APRIL 28, 1977

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How to design the new 16-k dynamic RAMs into memory systems/115

PRODUCT UPDATE: LSI enhances counter performance/130

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Electronics

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LSI in telecommunications

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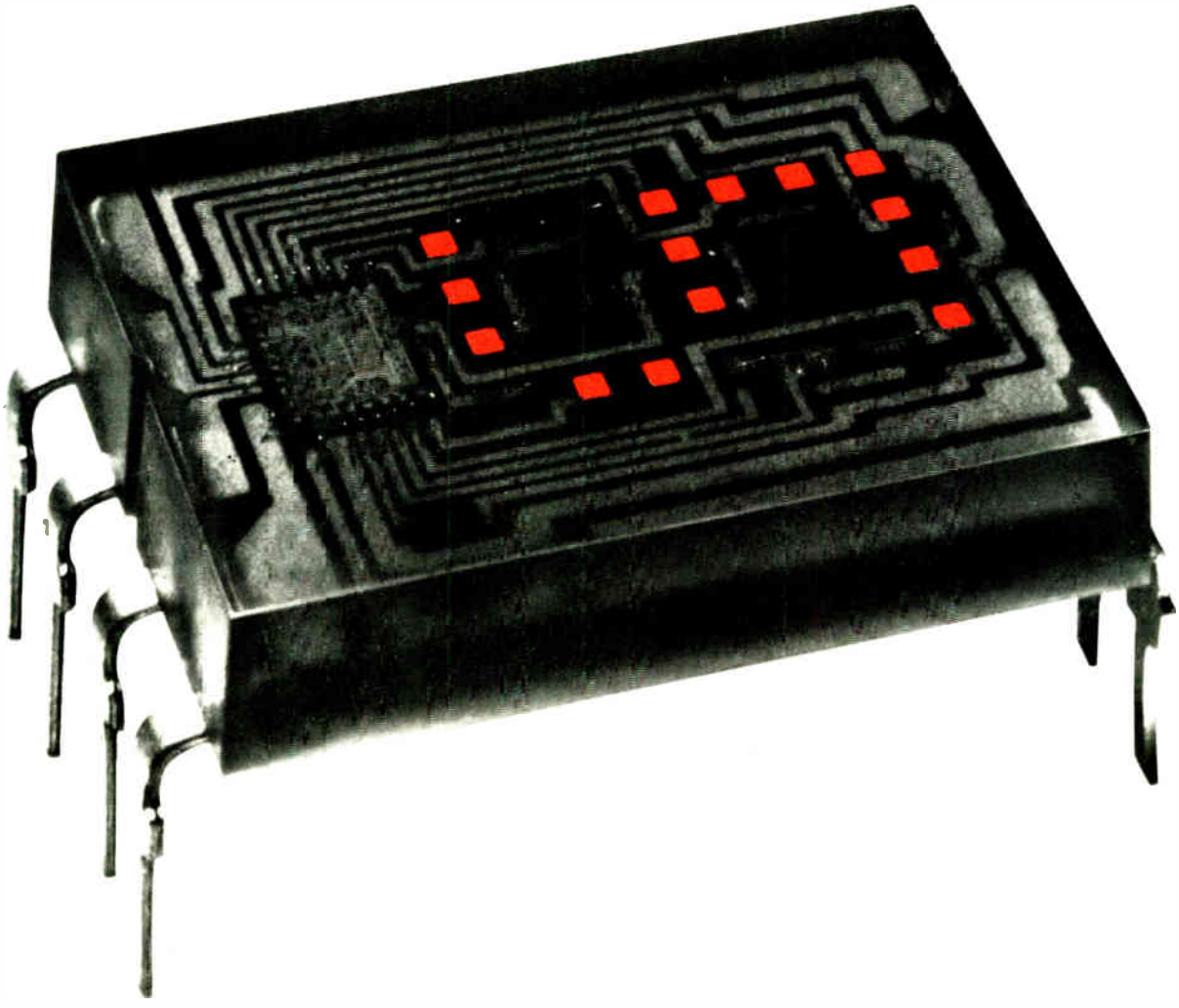

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Electronics

The International Magazine of Electronics Technology

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Highlights

LSI moves into communications, 93

Telecommunications equipment may look much the same as always, but buried out of sight are the beginnings of a major switch to large-scale integration. This special report provides details on many of the LSI chips under development and examines applications of some of the chips and the uses of microprocessors.

Cover, constructed by Bob Strimban and photographed by John Ashworth, features a Collins Radio CRC 8030 LSI tone-detector package.

Time to go solid-state, say Swiss, 80

The Swiss watch industry has decided to wholeheartedly embrace electronic watches. The goal for many firms is digital timepieces completely made in Switzerland.

16-k dynamic RAM fits all systems, 115

A new 16,384-bit dynamic random-access memory has minimal control circuit delay and low-power dynamic sense amplifiers. It includes features that make it suitable for microprocessor, multiprocessor, and minicomputer applications.

Product update: electronic counters, 130

In the many-modeled electronic counter field, custom LSI chips are widely used. The first of a periodic feature on product areas, this report surveys the models available and the technology inside them.

And in the next issue . . .

A preview of the Electronic Components Conference . . . an overview of electron-beam technology . . . an analysis of a new 4,096-bit static RAM.

Electronics

Publisher's letter

In this issue we are launching a new feature series—Product update. The initial article in the series covers what has been happening lately with one of the basic tools of the engineer, the electronic counter.

Among the most significant developments in counters is the advent of large-scale integrated circuitry—not so much the microprocessor as widespread application of custom LSI chips. These chips are having a positive impact on the cost/performance ratio, and some of the newer counters are packing in features that either commanded a higher price tag or were not even available before LSI.

From microwave counters to low-low-cost portable models, there is a lot of activity going on now. For a good look at all the action, take a look at the Product Update that starts on page 130.

The penetration of advanced electronics technology into other industrial areas has certainly picked up speed of late, and starting on page 93 you'll find a special report on the inroads being made by large-scale integration in the once-all-mechanical telecommunications field.

The in-depth report was put together by Dick Gundlach, our communications and microwave editor, who came away from his rounds of interviewing impressed by both the amount of work going on in semiconductor houses and telecommunications companies and by the high level of secrecy they are maintaining about that work.

"Although most semiconductor firms are reluctant to talk about who they are working with to develop LSI chips specifically for telecommunications chores," says Dick, "there's obviously been quite a bit of talking going on. I think that Mike Hamper, telecommunications marketing manager for National Semiconductor best sums up the optimism shared by most semiconductor makers about the huge untapped market that exists in telecommunications: 'If only 10% of the telecommunications people we talked with would buy just 10% of what they say they need, we couldn't supply that kind of volume.'"

It seems that many of the independent operating telephone companies are making the rounds of semiconductor houses, showing them specifications that they feel must be met and asking them to come up with LSI chips to do the job. Other companies are doing the same thing but less openly. And as usual, the major telephone companies are looking and evaluating, but very reluctant to give away too much information to the semiconductor houses.

Says Dick: "From my travels, talking with telephone companies and semiconductor manufacturer alike, I think a major stumbling block is proving LSI reliability to the telephone companies' satisfaction. A regulated industry like theirs cannot tolerate even slight outages of services. The consumer backlash is harsh and the regulatory agencies are getting tougher."

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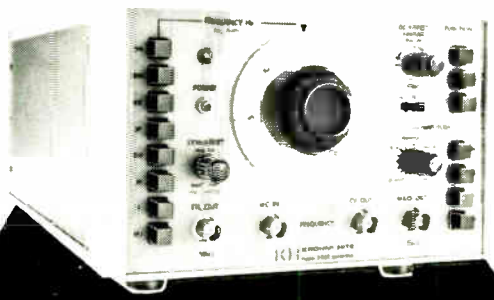

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Circle 4 on reader service card

Readers' comments

Don't forget Power Monolithics

To the Editor: You missed mentioning our Lambda Electronic IC Regulators in your special report on linear integrated circuits for power supplies [Feb. 3, p. 91]. For almost two years, we have manufactured series regulators that exceed every parameter in your article.

