., Machinery Div., 140 Federal St., Boston, Mass. 02107 [397]

Scrubber-drier. Three-stage system automatically cleans pc boards measuring 4¾ by 4¾ in. minimum up to a 24-in. width and any length. Thickness range for precision brushing is 0.250 in. to 0.010 in. No external air supply is needed for the drying chamber, which includes filters to keep out minute impurities. Applications include cleaning prior to resist-coating of copper plating and after resist removal. Chemcut Corp., 500 Science Park, State College, Pa. 15801 [395]



SGS offer the real alternative to relays

Their excellent noise immunity and unusually high fan-out allow them to be used in conjunction with, in competition with, or in place of traditional electromechanical elements.

High level logic family

Noise immunity: 5V
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Fan-Out: 25 (worst case)
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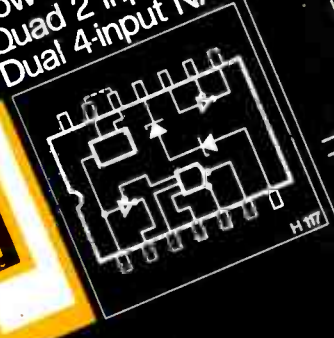
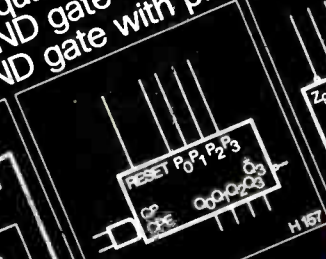
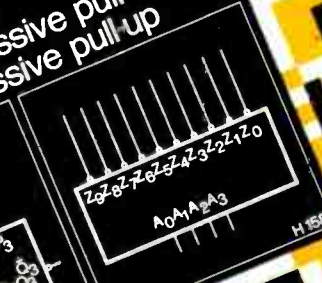
Low price
Immediate delivery

And now available from Singapore

H 117 One shot multivibrator
H 157 Decade counter
H 158 BCD to decimal decoder driver
H 102 Quad 2-input NAND gate
H 103 Triple 3-input NAND gate
H 104 Dual 4-input NAND gate with expander inputs
H 109 Dual 4-input AND power gate with expander inputs
H 110 Dual J-K flip-flop with asynchronous set input
H 111 Dual J-K flip-flop with asynchronous and clear
H 113 High to low level quad converter
H 114 Low to high level quad converter
H 122 Quad 2 input NAND gate with passive pull-up
H 124 Dual 4-input NAND gate with passive pull-up







Patent Pending Design Novato

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Circle 138 on reader service card

Semiconductors

Process boosts C/MOS specs

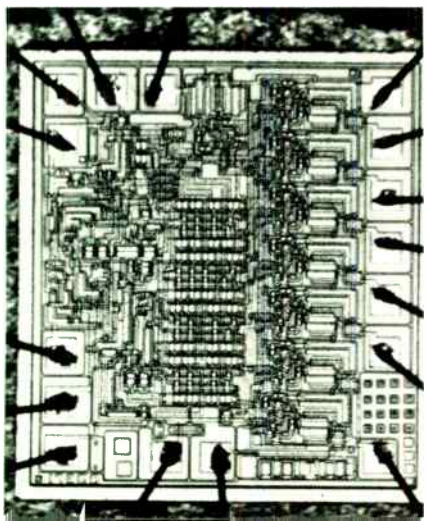
Dielectric isolation produces high speed, low leakage in 8-channel analog multiplexer

It's hard enough to put a p-channel and an n-channel device on the same substrate, so most makers of complementary MOS circuits have stuck with conventional isolation techniques—even though dielectric isolation promised higher speed and lower power dissipation.

Harris Semiconductor took advantage of both C/MOS design and dielectric isolation in two eight-channel analog multiplexers, the first in a new product line.

The merging of C/MOS and dielectric isolation provides a tenfold reduction in the junction area, resulting in a lower junction capacitance and therefore lower leakage currents and higher switching speeds. In addition, the multiplexers—the HI-1818 and HI-1828—provide optimum performance over the full military range of −55 C to +125 C. (Most standard MOS devices of this type cannot do this.)

The multiplexer measures only 64 by 59 square mils. Since about 60% of this area is available for active devices, greater packaging densities are possible than with comparable standard C/MOS or p-junction MOS devices. The greater density translates into increased economy per chip and more flexibility in circuit design. And by incorporating a parallel n- and p-channel switching arrangement, the design maintains an almost constant level of resistance, despite continual variations in the analog voltages.



Both commercial and military versions of these analog multiplexers are available in two configurations—eight switches with one common output for one-of-eight selection (HI-1818) and two banks of four switches each, with each group having its own common output for "two-of-eight" selection (HI-1828).

Other features are: off-state leakage current of only 10 picoamperes at 25 C and 1 nanoampere at 125 C; operating power dissipation of only 5 milliwats; access time of 250 nanoseconds; an analog signal range of plus or minus 5 volts, and a 250-ohm on-resistance.

Compatible with DTL/TTL systems, these devices are particularly applicable to pulse amplitude modulation (PAM) and pulse code modulation (PCM) telemetry systems, guidance systems, process control systems, and others utilizing analog multiplexing. They are also exceptionally well suited for a-d and d-a converters, functional generators, choppers, sample and hold circuits, and analog cross-point circuits.

Prices for 100 to 999 quantities are $29.95 for either type covering the 0 C to +75 C range, and $39.95 for either one covering the full military temperature range.

Harris Semiconductor, a division of Harris-Intertype Corp., Melbourne, Fla. 32901 [419]

FET's input noise voltage is only 0.6 μV over wide range

Because of their high input impedances, field effect transistors are first choice for instrumentation inputs, professional microphone amplifiers, and phonograph and tape playback amplifiers—applications needing a broader dynamic range than most bipolar transistors offer, and where minimum loading of the source is a necessity. But even the best FETs sometimes are noisier or have less gain than desired.

With this in mind, Crystalonics has developed the C413N ultra-ultra-low-noise FET. Crystalonics already carries "ultra-low-noise" FETs in its catalog. The reason for the added "ultra" is the C413N's input noise voltage specification. Total e_n is only 0.6 microvolt rms over a 10-hertz to 20-kilohertz range.

A maker of recording tape has begun using the FETs in conjunction with specially developed tape heads to determine the absolute residual noise on magnetic tape—a demanding application since new magnetic materials are constantly being developed which combine reduced noise with increased audio output.

Crystalonics' marketing manager, Joel Cohen, says it is "a pity" the n-channel devices cost $35 each; he would like to see them used in cassette players "plagued by high noise", and even Dolby-equipped reel-to-reel home equipment could be improved with the C413N.