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Chris Field
Power Monolithics Inc.
Corpus Christi, Texas

Reaching for solar energy

To the Editor: Our Government has indeed delayed long enough in stimulating research and development efforts to harness the vast energy supply from the sun [March 17, p. 10]. However, many scientists suggest that solar energy collected from outer space might be the best long-term solution to our energy shortage.

With enough attention from Congress, there is no reason to believe that a program to construct orbiting solar power stations or perhaps space colonies could not begin in the future. Such orbiting colonies could conceivably be used to manufacture the solar cells needed on earth and to convert solar energy into microwave energy.

P. F. Justus
Kansas City, Mo.

Correction

In the preview of this year's International Solid State Circuits Conference [Feb. 17], a transposition took place in the last sentence of the last paragraph on p. 83 between "nonclocked" and "clocked." The sentence should read: "The price here is nonvolatility, since nonclocked devices dissipate more standby power than clocked ones and therefore are not suitable for battery-backup applications."

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Circle 210

2 FIFO Register: simplify microprocessor interfacing.

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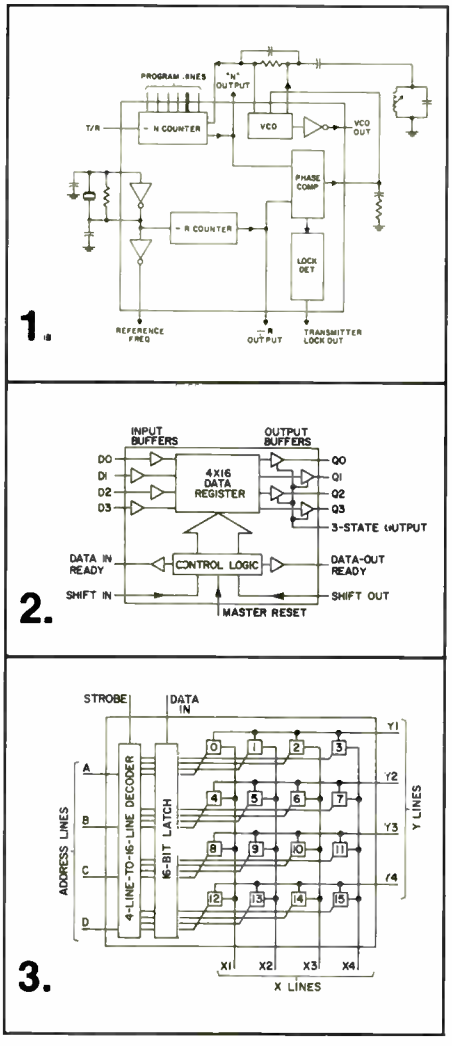
Circle 211



3 4 x 4 Crosspoint Switch: lower the cost per crosspoint.

The CD22100 is 16 switches on a single chip, replacing 16 relays (at about 1/3 the cost) or 3 standard ICs. This can mean major space savings in in-house telephone and data communications systems, for example. And of course fewer connections means higher reliability. Coming soon: a 4x4x2 crosspoint switch.

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News update

■ The Naval Air Systems Command has authorized Lockheed-California Co. to incorporate a color tactical display on the feasibility model of the Tactical Airborne Signal Exploitation System (Tases), a planned modification of the S-3A antisubmarine warfare aircraft. The display would be the first airborne color system for antisub use [*Electronics*, Oct. 14, 1976, p. 25].

Designed and produced by Loral Electronic Systems in Yonkers, N.Y., the display consists of a beam-penetration CRT that uses a multilayer phosphor to produce three colors—red, green, and yellow—with two tones each, providing six codes for target identification and priorities. The Loral Corp. division hopes to get the color unit also on planned updates of the carrier-based S-3A and land-based P-3C patrol aircraft, both built by the Lockheed Aircraft Corp. division.

"We're looking also to add color displays for other command and control aircraft, such as the E-3A Airborne Warning and Control System [Awacs]," says Jules Frohmann, Loral division regional vice-president for marketing. The color CRT display, has its own 16-bit microprocessor to generate characters on the display and keep them there until new information comes from a central processor, thereby eliminating flicker.

The color display is interchangeable with the S-3A's monochromatic unit, now supplied by Loral, notes Ed Milkovich, Lockheed's Tases program manager. Use of the color unit, he continues, "is significant as it would increase the amount of data presented to the operator without generating any confusion."

The success of the program will largely determine whether the color unit goes on planned updates of the S-3A. "There are some very evident improvements we would get from a color display, such as highlighting a threat platform," says Capt. Toxie Calff, the Navy's S-3A program manager. But the decision as to what will go on S-3A updates, he adds, "won't be made for a couple of years." **Bruce LeBoss**

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Editorial

Semiconductors: two steps forward. . . .

There is a lot of talk suddenly about 65,536-bit random-access memories. But, considering the fact that most semiconductor manufacturers are still struggling for volume production of 4- and 16-kilobit RAMs, why are these denser chips already as far along the development path as they seem to be? The answer is simple: fierce competition.

While some observers, overstating the case, see 65-k RAMs popping out soon in large quantities and swamping the smaller parts, 65-k dynamic RAM production appears to be closer to realization than most people thought only a few months ago. Disclosures of 65-k designs already are being prepared for next year's International Solid State Conference. Every major memory supplier has an active 65-k program—both in process development and fine-line fabrication. A leading supplier even promises samples of manufacturable 65-k RAMs in two years.

If 1979 is indeed the year of the 65-k RAM, then the development time for memories has contracted sharply—to just over 2 years. And since advances in memory quickly filter into other digital designs, the same two-year cycle time would apply to microprocessors and peripheral circuits as well.

Such a frantic pace is, of course, nothing new in the semiconductor industry. But it does point up one immutable fact of semiconductor life: innovate or perish. Success appears to come more surely to the companies that continually recycle a large part of their revenue into next year's process and component design. Manufacturers who lack this focus learn the hard way how difficult it is to keep up with today's rapidly changing technology.

. . . and one step back?

How much should a manufacturer looking to use the fruits of electronics technology in his own products reveal to the supplier of that technology? That is certainly one of the toughest decisions that management has to make. Put in simple terms, the problem comes down to deciding what balance to strike between two extremes.

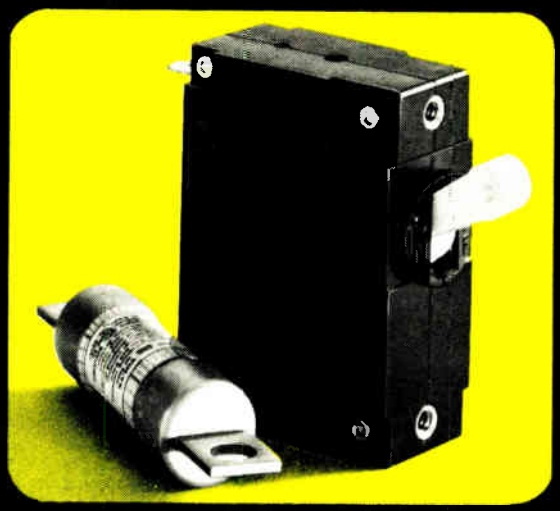
On the one hand, the buyer could lay out all its development and marketing plans. But that course holds the risk of tempting the supplier to jump into that market itself. On the other hand, it could hold back so far as to straightjacket the supplier and risk coming up with a limited-use and costly design.

A major case in point is the tug of war now going on between the semiconductor houses and the telecommunications industry. Telephone companies and firms supplying hardware to them are giving more than just a casual look at what advanced solid-state technology can do for them. Indeed, the growth in demand for phone services is pushing the phone companies toward LSI because of its cost, reliability, and versatility benefits, and they need the know-how of the semiconductor makers.

The trouble is, the phone companies are reluctant to deal too closely with them because semiconductor houses have often used their supplier role as a springboard to competing in their customers' marketplace.

But this reluctance to work closely is really ill-founded. Semiconductor makers need all the information they can get if they are to produce the best designs. The enormous pressures in electronics have shown, time and again, the greatest benefits to all—supplier and buyer as well as consumer—come when open competition forces the strongest designs.

The $5.88 circuit breaker. Lower cost protection than the $1.37 fuse.



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CPU Slice (ALU and general registers)	Am2901A, 2902, 2903*, 2904*
Microprogram Control Units	Am2909, 2910*, 2911
Branch and Instruction Control for Microprogram Sequencers	Am29803, 29811
LSI Bus Interface Devices	Am2905, 2906, 2907, 2915A, 2916A, 2917A
Priority Interrupt Control	Am2913, 2914
Main Program Control	Am2930*, 2931*, 2932*
New More Powerful MSI functions	Am2918, 2919, 2920 2921, 2922

*In Development

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- The Am2900K1 Learning and Evaluation Kit
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People

ITT's Thomas is out to be top MOS-memory source

"We're aiming to be the European source for MOS memories," declares Gerry Thomas, who was recently named general manager of ITT Semiconductors in England, the lead memory house for ITT worldwide. To get out in front, Thomas is counting on an ITT version of the second-generation 4,096-bit metal-oxide-semiconductor memory announced last year by Mostek Corp. of Carrollton, Texas. And to stay in front, ITT will be developing larger memories as well.

ITT will be one of the first manufacturers in Europe to supply the 4027. According to the 46-year-old Thomas, who has spent 16 years with the company, the device "puts ITT in the thick of the memory business." He looks for it to bring the firm a share in a worldwide market for MOS memory that the company expects will reach $600 million by 1980, about half of it in 4,096-bit and 16,384-bit devices.

Million dollar update. Demand for the 4-k part will grow fast, Thomas believes. Having invested $2.7 million in new design, production, and testing facilities at his plant in Footscray, near Sidcup in Kent, he is already making the 4027 in volume for such applications as computers, point-of-sale terminals, and television tuners.

As for a 16-k device, Thomas says ITT has one already well along in design. He expects to have samples available later this year of a device patterned on Mostek's 4116 RAM. By 1979, he will also have a 65,536-bit memory ready for market, he says. Key to the memory design for ITT Semiconductor will be the n-channel ion-implanted Coplamos process it licensed recently from Standard Microsystems Corp. and has successfully modified.

But Thomas, who was ITT Semiconductors' technical director and director of operations before becoming general manager, also has other targets in mind. One concerns a controller chip that has been used successfully in washing machines but which he would like to see as successful in other home appliances. Another is to bring out special metal-oxide-semiconductor circuits for television, including a second-generation color-processing intermediate-frequency circuit.

Sharing. Gerry Thomas wants part of an MOS-memory market he expects will reach $600 million in the year 1980.

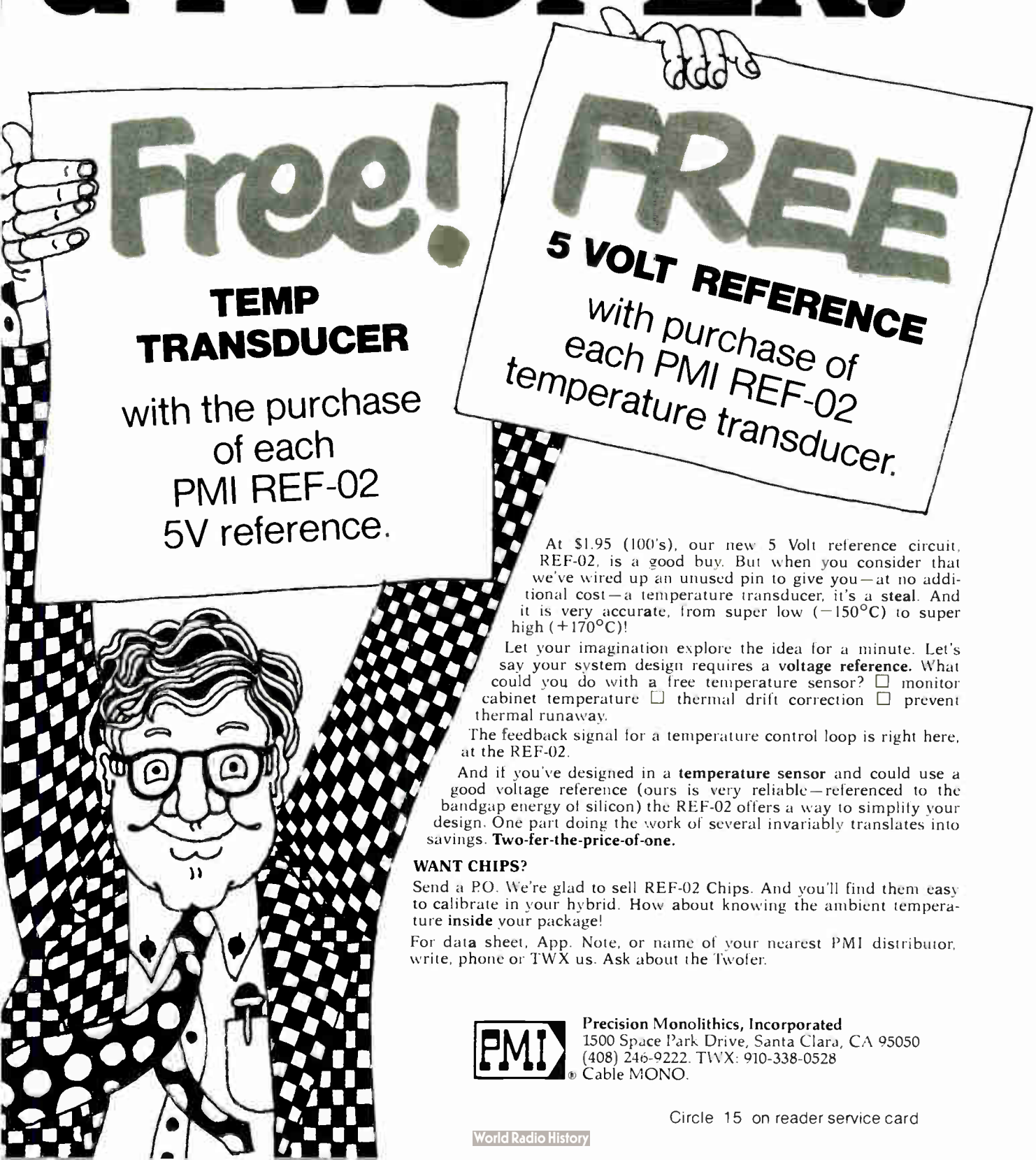
Linear ICs, converters key to Zeltex growth, says Preletz

Three years ago, when Mike Preletz took over operation of Zeltex Inc., he set some high sales goals for the Concord, Calif., manufacturer of data-conversion products. This month the company, founded in 1962, revealed how successful Preletz has been—sales have nearly quadrupled to $10 million, right on schedule.

Internal developments accounted for about half of this growth, while the remainder came from the acquisition last year of Silicon General Inc., a Westminster, Calif., producer of linear integrated circuits. Preletz has his sights set at the $20 million level by 1980, and there isn't a doubting Thomas anywhere.

Aggressive? "Absolutely," says the 39-year-old president and chairman of the board [*Electronics*, May

Our REF-02's a TWOFER.



At $1.95 (100's), our new 5 Volt reference circuit, REF-02, is a good buy. But when you consider that we've wired up an unused pin to give you—at no additional cost—a temperature transducer, it's a **steal**. And it is very accurate, from super low (−150°C) to super high (+170°C)!

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And if you've designed in a **temperature sensor** and could use a good voltage reference (ours is very reliable—referenced to the bandgap energy of silicon) the REF-02 offers a way to simplify your design. One part doing the work of several invariably translates into savings. **Two-fer-the-price-of-one.**

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Circle 15 on reader service card

People

Growth. Zeltex will double to $20 million by 1980, says Mike Preletz, its president.

16, 1974, p. 14]. "We can do it [$20 million] with just 20% growth per year without extending ourselves or diluting our interest."

Preletz, a 1960 graduate of West Point, who was general manager of TRW's Semiconductor division before joining Zeltex in 1972, expects to increase the emphasis on high-technology products for the computer and military markets. Faster conversion rates and higher accuracy, resolution, and reliability are all evident in the firm's latest analog-to-digital converters and the data-acquisition system modules—trends which will be boosted further by the relationship with Silicon General, which shares many Zeltex customers. "We have just begun to realize the benefits of that union, and the total is definitely greater than the sum of the parts," Preletz says with a good deal of satisfaction.