While cutting noise, Crystalonics has managed to achieve increased transconductance in its new FETs: typically about 40,000 micromhos versus the 600 micromhos of earlier low-noise FETs. Minimum G_m for the new unit is 25,000, assuring a voltage gain of 25 with a 1-kilohm drain load; the 40,000 typical transconductance means a typically higher gain as well—about 40.

Other characteristics of the C413N include output power derating factor of 2.3 milliwatts per degree C—an almost flat temperature coefficient. Gate leakage current at normally encountered ambient temperatures is only 3.0 nanoamperes, and pinch-off comes at a low 1.5 volts typical.

Delivery is from stock.

Crystalonics, a Teledyne Co., 147 Sherman St., Cambridge, Mass. 02140 [420]

Semiconductor briefs

Optical memory. ROM model 401-22 uses fiber optics rather than a lens and requires a mask preparation technique that does not need peripheral maskmaking equipment. Other features include user programability and alterability. Unit is transistor-transistor logic compa-

New products

tible, has an access time of 150 to 200 nanoseconds. Quadri Corp., 2950 Fairmont, Phoenix, Arizona 85017 [416]

Mixer/modulators. Models LSI1496 and LSI1596 double-balanced devices operate up to 175 MHz, offer low power drain and high internal carrier suppression, typically 65 dB. Operating temperature of the 1496 is from 0 to 70 C; the 1596, −55 to +125 C. DIP and TO-100 packages are available. Price of the 1596 in 100-999 quantities is $4.80. Delivery is from stock. Lithic Systems Inc., 10010 Imperial Ave., Cupertino, Calif. 95014 [413]

Circuit package. Forty-lead MOS/LSI DIP is designed for low-cost, hermetically sealed semiconductor devices, and offers a unitary lead frame for uniform lead centering and spacing.

No brazed leads or brazed intermetallics are necessary. The package is constructed of alumina ceramic, crystalline glass, metals, and thick film. Owens-Illinois Electronics Materials Group, P.O. Box 1035, Toledo, Ohio 43601 [412]

Image sensor. A 64-element self-scanning optical array, model RL 64, is designed for facsimile and process control applications, optical character recognition, and pattern recognition. The diodes operate in the charge storage mode, permitting use of low illumination levels, and are spaced on 2-mil centers with inte-

How to get the RF transistor they said couldn't be designed, designed.

Gentlemen:
I need a custom transistor to meet the following specifications:

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Volts_____ Anticipated quantity_____
Additional Comments_____

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A-28	30-80MHz	3, 25 & 70W	28V
B-8	175MHz	2 & 5W	8V
B-12	175MHz	3, 25, 40 & 70W	12V
B-28	175MHz	3, 25, 40 & 70W	28V
C-8	470MHz	2 & 5W	8V
C-12	470MHz	3, 12, 25 & 40W	12V
C-28	400MHz	3, 12, 25 & 40W	28V
D-28	1GHz	3, 10 & 20W	28V

CTC's standard products: A guide to our capabilities; but hardly the limits.

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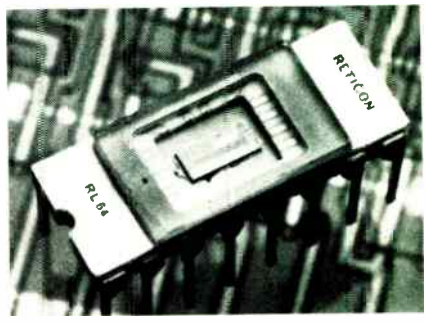
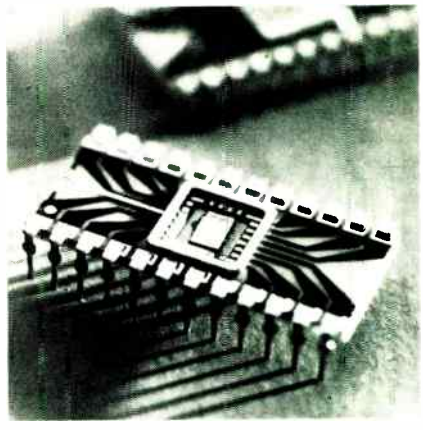
New products



grated shift counters, driver, and video preamplifier circuitry. Price is $150 in OEM quantities. Reticon Corp., 365 Middlefield Rd., Mountain View, Calif. 94040 [411]

Infrared lamps. Models SSL-54, 55B, and 55C have typical ratings of 1.0 mW, 5.2 mW, and 6.7 mW respectively. The three lens-end TO-46 packages are suited for use in mark-sensing applications, since the narrow beam of the gallium arsenside diodes contains about 50% of the total IR energy produced. Prices in 1,000 quantities are $1.21, $2.25, and $2.52 each respectively. General Electric Co., Nela Park, Cleveland, Ohio 44112 [414]

Bipolar ROMs. Two models feature integration of the output data register into the memory element, thus eliminating the need for eight external latches. The 8205 is organized 512 by 8; the 8204, 256 by 8. Both



have a typical access time of 35 ns, and are available in 24-pin packages. Standard code converter patterns are available. In 100 quantities, the 8204 is priced at $16.40 each; the 8205, $29.50. Signetics Memory Systems, 740 Kifer Rd., Sunnyvale, Calif. 94086 [415]

New books

Future Developments in Telecommunications, James Martin, Prentice-Hall Inc., 413 pp., $14.00

James Martin takes off from 13 inventions that will have a shattering impact on society because of their effect on telecommunications. He views technology in a social context: an increase in crime demands better security systems; international data bank networks influence the manufacture of products. What Marshall McLuhan merely generalized about, he pinpoints in his description of how communications may be expected to develop from the early 1970s through the late 1990s.

His book is accurate enough for the engineer, yet readable enough for the nontechnical audience. It deals mainly with telephone and computer communication systems, but also includes CATV, the specialized common carriers, and land-mobile and military systems. Martin can explain the tradeoffs between analog and digital systems, time and space division multiplexing, and at the same time relate this technology to economics and the broader aspects of communication between people.

His approach is realistic—rooted in what can happen—yet imaginative enough to encompass how advances in molecular biology may affect electronics, how entertainment may be changed by wall screens and 3-d video, and how computer programing may become a test of "literacy."