Independent growth. Silicon General has strengthened its position in the linear market with the development of proprietary voltage regulators, power control circuits, and new linear devices. This has set the stage for steady independent growth, Preletz points out.

In addition, Zeltex is already using some of Silicon General's chips for its products and expects to use even more of them in the future as the two firms coordinate their new-product developments. Nor is this the limit of Preletz' ambition—he does not rule out the possibility of further company or product-line acquisitions.

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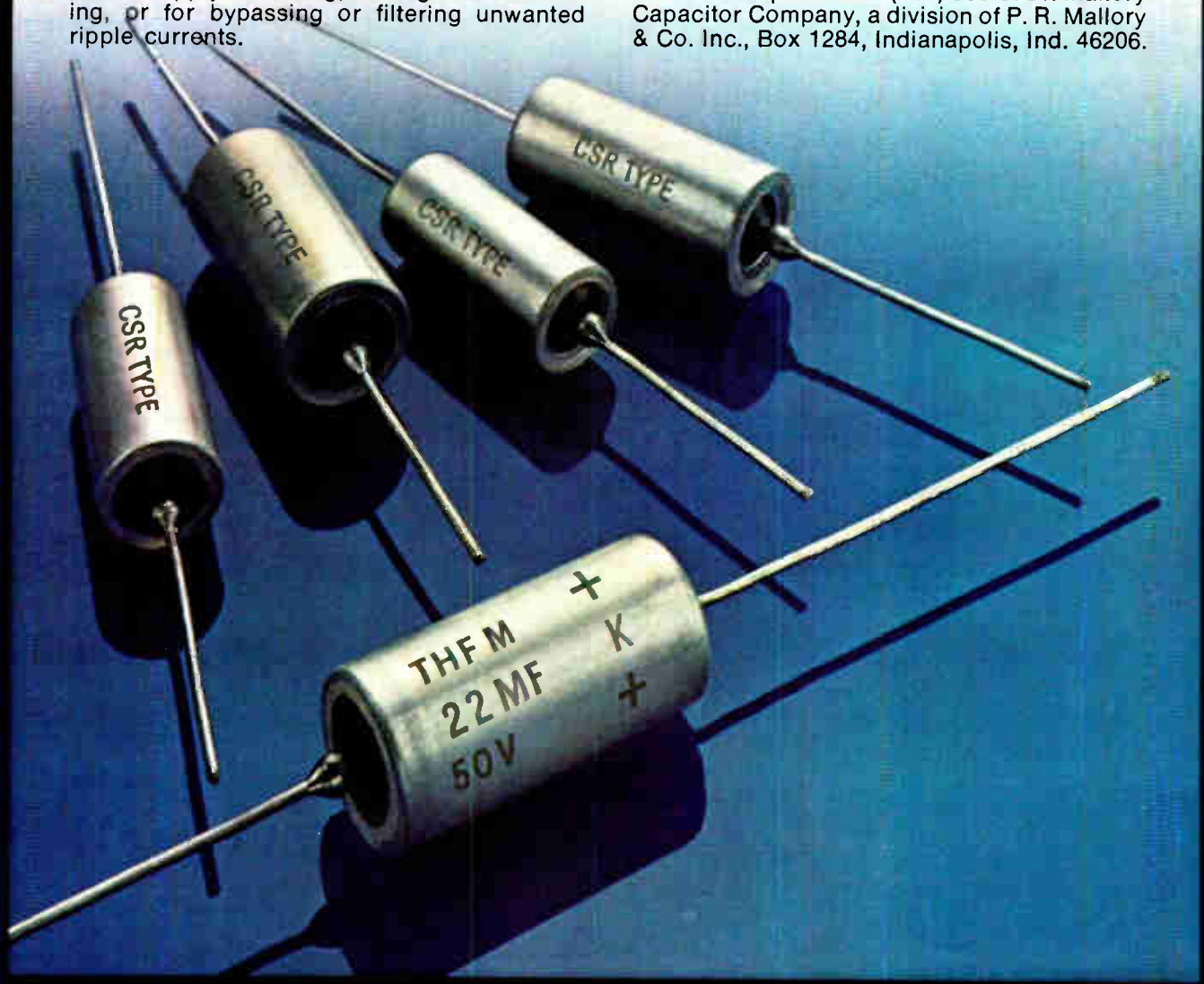

MALLORY

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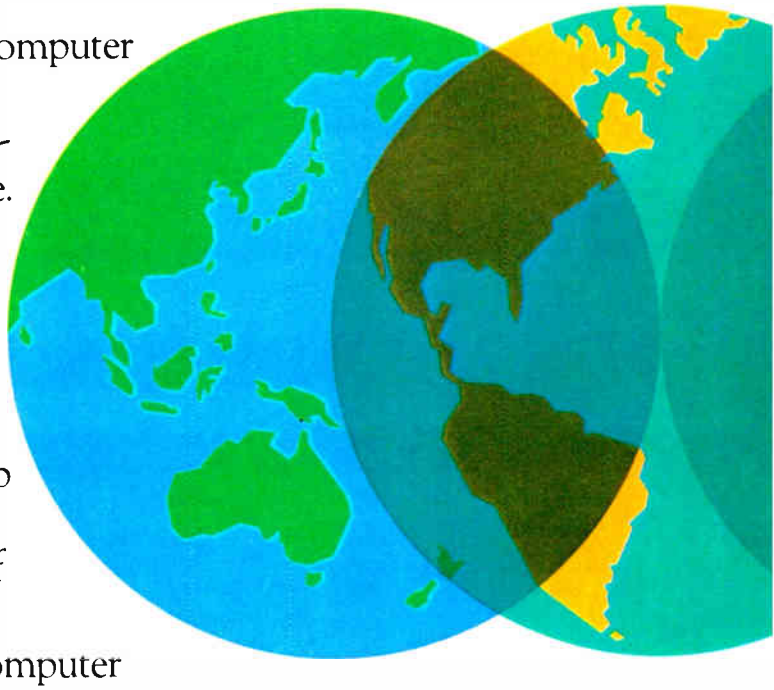
Intel delivers micro ahead of the fast



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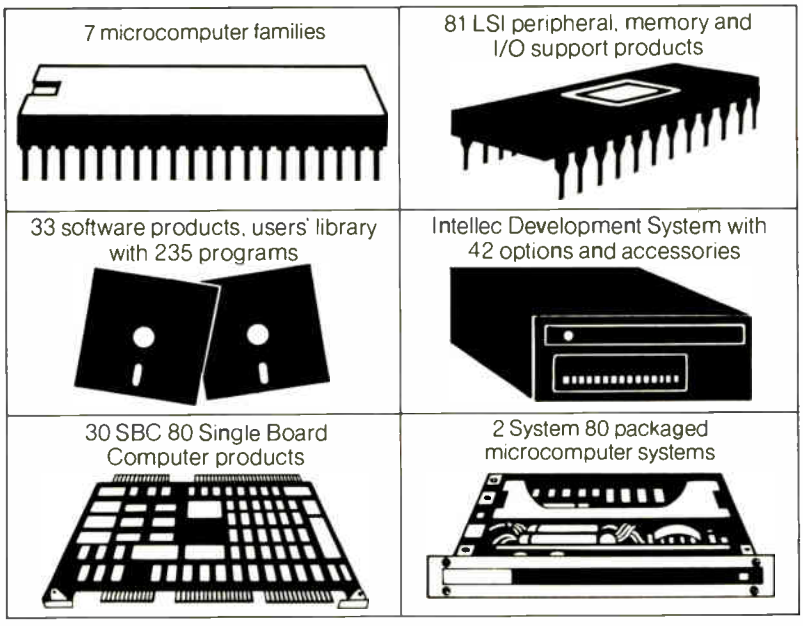

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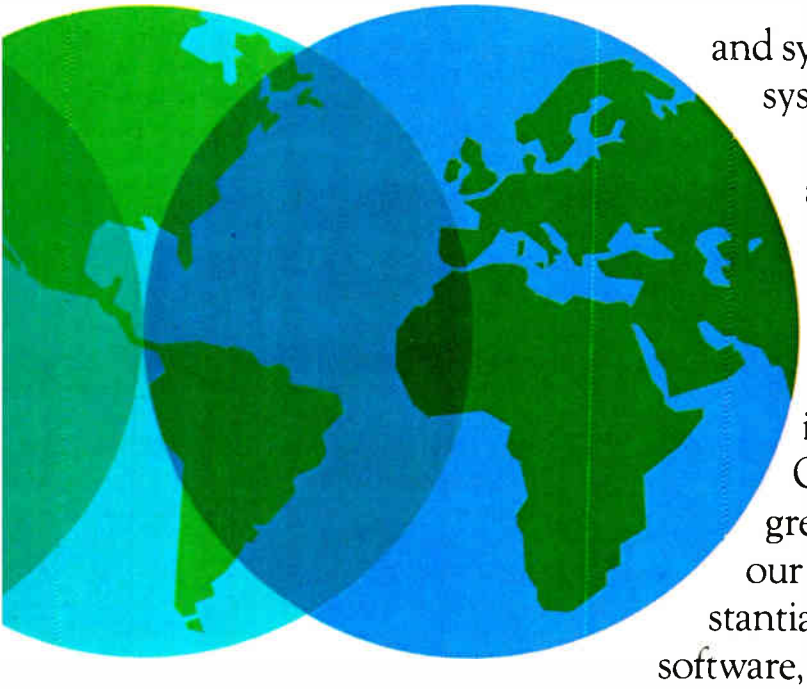

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Meetings

Appliance Technical Conference, IEEE, Pittsburgh Hilton Hotel, Pittsburgh, May 10–12.

Electronic Components Conference, IEEE, Stouffer's National Center Inn, Arlington, Va., May 16–18.

Naecon—National Aerospace and Electronics Conference, IEEE *et al.*, Dayton Convention Center, Dayton, Ohio, May 17–19.

National Quality Control Conference, American Society for Quality Control (Milwaukee, Wis.), Philadelphia Marriott Hotel, Philadelphia, May 16–18.

9th Annual Aviation Review Conference, FAA, Sheraton-National Hotel, Arlington, Va., May 16–18.

Nepcon '77 East, Industrial & Scientific Conference Management Inc. (Chicago), The Civic Center, Philadelphia, May 17–19.

National Micrographics Association Conference and Exposition, NMA, Dallas Convention Center, Dallas, May 17–19.

International London Electronic Component Show, Radio and Electronic Component Manufacturers Federation, Olympia, London, England, May 17–20.

Computer Security and Integrity Symposium, National Bureau of Standards and IEEE, NBS, Gaithersburg, Md., May 19.

Seventh International Symposium on Multiple-Valued Logic, IEEE, University of North Carolina at Charlotte, May 24–27.

Semicon/West 77, Semiconductor Equipment & Materials Institute (Mountain View, Calif.), San Mateo Fairgrounds, San Mateo, Calif., May 24–26.

1977 Incremental Motion Control Systems and Devices Symposium, University of Illinois, Ramada Inn, Champaign, Ill., May 24–27.

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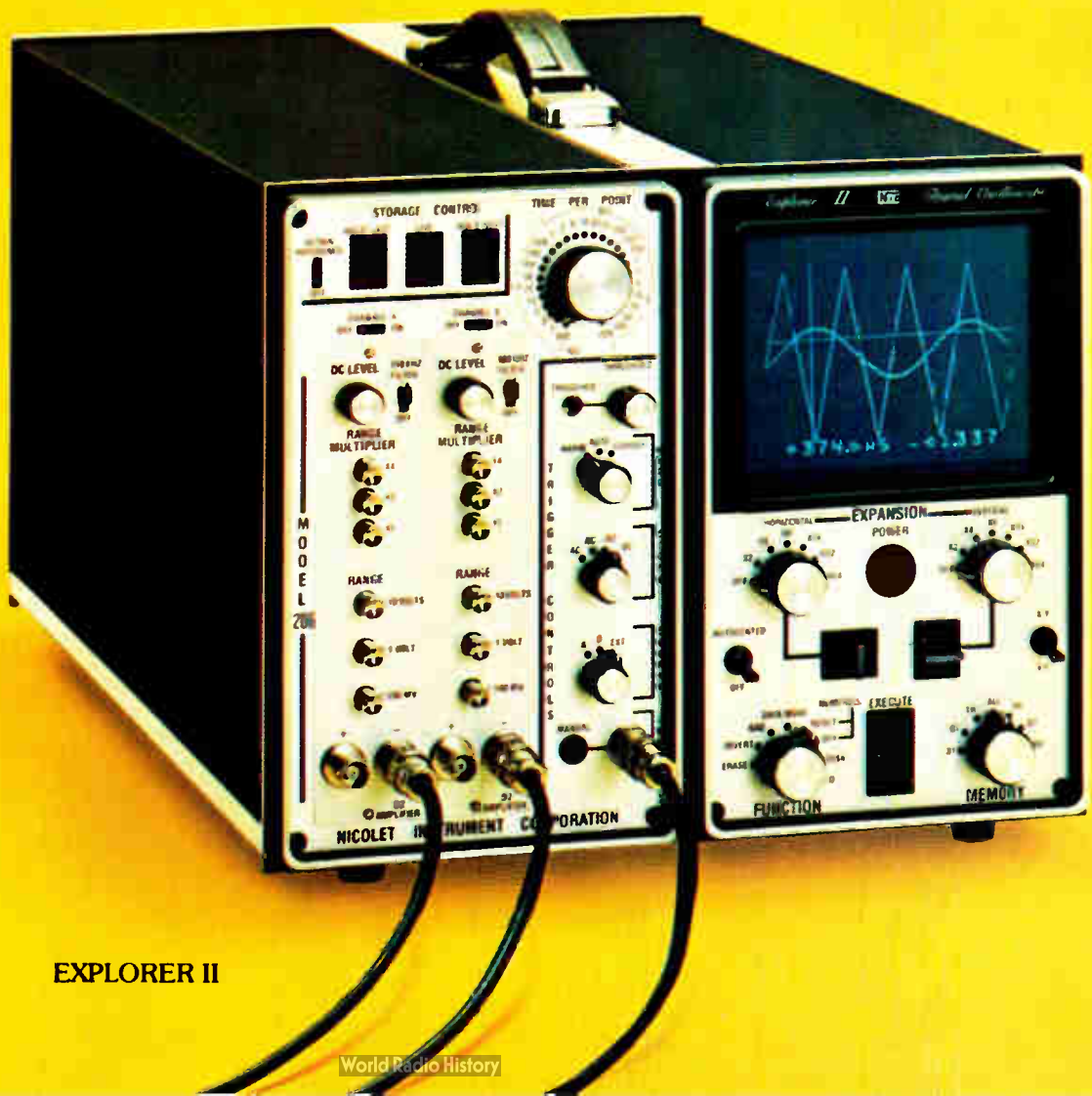

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There's a lot more to EXPLORER II. But a simple listing of features doesn't tell the story very well. You really have to see it in action, or better yet, use it. Then, we think you'll agree — It's some 'scope.