Modern Data Communication, Concepts, Language, and Media, William P. Davenport, Hayden Book Co., 200 pp., $7.95

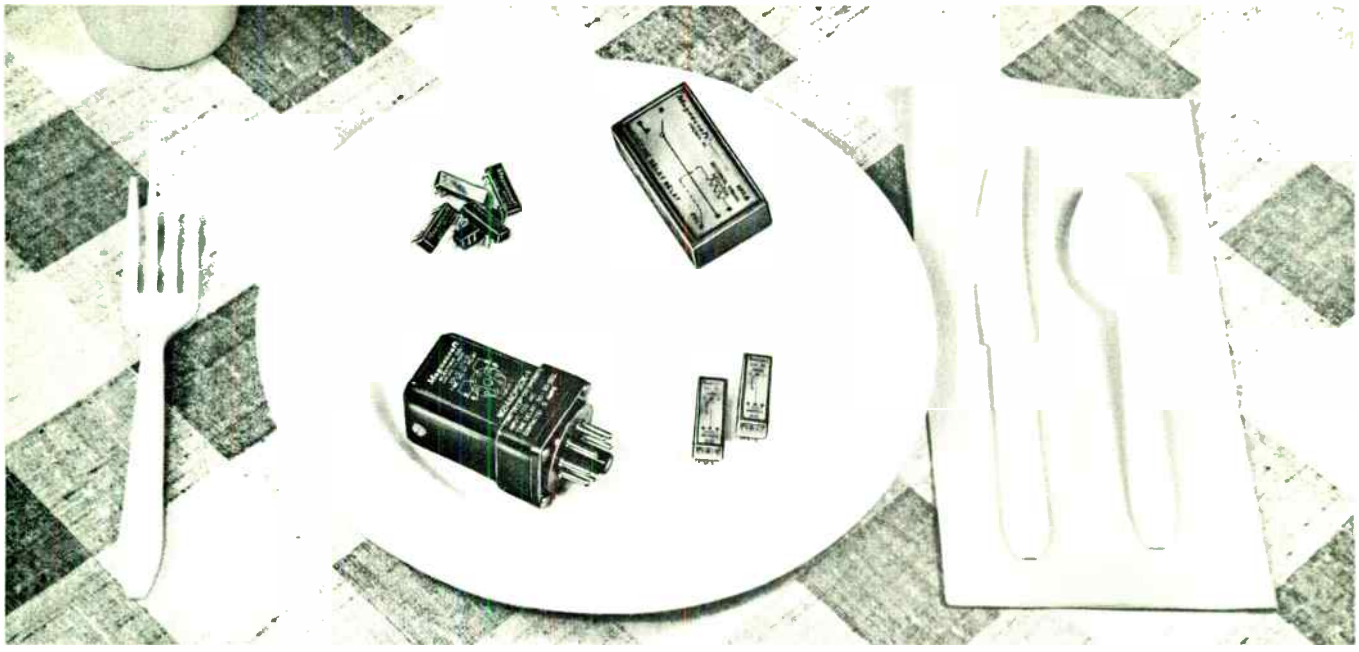
If you want to be up to data communication without really trying, this is the book to go with. Without getting into any complicated mathematics, Davenport provides the background needed to understand what has happened in the field and what factors must be considered in designing data communication subsystems and components.

The book is for the engineer who is not a specialist in data communication and for engineering managers who need a "talking" familiarity with the overall field. How do you know if you're a specialist? If you can give four factors that affect the efficiency of a communication system, describe three error-correction codes, and define ASR KSR, RO, and TSC, then you probably are.

The author answers many general questions and yet does not get bogged down with specific problems. He explains the broad aspects of Nyquist and Shannon theory so a reader can gain an insight into the theoretical maximum speed for a given channel or the effect of noise on transmission capacity.

Electronic Switching, Timing, and Pulse Circuits, 2nd edition, Joseph M. Petit and Malcolm M. McWhorter, McGraw-Hill Book Co., 283 pp., $12.50

An Introduction to Computing: IBM System/3, Jerome T. Murray, McGraw-Hill Book Co., 170 pp., $6.95



designers will have a **PICNIC** with these new relays

NON-POSITION SENSITIVE MINIATURE MERCURY WETTED REED RELAY CLASS 137MPC—This amazing new relay represents a significant state-of-the-art advancement in relay technology. The low-profile miniature PC-mounting mercury wetted reed relay offers bounce-free operation in any position. Now circuit designers will have new freedom of design. Further, the relay is only 1.12 x .40 x .375 inches, requiring minimal area on printed circuit boards. This relay features stable contact resistance of 100 milliohms over its long life of over 20 million bounce-free operations with diode suppressed coil. Circle 285 on reader service card

SOLID STATE (HYBRID) TIME DELAY RELAY CLASS 214CP—Magnecraft takes great pride in announcing this new time delay relay. Proven hinge-pin reliability designed into the output relay driven by a solid state circuit used in thousands of our timers, gives you the best low cost small size timing relay on the market. Operate delay timing ranges are offered between 3 hundred milliseconds and 4 minutes with ±5% repeatability and input supply of 115VAC.

We are sure you will share our enthusiasm in this new product when you apply the small size and cost savings to your circuit designs. The body of the timer is only 1.4 x 1.4 x 2.1 inches, the size of our 88 general purpose relay case. The adusting potentiometer gives full range timing control and the very popular octal socket pins extend just a bit beyond the body of the time delay relay to an overall height of 2.3 inches. Circle 286 on reader service card

DUAL-INLINE-PACKAGED REED RELAYS CLASS 107DIP, 108DIP, 117DIP AND 118-DIP—Magnecraft is proud to announce its new DIP (dual-inline-package) line of 8-pin reed relays. These new relays are designed not only to be compatible with the standard packaging developed for integrated circuits, but to offer Magnecraft quality at a lost cost. This unique design gives further savings by offering the user the optimum in automated insertion and other economical installation techniques associated with printed circuit applications.

These fantastic new epoxy molded reed relays are ideal for use in circuits where high density packaging is essential. The 5VDC IC compatible versions of these relays will operate directly from TTL or DTL circuits.

Other standard coil voltages are available from stock in 6, 12, and 24 VDC as well as contact configurations in 1 form A, 2 form A, 1 form B, and 1 form C. Most versions are also offered with a choice of an internal clamping diode. The size of this device is a tiny .750 x .300 x .210 inches. Circle 287 on reader service card

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New literature

Data acquisition systems. Varadyne Systems, 1020 Turnpike St., Canton, Mass. 02021. A four-page catalog offers general descriptions, system timing information, and specifications on data acquisition systems designed to interface directly with most minicomputers. Circle [421] on reader service card.