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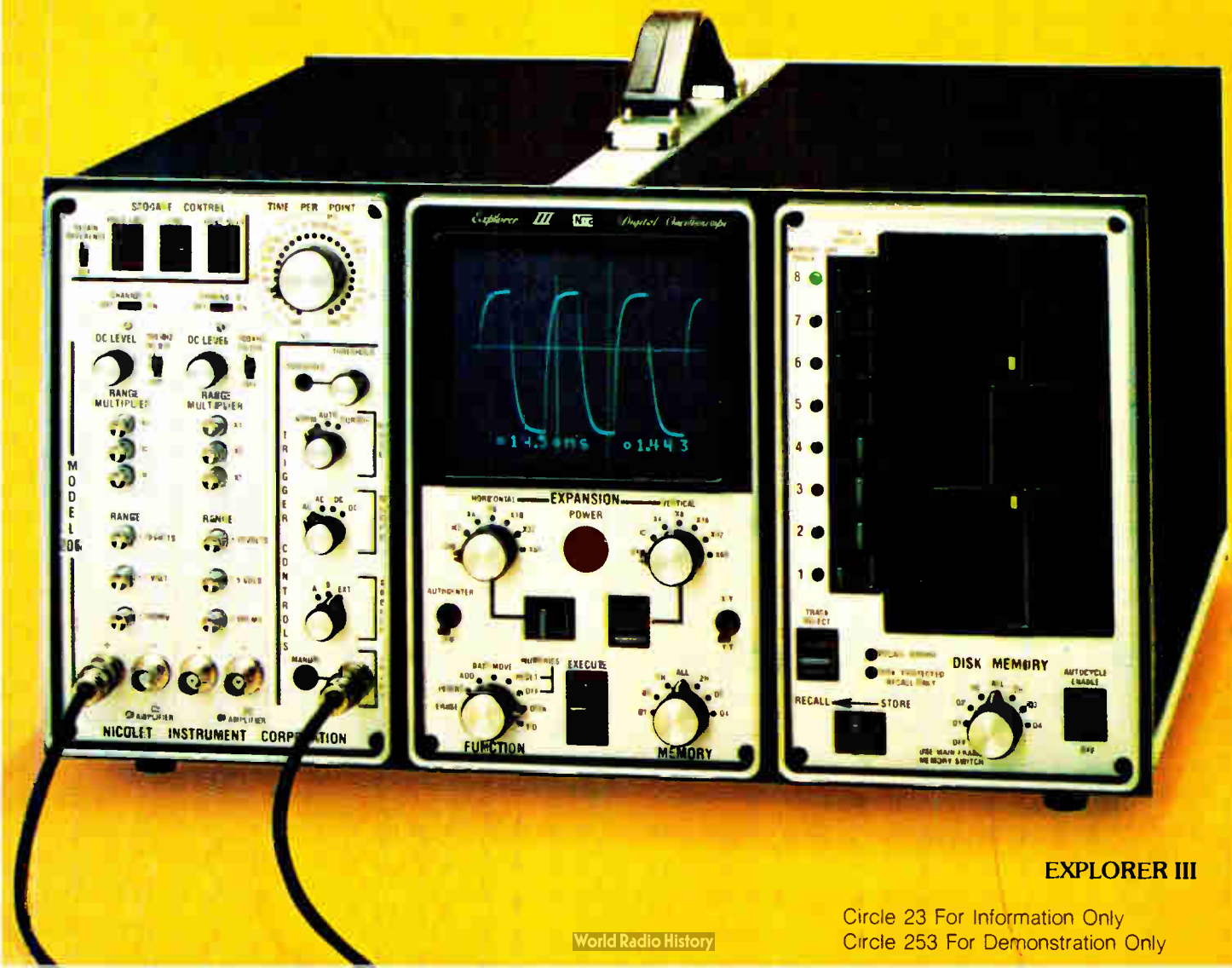

EXPLORER III

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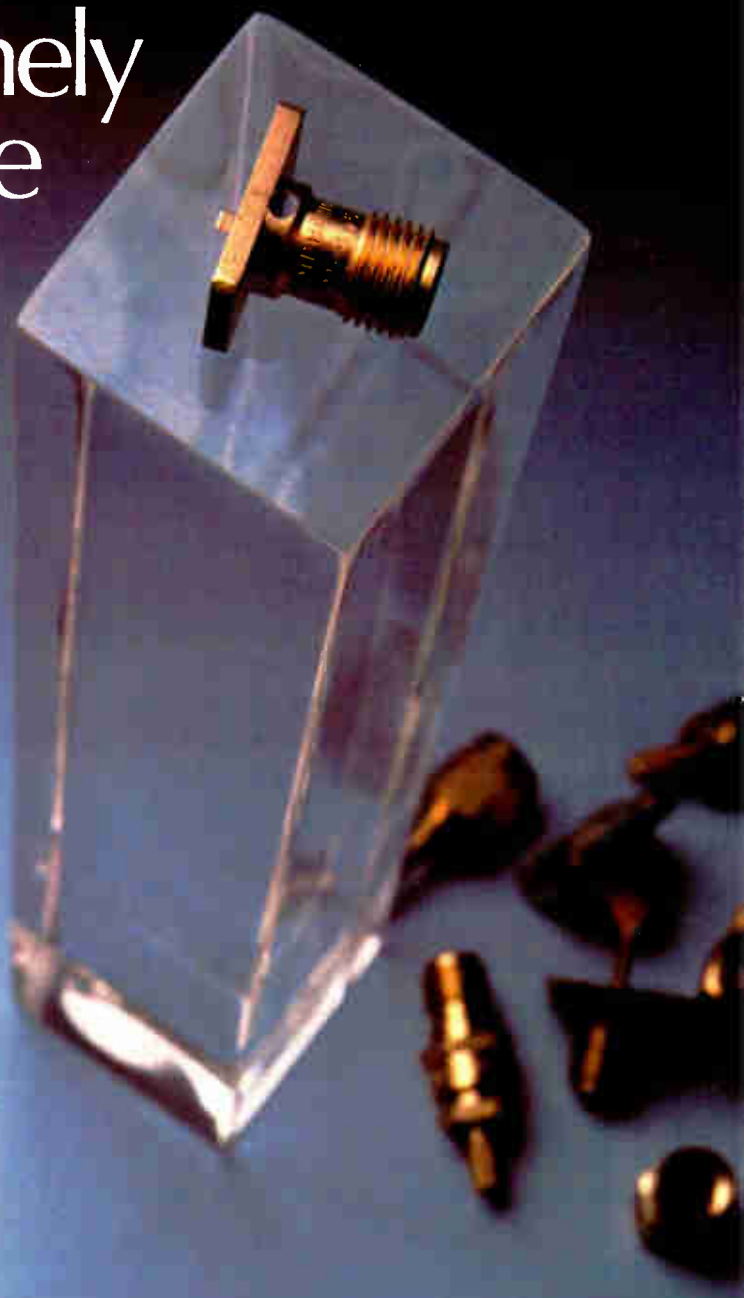
It's lonely at the top.



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Electronics newsletter

TI's Clough foresees 18% rise in 1977 for semiconductors

The worldwide semiconductor market shot up from $4.2 billion in 1975 to $5.6 billion last year, a 32% hike, but the best is yet to come, says Charles Clough, semiconductor marketing manager for Texas Instruments Inc. of Dallas. The 1977 market, he predicts, **"will be up strongly over 1976," increasing 18% to $6.625 billion.** Integrated-circuit sales, which last year topped those of discrete components for the first time ever, will lead this year's growth with a 24% rise to $3.580 billion, while sales of discretes will grow 12% to $3.045 billion.

The U.S. semiconductor market, which jumped 33% from $1.8 billion in 1975 to $2.39 billion in 1976, **will tag on another 18% this year to reach $2.83 billion.** Pacing that growth will be the computer (up 26% to $540 million) and industrial (24% to $620 million) segments. Also increasing strongly, says Clough, will be the distribution (15% to $550 million), consumer (14% to $620 million), and Government (14% to $500 million) segments. The growth in computer end-equipment sales, Clough says, "will be paced by minis and peripherals, while the industrial segment will be led by the telecommunications industry." The major computer companies have their inventories in line and, he adds, 1977 procurement contracts indicate unit consumption increases of 20% to 30%. Second-tier computer companies have balanced inventories, and backlog is in line with lead times.

Harris readies 16-k PROM using new bipolar technique . . .

Look for Harris Semiconductor in Melbourne, Fla., to build a 16,384-bit bipolar programmable read-only memory with a new passive-isolation process. The so-called "sidewall-isolated" technology **resembles an old Harris process called poly-planar** and uses polysilicon as a backfill to isolate both elements within the bipolar devices and the devices themselves. It helps the 2,048-by-8-bit PROM achieve its 70-nanosecond access time and 500-milliwatt power dissipation. To be introduced later this year, the HM 7616 is designed as a pin-for-pin replacement for 4-k and 8-k PROMs, as well as 16-k erasable PROMs.

The Harris division is also developing a high-speed complementary-MOS 8-bit microprocessor and peripherals for a custom telecommunications application.

. . . and monolithic 12-bit bipolar d-a converter

Harris is also going into production with a monolithic 12-bit bipolar digital-to-analog converter, the second such chip to be announced in the last two months. Like the first device, which is being made by Precision Monolithics Inc., Santa Clara, Calif., the Harris d-a converter is functionally equivalent to Analog Devices' AD562, a 2½-year-old hybrid built with a pair of custom large-scale chips. **Providing both high speed and good stability,** the Harris device settles to within 0.01% of the final output value with 100 nanoseconds maximum and holds gain temperature coefficient to a tight 2 ppm/°C. Like the AD562, it is a current-output d-a converter and has no internal voltage reference. Price is approximately $29 each in quantities of 1,000.

Electronics newsletter

Fairchild to make 8-bit ECL chip set . . .

Fairchild Camera and Instrument Corp. plans to start production of an 8-bit microcomputer chip set with typical instruction execution times of 20 to 50 nanoseconds. Combining emitter-coupled logic with Fairchild's Isoplanar II, an oxide isolation process, the new family will make it possible **to build a high-speed "midi-computer" with a mere half-dozen chips.** The CPU and three other parts have already been defined.

. . . as systems unit prepares smart digital panel meter

Fairchild Camera & Instrument Corp.'s next big effort in digital panel meters will be "smart" DPMs, **which will incorporate an F8 microprocessor** to control high-low alarms, take average readings, do peak and valley recording, and so on. Oriented toward the upper end of the original-equipment-manufacturer market, the DPM will sell for under $300 in quantities of 100, says James D. Bowen, vice president and general manager of the Instrumentation and Systems group. The San Jose, Calif., operation already has a large initial order from one customer and plans to introduce the meter officially this fall.

Avnet add to Shugart drives to micro line

Hamilton/Avnet Electronics, the largest independent electronic components distributor, is expanding its microcomputer activity with the addition of peripherals for OEMs building microcomputer systems. The Culver City, Calif., distributor, whose microcomputer activity to date consisted of distributing the learning kits of Intel and Motorola, **will handle the line of floppy-disk drives** from Shugart Associates of Sunnyvale, Calif. Soon to be added will be CRT terminals, line printers, and other peripherals.

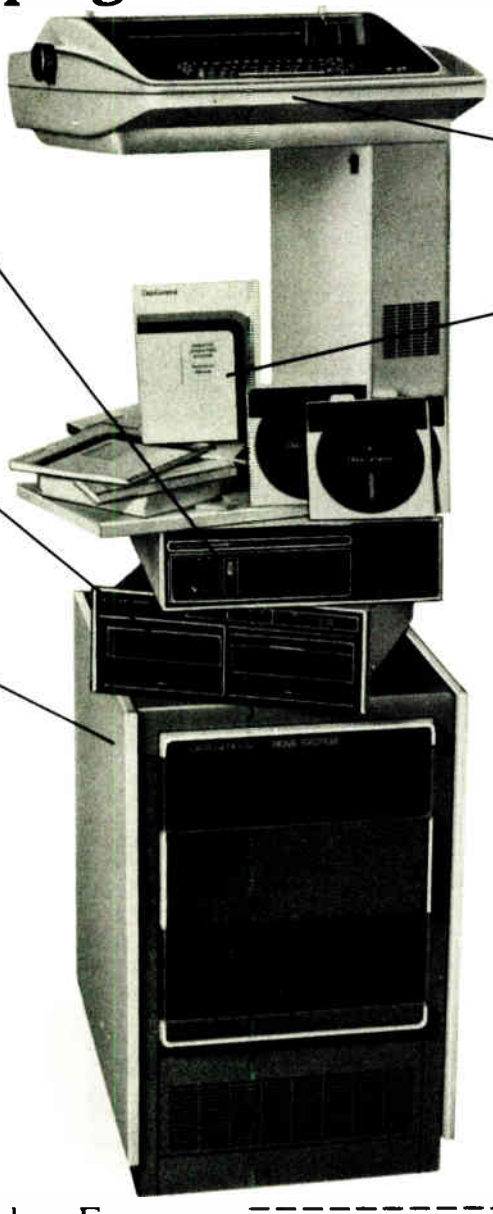
Travel agents to try computer-run reservation system

Three companies will conduct on-site tests of their versions of a computerized reservation system for travel agents. Sponsored by 12 airlines, American Express, and the American Society of Travel Agents under special antitrust immunity from the Civil Aeronautics Board, this pilot project **will enable selected travel agents to tap many airline reservation systems from a single display terminal.** Approximately $100,000 each has been awarded to Honeywell Information Systems, Incoterm Corp., and Timeshare Inc. to test systems in Seattle, New York, and Chicago, respectively.

Addenda

Experienced old-guard members continue to lead President Carter's list for top technology appointments. **Latest example: Robert Frosch, 49, who will be named to head NASA.** He served in the mid-1960s as head of the Defense Department's Advanced Research Projects Agency before becoming assistant Navy secretary for R&D. He is now deputy director of Woods Hole Oceanographic Institution. . . . Navy Secretary W. Graham Clayton said in his first policy address, to the Navy League in Washington, that the Navy still puts **a high priority on the controversial Project Seafarer** shore-to-sub communications system despite the House Armed Services Committee's refusal to spend $23.7 million to start the grid [*Electronics*, April 14, p. 49] . . . . Texas Instruments will introduce **a new line of $9.95 watches this summer.**

Here's how Data General's microNOVA system stacks up against the competition.



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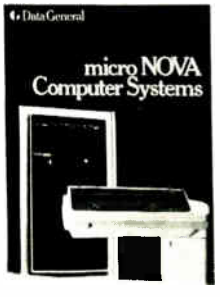

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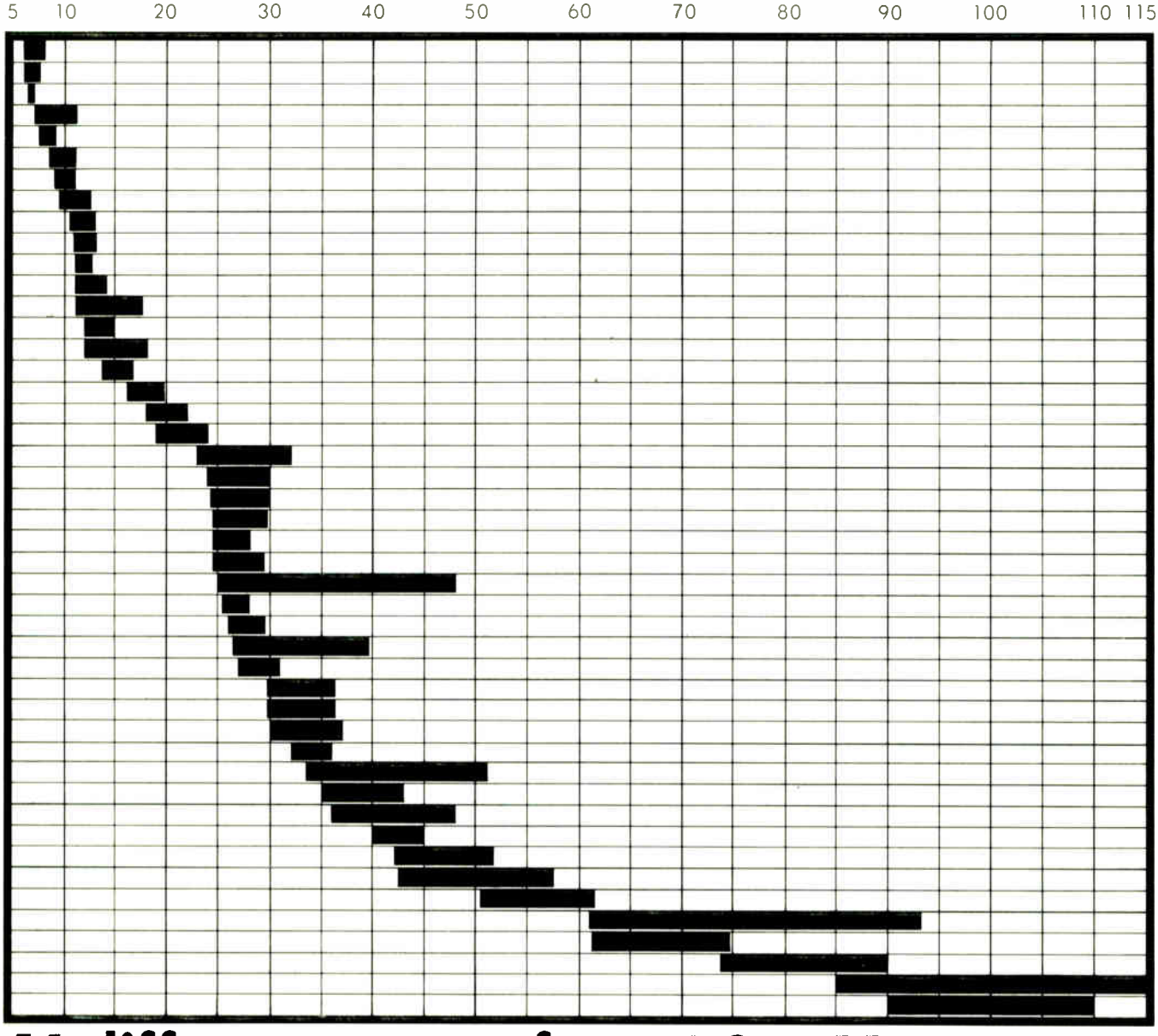