Rf coils. Vanguard Electronics, 930 W.Hyde Park, Inglewood, Calif. 90302 has available a two-page data sheet with drawings, specifications, and information on rf coils. [422]

Transistor. IBM Corp., P.O. Box 218, Yorktown Heights, N.Y. 10598. The history and technical background of an experimental Schottky barrier transistor is detailed in an eight-page brochure. [423]

Pc laminates. U.S. Polymeric, Canal and Ludlow Streets, Stamford, Conn. 06904 is offering a six-page brochure with specifications, properties and characteristics of pc circuit laminates. [424]

Semiconductor memories. Intel Corp., 3065 Bower Ave., Santa Clara, Calif. 95051 has published a 20-page catalog describing 21 semiconductor memories employing silicon gate MOS and Schottky bipolar technologies. [425]

Planar triodes. Eimac Div., Varian, 1678 S. Pioneer Rd., Salt Lake City, Utah 84104. Characteristics of ceramic and metal planar triodes for commercial airline and general aviation equipment are detailed in a 16-page brochure. [426]

Transistor dice. Teledyne Semiconductor, 1300 Terra Bella Ave., Mountain View, Calif. 94040 has issued a 32-page catalog with illustrations and data sheets describing transistor dice including small signal, rf power, and high-frequency transistors. [427]

Capacitors. Polyflon Corp., 35 River St., New Rochelle, N.Y. Bulletins provide information on high-Q, miniature high voltage, polychip, and other capacitors. [428]

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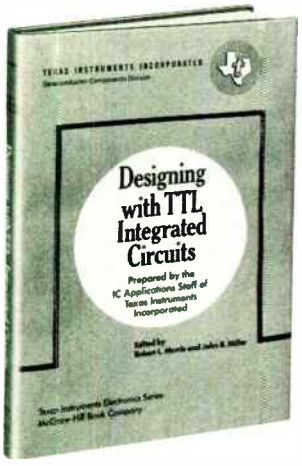

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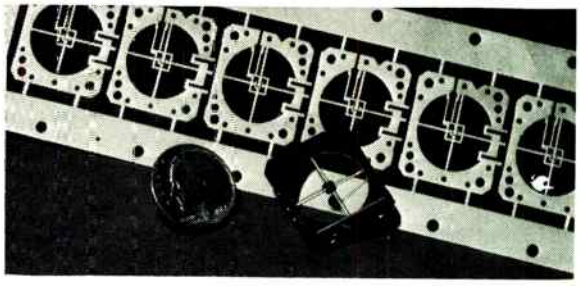

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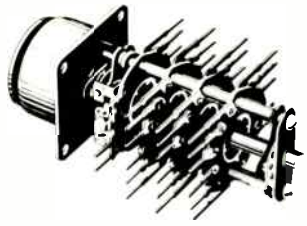

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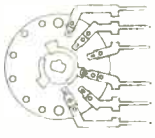

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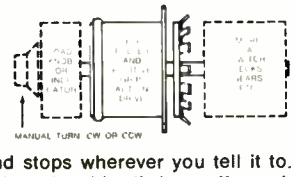

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International Newsletter

August 16, 1971

U.S. firm is likely to land contract for MRCA nose radar

The award for the mapping and terrain-following radars on the British-German-Italian Multi-Role Combat Aircraft is set to be made, say European sources, and it's likely to go to an American company. Informed sources say the finalists are Texas Instruments and the Autonetics division of North American Rockwell.

Award to an American firm would be a major blow for the two British bidders, Elliott Automation Radar Systems Ltd. and Ferranti Ltd. British sources say cost was the big factor mitigating in favor of the U.S. companies, and that the difference was sufficient to persuade the British government to back down on support for Elliott and Ferranti and overrule the Royal Air Force's objections to the frequencies of the U.S. gear [*Electronics*, May 24, p. 75]. The Germans have always favored the American equipment, because the cost can count toward offsetting the expense of keeping U.S. forces in Germany.

Israelis to sell sea-to-sea missiles

Israeli sources say that nation is prepared to sell its new "Gabriel" sea-to-sea guided missiles to "friendly" countries, with deliveries starting within a few months. The first transaction is said to have been concluded already with an as-yet unnamed country. Technical details on the Israeli missile are unknown, but some sources give its range as between 13 and 20 miles, flying low on cruciform wings. It's said to be more advanced than the Soviet Union's Styx or anything of the kind yet announced in the West.

U.S., Europeans reach accord on Aerosat

The Madrid meeting between U.S. and European officials on the Aeronautical Services Satellite [*Electronics*, July 19, p. 7E] resulted in "quick agreement" on most details of the program, Paris informants say. Among the important decisions made: the major users will own, not lease the air traffic satellites that will be launched over the Atlantic and Pacific beginning in 1974.

The international meeting also reportedly set up a top-level Aerosat Council, to be comprised of five Americans, five Europeans, and perhaps representatives from Canada and Australia. And in keeping with the principle of 50-50 participation by the U.S. Federal Aviation Administration and the European Space Research Organization, a 50-man operational staff is slated to be set up, to be made up equally of Americans and Europeans. Still to be decided, however, is who will get the major share of hardware contracts. A prime contractor is being sought to coordinate international bidding in the fall, with contracts to be awarded next spring.

Crashes spur Germans to install railroad telecommunications

A rash of fatal rail accidents is prodding West Germany's federal railway to speed up installations of a new telecommunications system. Developed by AEG-Telefunken, the system, which will link all trains over the Bundesbahn's 18,200 miles of track, calls for a network of interlinking transmission-reception control stations, each slated to handle communications with trains on all tracks within a 30.5-mile radius, with relay stations to be set up every eight miles. Communications will be frequency-modulated at 460 megahertz. Pushbuttons will enable drivers and control

stations to communicate by transmitting a variety of instructions and questions.

The Bundesbahn, which has already tested the system successfully, has launched the first regular operation in North Germany between the towns of Luebeck and Puttgarten. **Scheduled completion has now been moved up to Jan. 1, 1976.** Total cost of the nationwide system is put at $72.5 million.

Japan sets price floor on calculators for export

The latest move by Japan's Ministry of International Trade and Industry to calm the outcry over alleged dumping of Japanese goods is an export price cartel for electronic calculators. The cartel, to be formed by the Japan Machinery Export Association, **will establish FOB minimum prices for various calculators, ranging from a minimum of $85 for eight-digit units with no memory to $200 for 16-digit machines with three memory stores.**

Another provision will restrict introduction of new models to twice a year, probably at the Hanover Fair in West Germany and the HEMA show in the U.S. The agreement, to become effective later this month, does not cover exports to the Communist Bloc countries or activities in the domestic market.

Insiders say the cartel wasn't formed solely to allay dumping charges. **In fact, calculator exports are slumping, because foreign buyers feel that if they wait out the market, they may be able to buy an improved model, or the same unit at a lower price.** The price floors and curbs on model introductions are expected to counteract that trend.

British government backs ICL . . .

Doubts about the long-term viability of International Computers Ltd., caused by the general dip in computer orders and the British government's hard line toward cash-hungry companies, have been dispelled at least temporarily by an official statement confirming continued support of the company.

The government will press buyers spending state money to buy ICL gear, and it's already proved an effective ploy. What's more, the government will continue to supply money for basic research, contracts to develop specific products, and guarantees for the banks that finance ICL's leasing activities.

These government measures mean that ICL can count on security until its completely new line, now in development, is launched in three or four years. The official decisions are due at least partly to the leading role ICL could play in a European computer industry if Britain enters the Common Market, and to increasing support given by Continental governments to domestic computer companies.

. . . as France gives more aid to CII

One example of the spurs provided by Continental governments to native computer firms is the commitment by the French government of more than $100 million in development funds to its national computer manufacturer, Compagnie Internationale pour l'Informatique (CII). This capital infusion comes as a five-year renewal of "Plan Calcul," under which CII was set up in 1967. **The money will go mostly for research and development leading to new models in the medium-to-large scale Iris computer line.**

French develop vanadium dioxide thin film switch

Group working at LETI, near Grenoble, patent a device that even changes color when current flows

The problems of devising workable solid state amorphous threshold switches have kept a group of French researchers thoroughly switched on for the past two years. And now the group, working at the Laboratoire d'Electronique et de Technologie de l'Informatique, have patented a rival to other amorphous semiconductor devices.

Jacques Duchêne, who earned his doctorate in solid state physics only last year, now has laboratory data that shows that vanadium dioxide can outperform the widely-heralded tellurium glass Ovonic switch (*Electronics*, Sept. 28, 1970 p. 56). Moreover, Duchêne claims, VO_2 has additional display uses because it changes from green to red when current runs through it.

Duchêne did most of his research at the LETI complex snuggled in the Isère valley on the edge of the French Alps. The government-controlled lab, just outside of Grenoble, brings together an impressive array of young scientists, many of them still on the graduate student level.

Under the supervision of Igo Melnick, Duchêne achieved a reliable homogenous polycrystaline VO_2 film by reactive sputtering in an oxygen-argon atmosphere. Carefully controlled sputtering has produced more uniform VO_2 than other researchers have reported they have been able to make, according to the French. As a result, LETI feels it has a real breakthrough in its switch—with possible applications ranging from logic and memory, to thermal switching and displays. No specific industrial applications have been contracted as yet, but licensees are being sought in France.

Duchêne says his VO_2 device changes from semiconductivity to a metalic high-conductivity state at 68°C. He has recorded an increase in conductivity of up to 10^3 in bulk monocrystals. But even the sputtered polycrystaline films have rewarded him with a respectable conductivity change factor of 10^2.

The switch increases its conductivity when voltage is applied to one of two substrate electrodes. As the voltage heats up the vanadium dioxide, its properties change, turning conductive at 68 C. As soon as the voltage is cut off, it reverts.

Denis Randet, who runs the applied physics division of the LETI complex says hundreds of glass or quartz substrates have been successfully sputtered with VO_2 proving the reproducibility of the combination under strictly controlled conditions. Some of the switches have been turned on and off 100 million times, resulting in no chemical change in the film's characteristics. "Thus we have a device with no burnout—no chemical alteration at all—that will have a very long life and can be considered quite cheap and reliable," Randet says.

Randet, Melnick, and Duchêne are proud of their highly refined sputtering procedure, which they say distinguishes their VO_2 thin film and makes the switch workable—and probably commercially viable.

The key to this process, Duchêne says, is the use of a radiant heater to raise the ambient temperature in the sputtering apparatus to 300-400°C before the sputtering begins. He experimented with various substrate shapes, depositing both coplanar and sandwich devices. The sandwich-type switch has proved more desirable, he says, because the electrode gap can be reduced to a few microns—the film thickness.

"Our switch has the advantage of built-in stability," Randet says, "thanks to the use of a physical phenomenon—VO_2 conductivity fluctuation—which is reproducible and well understood."

France

Matching network lights way to higher rf transistor power

Makers of radio-frequency power transistors face an exasperating set of tradeoffs as they move onward and upward to higher outputs, higher frequencies, and larger bandwidths.

Packing added power into a transistor generally means adding on basic interdigitated transistor structures in parallel. But these additions push the transistor's input impedance way down. That's a big drawback, because the device has to be matched to its microwave circuit mates, which normally have 50-ohm impedance. Find the right matching network, though, and you can boost

power substantially without paying a prohibitive penalty in narrowed bandwidth.

A network that does the job admirably has been worked out at Thomson-CSF by a group headed by Claude Vergnolle. Mainly because of the network, Thomson-CSF will have 40-watt transistors, amplifiers with a minimum of 6-decibel gain over a full octave frequency range of 200–400 megahertz, ready for the market early next year. These first 40-watt packages will carry pricetags of about $180 initially. They'll be followed sometime next spring by 20-watt amplifiers spanning a range of 800–1,400 MHz.

Upwards. Vergnolle maintains that these two units put Thomson-CSF out front of the competition as far as octave-bandwidth power transistors go. But his group has greater things in mind. By the end of 1972, he says, Thomson-CSF will have a 100-watt package for the 200–400-MHz band in production.

To build the octave-bandwidth hybrid amplifiers, Thomson-CSF ties eight basic transistor cells on a single chip together with a passive matching network of 10-ohm impedance. This 10-ohm "active" module, in turn, is paired with two other passive matching networks to boost the impedance to 50.

All told, the active module can be considered as eight transistors, each matched to a 10-ohm impedance by large-bandwidth impedance transformers. These transformers turn out to be a trio of 3-dB couplers with their output ports split into two. Because of the branching, the inductance required at the transistor cell is very low—about the same as the self-inductance of a short 50-micron connection wire between the cell and the associated capacitor in the matching network. This is crucial, because self-inductance is what limits bandwidth in power transistors.

The couplers also have ballast resistances between equipotential points. Because of them, small differences in the power outputs among the transistor cells aren't bothersome: any reflected power is dissipated in the ballast.

To be sure, the low inductance that results from branching the couplers has to be offset with higher capacitance compared to that for an equivalent matching filter. But Vergnolle gets around that by using capacitors that have the high values needed but nonetheless are compatible in size with the capacitor chip. With the MOS capacitors, there's no problem integrating the resistances. They're obtained by evaporating nickel chromium over the thermally grown oxide that serves as the dielectric on the MOS capacitor chips. As for inductances, there's no particular problem either, since they're simply calibrated connection wires between the transistor and the capacitance chips.

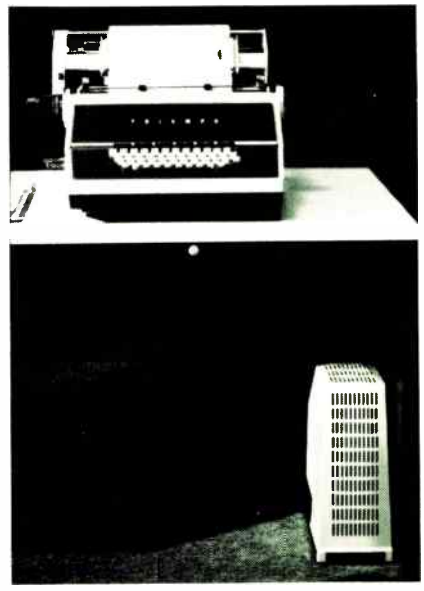
To make the active modules even easier to produce, Thomson-CSF packs 12 transistor cells on a chip that measures 3.5 by 0.075 millimeters. That insures a good yield since only eight need be good. The active module alone, Vergnolle says, costs only about twice as much to produce as the transistor alone. Vergnolle is scheduled to explain the work August 29 at the European Microwave Conference in Stockholm.

West Germany

The minicomputer for every garage

When engineers at West Germany's Triumph/Adler group applied the Volkswagen (people's car) concept to computers, they came up with the TA10. "It has the program flexibility of a middle-sized computer, but a lower storage capacity," explains company expert Georg Gimpl. "As such it fills a market gap and boosts a cost-performance relationship second to none. It's the Volkswagen of the computer world and we call it the Volkscomputer."

Triumph/Adler, a subsidiary of the U.S. company, Litton Industries, put the TA10 on the market this spring. It's aimed at competing with small invoicing and bookeeping computer systems, which have been evolving in West Europe. On the surface, it differs little from other setups in its category. But price in terms of achievement seems to set it apart. It has a data and program storage of miniproportions—10 words by 48 bits and 256 words by 14 bits, respectively. Yet, says Gimpl, "The TA10 has a three-rule calculating unit able to program square roots, as one example of its middle-sized computer flexibility."



Portable. Triumph/Adler's new small computer can be carried to the job in it own case, works with typewriter keyboard.

The system, which has one keyboard input and two output channels for printer and punch tape, carries a $2,950 pricetag, including the electronic and keyboard equipment. It comes with a punch tape machine for an additional $2,170.

The Volkscomputer's entire electronics consists of medium-scale integrated circuits mounted on three wafers of reinforced-fiberglass/epoxy material. In addition to the control and programing units, the computer contains seven metal oxide semiconductor data storage devices and three MOS processing units, including a multiplication capability of up to 16 digits. The computer is housed in a portable-typewriter-sized case. Programing is done by keyboard or exchangeable cassettes. But Triumph/Adler also has in preparation a software, magnetic tape program, which is slated to hit the market after this year.

The TA10 is primarily sighted at a market of about 100,000 companies in West Germany, 80% of which employ 100 people or less. But Triumph/Adler is also looking at other West European markets and even casting a glance at the sales possibilities in the U.S.

Great Britain

Planar structure handles 10-watt microwave pulses

For ordinary low-power, continuous-wave, microwave generation a gallium arsenide chip is best made as a sandwich. But for high-power, pulse-mode operation a planar structure is likely to be best. The planar device has both terminals on the same face and is usually made by epitaxial deposition onto a semi-insulating substrate.

At the European Microwave Conference later this month, Hans Hartnagel of Newcastle University will talk about the advantages of the planar layout. Hartnagel has made planar devices 2,500 microns wide, with 100 microns between electrodes, that deliver 10-watt pulses into 50 ohms at a rate of 1 gigapulse per second, in bursts of 50 pulses.

He says heat sinking does not appear to be a problem, and in pulsed power devices the limit is more likely to be set by the time taken to charge the domain capacitance by the load resistance. As the device is made wider to obtain greater power the charging time goes up and eventually reaches half the signal frequency interval, after which power begins to fall off, other things being equal. At 1 Gp/s, Hartnagel figures that maximum possible domain width is something approaching 4,000 microns, corresponding to a power approaching 20 watts.

Planar construction, says Hartnagel, creates heat contours within the device that make it operate more efficiently than a sandwich device, quite apart from getting the heat away more effectively. In a sandwich structure, the heat has to go out through the contacts, usually the anode contact, which is much warmer than the active layer. A planar structure can be made so that the active layer is warmer than the contacts and the resulting improvement in carrier density more than outweighs the reduction in electron transfer between energy bands. Further, a cool cathode promotes a high field and good domain nucleation. However, a cool contact doesn't help at the anode end, where high conductivity and a low field are necessary to prevent breakdown.

Though it is possible to achieve optimum conditions by doping, Hartnagel's argument is that a planar structure allows such conditions to be obtained by surface shaping and other means that may be easier than doping.

One way of keeping the anode field low is to make the anode edge thicker than the rest of the active layer, by etching down most of a layer that's thick to start with. A 10-micron layer might thicken to 15 or 20 microns over its last 4 or 5 microns of width. However, Hartnagel says a better bet may be creating an accumulation layer, and hence a low field area, near the surface by the anode. He proposes to do this with a layer of silicon oxide topped by a metallic layer extending a couple of microns over the active layer from the anode and connected to it. The difference in potentials between the metal and the semiconductor under it would create a space-charge layer of high conductivity. He thinks this method could be made to provide closer control than the thickness-variation method.

Extra. Either of these methods should solve one of the snags of planar construction: migration along the surface of anode material, pulled by the high cathode field. The anode material apparently travels through surface imperfections in the lattice bonding and eventually forms a short-circuit channel. It requires some local lattice heating near the anode to start it off. If the anode field is kept low, local temperatures would not rise to the initiation level, Hartnagel says.

He has found surface effects important generally. Some rough grinding debris left on a surface quenched the domains when the bias voltage was reduced below threshold, though it did not happen when the surface was etched clean. Hartnagel thinks the debris causes surface charges which do the quenching.

Planar layout also makes it easy to add a third electrode. A grounded third electrode is a simple way of preventing signals that are reflected back through the anode from triggering an unwanted domain from the cathode. The grounded potential acts as a shield and reduces the reflection reaching the cathode to an insignificant level.

Infrared light-emitting diodes sort packages

In the ballyhoo surrounding visible-light-emitting diodes, infrared emitters have been rather overlooked, even though they may be a better commercial bet, albeit in a smaller way. Already IR coupling is an established isolation technique. And now a British electronics component firm and small-scale-systems maker has built a light-activated, binary code reader using IR instead of visible light—and claims some important advantages for it.

The designer, Jean-Claude Chaimowicz, of MCP Electronics Ltd., Wembly, says MCP's system is intended for reading black and white digital code markings on packages on a conveyor belt. Most existing systems use an ordinary electric light and read the direct reflection from special tape stuck on the package. Geometrical reflection imposes tight tolerances on the alignment of the package on the conveyor. Further, it's important that ambient light doesn't upset the reading.

In place of the lamp, Chaimowicz uses gallium arsenide diodes with emission peaking at 9,500 angstroms in his demonstration system. They put out 150-milliwatt, 10-microsecond pulses at 1.5 kilohertz. Chaimowicz reckons about 1 mW gets through the optical focusing system to the label, and about 20 pulses will

hit a single target area on the label, as it passes the beam. If it's black, the radiation is absorbed; if it's white, a detectable amount of radiation is backscattered through wide angles and can be picked up by a conveniently placed silicon detector. Hence replacing reflection with backscatter relaxes package alignment tolerances, though it doesn't cut them completely. The GaAs diode also helps to loosen the tolerance on the distance between the transmitter/receiver and the package. Because it's very nearly a point-source radiator, the diode is not difficult to align so that the IR beam edges are nearly parallel.

The usual target arrangement will be in two rows. White above black equals binary 1 and black above white binary 0. Eight pairs in sequence gives a 256-bit word. Chaimowicz uses a transmitter and detector for each row, with transmission pulses interlaced between top and bottom. The contrast ratio between black and white will be fairly steady, so that considering both halfs of a bit together is a check that the beams are on target.

Filter. Besides providing enough power to produce detectable backscatter, running the diodes in a pulse mode eases the ambient interference problem because it results in an ac detector output that can be distinguished from the dc output produced by ambient IR. Chaimowicz says it also helps if the silicon detectors are operated in the linear portion of their response curves. He uses a low-pass filter to cut off visible light. He claims the receiver system will work in a total ambient light level up to about 150 times the strength of the information signal.

All the main optics and electronics of the MCP system are in a box measuring 14 by 3.5 by 3.5 inches that is bolted beside the conveyor line. There is a master clock, consisting of a free-running multivibrator producing a 1.5-kilohertz square wave, followed by two monostables triggered alternately by the front and back edges of the wave and producing the two interlaced pulse trains to drive the transmitters. The two receiver channels feed into a common amplifier and a Schmitt trigger threshold discriminator and pulse shaper. Thereafter the signals are processed digitally, using integrated circuit logic.

The shaper output and the clock feed into NAND gates and a bistable that separates the channels and creates envelopes out of the individual backscatter returns from a white target area. Because response of the two halves of a bit are interlaced, it's simple to record a 1 or a 0 and read the result out. Another advantage is that the system will read only genuine bits and, provided the number of bits per carton is constant, the system cannot get out of line.

Japan

New TeO diode has great expectations—a 2-W output

Unusually, liquid epitaxy is used to fabricate both the active regions and the low-resistivity-contact layers of transferred electron oscillator diodes in a new process developed by Masatoshi Migitaka at Hitachi Ltd.'s Central Research Laboratory. With some samples efficiencies as high as 7.45% at 8.51 gigahertz have been obtained—several percent better than the best results with diodes made by vapor epitaxy.

Since maximum power output is roughly proportional to efficiency, Hitachi researchers expect such devices to achieve a 2-watt output when mounted on type 2A diamond. So far they've only achieved 250 milliwatts, because they can test the experimental chips most easily in prong-type packages that dissipate heat poorly; but they have found other diode chips, of the same size but with 3.5% efficiencies, yield as much as 900 milliwatts when mounted on the diamond. The high power output will be obtained with the usual low-noise output of transferred electron oscillators.

Generally, transferred electron oscillator diodes have an n^+nn^{++} structure, with the pure n layer grown on the n^+ substrate by vapor epitaxy and the highly doped n^{++} layer deposited by liquid-phase epitaxy. However, quite a few dislocations occur in the n and n^{++} layers, seemingly due to the differences in lattice constants and to flaws in the substrate surface. Moreover, high-resistance layers are often found at the interfaces between the n^+, n and n^{++} regions, and are probably caused by contamination of the surfaces on which the epitaxial layers are grown.

These defects limit efficiency, and Migitaka set out to combat them all. To reduce dislocations, crystal lattice differences are minimized by using selenium as the dopant because its atomic radius, unlike that of the normally used tellurium, is nearly equal to those of gallium and arsenic. In addition, the impurity concentration is limited to at most 10^{18} atoms per cubic centimeter, since higher levels would reduce electron mobility.

To prevent damaged substrate surfaces from affecting the active n layer, an extra n_2^+ buffer layer is grown, changing the configuration to an $n^+n_2^+n_3^{++}$ structure. And since all three layers are grown without removing the substrate from the furnace, no contamination can occur at their interfaces.

Recipe. Precise control over surface morphology and layer thickness is maintained by use of a sliding boat consisting of two graphite blocks. The substrate is laid in a hollow in the lower block, over which the upper block is moved by means of a quartz rod. In the upper block are four square holes: two contain the gallium arsenide solutions for the n and n^+ layers; one contains an undoped GaAs solution for washing off any melt that remains on the surface between processes; the fourth contains a graphite cover that protects the substrate from gas erosion during preliminary heat treatment in the hydrogen-filled furnace and also serves as a mechanical wiper between process steps.

After the substrate has been heat-treated, the furnace is cooled at a fixed rate and the three layers are grown one after the other by sliding the upper part of the boat so the desired solution contacts the substrate.

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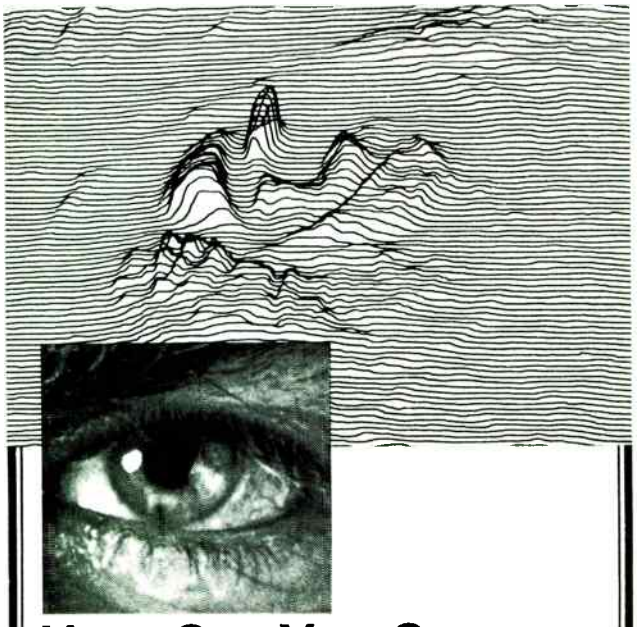

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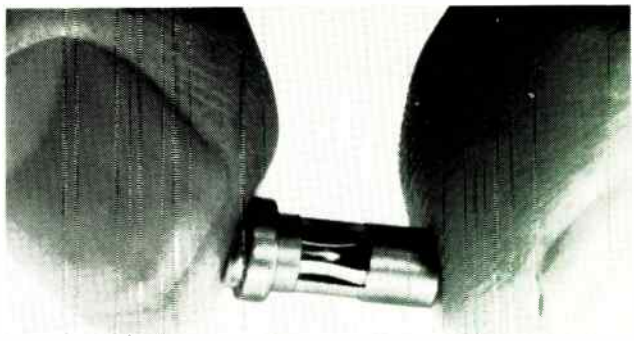

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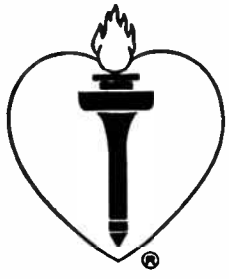

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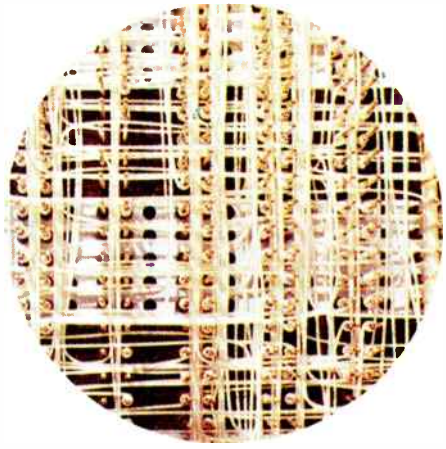

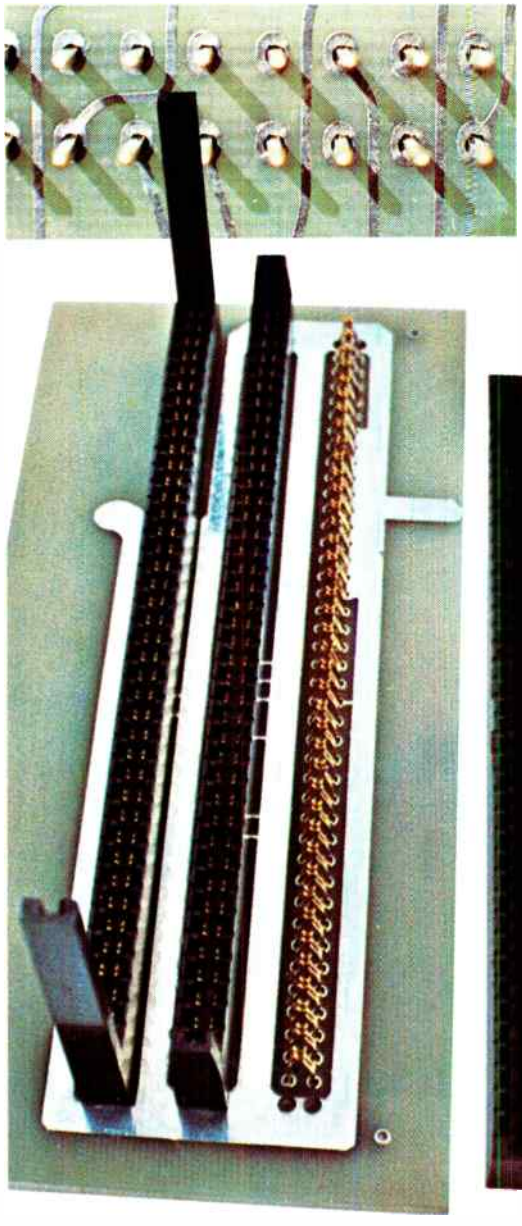

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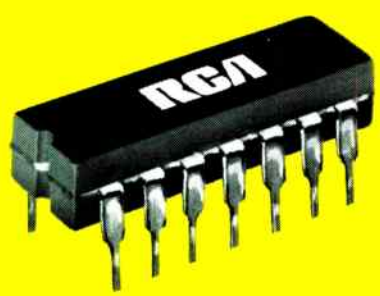

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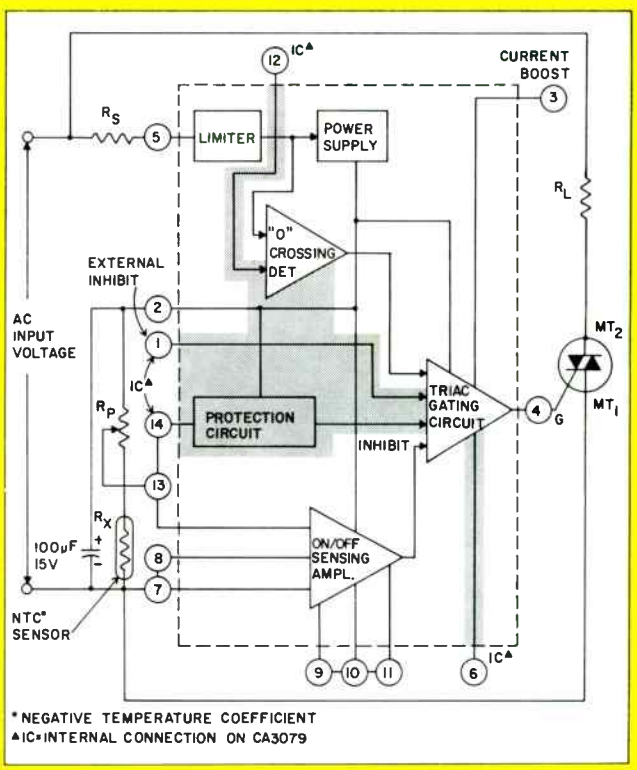

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