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Silicon transducer strapped to wrist reads blood pressure

Nicolet to produce first commercial unit to take pressure continuously with noninvasive device

Doctors have long relied on surgically-inserted catheters for continuous blood pressure readings of critically ill patients. There may soon be an alternative if a new instrument, an arterial tonometer developed by Nicolet Instrument Corp., a Madison, Wis., maker of medical research and clinical equipment, proves to be a success.

Instead of the surgical procedure, the $7,000 tonometer relies on a noninvasive transducer, which is strapped over the artery in the wrist. Catheter-based equipment, selling for half this price, inserts into an artery a device that is tipped with or connected to a pressure transducer.

Physicians who have seen the Nicolet device are guardedly optimistic. "If I can get beat-by-beat pressure without sticking an artery, I'm very attracted to it," says one Veterans Administration physician, "but I'd want to test it against inter-arterial pressures [obtained with catheters] under various conditions."

As pressure in the artery builds up and subsides with each heart beat, the artery itself expands and contracts—and this is sensed by the transducer in the Nicolet machine. With the aid of a Z-80 microprocessor from Mostek Corp., the tonometer displays the blood-pressure waveforms on a Tektronix 5100 oscilloscope mainframe. These waveforms help medical personnel to position the transducer for a maximum pulse signal. They also provide a visual track of changes in the patient's condition.

Scope readouts. The cathode-ray-tube scope also shows digital readouts of systolic/diastolic blood pressures, mean blood pressure, pulse pressure, and heart rate. These are calculated by the microprocessor, using algorithms that recognize and count the analog signal's peaks and measure areas under the curves.

The Z-80 also sounds an alarm when the signal changes more than 25%. The machine has a front-panel input to display electrocardiogram signals directly beneath the blood-pressure wave. Both signals can be "frozen" in the system memory and on its screen, a technique that brings up cursors for measuring time and pressure differences between points on the pressure curve and timing shifts between the pressure and cardiogram signals. Also there is a digital port for output to a hard-copy recorder.

"The advent of the microprocessor is what gives us a useful clinical product in a small package, instead of a laboratory curiosity," says Jeffrey C. Petzke, product manager for Nicolet. "It supervises the system, takes in the data, does the calculations, and puts the information into fixed memory areas."

But even the microprocessor cannot do everything, Petzke continues. Fast, hardwired logic is needed to take the analog and digital data from the tonometer's 12,288-by-8-bit random-access memory and display it. The program for the microprocessor is stored in a 5,120-by-8-bit programmable read-only memory.

The piezoresistive pressure sensor fits in a half-inch-diameter steel plug. "A cuff holds the sensor to the wrist, and an air bladder partially constricts the artery to maximize the waveform," Petzke explains. With the sensor in place and the waveform on the screen, a cuff like that on a common blood-pressure sphygmomanometer in a doctor's office is used to calibrate the instrument. The piezoresistive sensor then measures changes from this "norm." Electronics has been applied to sphygmomanometers but only to the point where they are pumped up and read out automatically; they don't read continuously (see International Newsletter).

The sensor is a silicon wafer 1 millimeter in diameter and doped

Reading. Nicolet Instrument's arterial tonometer is built into a Tektronix scope's mainframe. Cuff pumped up with air holds piezoresistive transducer securely on wrist.

with four resistive areas. It is built by Kulite Semiconductor Products Inc., Ridgefield, N. J. "Two of the resistors are near the center of the wafer; the other two are near the wafer's edge," explains Dennis E. Bahr, engineering manager for the tonometer. "The edges of the device are held rigid, so as pressure increases, the center resistors lengthen, increasing their resistance, and the outer resistors compress and shorten." The resistor areas are wired in a four-arm bridge. "As the resistors change in value, the microprocessor sees a voltage imbalance in the piezoelectric bridge that's directly proportional to the pressure."

The Nicolet project team has tested the instrument on dogs, comparing blood pressure waveforms obtained simultaneously with a conventional sensor-tipped catheter system. "If there are any differences in the waveforms, they were not visually apparent," Bahr says. Next month it will go on trial on catheterized patients in hospitals in Madison, and Iowa City, Iowa. Limited production starts next month also. □

Displays

Liquid crystals for watches are turning out to be in good supply

Punctured by the electronics industries' old bugaboo of double and triple ordering, the shortage of liquid-crystal displays for digital watches may be evaporating. Beckman Instruments Inc., the major LCD supplier began the year working around the clock seven days a week in an expanded facility, but now reports tapering down to 70% to 80% of its all-out effort. Motorola, too, thinks LCD production is now ample.

On the other hand, William K. Weakland, general manager of Hughes Aircraft Co.'s digital-watch operation, which only recently added LCD watches to its light-emitting-diodes designs, insists, "LCDs are still in short supply." He estimates that three or four months' lead time is needed at present "to buy LCDs from any quality house."

Several factors have helped dissolve December's near-unanimity that booming demand would snap up all LCDs produced well into this year [*Electronics*, Jan. 6, p. 67]. Bolstering that outlook, it seems, was a distortion of booking caused by double and triple ordering from suppliers.

Aggressive buyers. "From the start, I saw the [so-called] shortage caused by overly aggressive attempts to buy," observes Thomas Hyltin, president of Micro Display Systems Inc., a Dallas-based module manufacturer. Agreeing, Beckman's Leslie W. Chapin, vice president and general manager of the Electroproducts group, Fullerton, Calif., says, "Module manufacturers panicked in January and February and said 'don't ship'." The abrupt change was caused not only by the usual cyclic seasonal lull in the watch business, but by the negative effects on LCD module sales from "dumping of LED models by firms going out of the business."

Also, new capacity is starting to come onstream, from Motorola in particular, which claims that "shipments have been building fast since the fourth quarter." Timex also this month began pushing the display capability of the facility in Somerset, N.J., it recently acquired from RCA Corp. Several sources, though, claim added capacity is not yet making a difference.

As a supplier, Chapin is unworried about the slack period, noting that "the order pace is already picking up and should heat up again around June." Some standard LCDs are now available from stock, but specialized orders may take several months. He sticks with his earlier forecast of 12 million to 15 million LCD watches to be sold worldwide in 1977. But to lessen dependence on a few large customers, Beckman is moving to diversify its order base. He says Beckman is now selling about 20% of its output to module makers in the Far East.

One thing spooking both component suppliers and module builders is Japanese competition. "The Japanese are already here," notes Weakland, "but so far it's been more talk than sales." Motorola concurs, "but it's only a matter of time," predicts Gene Simpson, assistant general manager of the Communications Systems division, located in Schaumburg, Ill. The plans are now very clear, he believes, "to inundate the American market with modules and components."

Finally, Micro Display's Hyltin sounds a cautionary note about the quality of LCDs built by new producers—"they could have the kind of reliability problems" that plagued early LEDs and hurt the reputation of digital watches. □

Liquid-crystal cell to upstage CRT?

A liquid-crystal projection display capable of showing 20 times as much information as a present-day cathode-ray tube is in the offing, or so John Dewey's group at IBM Research Laboratories in San Jose, Calif., believes.

"Today's CRTs must be pushed to display just 2,000 characters," noted Dewey last week at the Society for Information Display's conference in Boston. But 40,000 characters, each made up of 9 by 12 picture elements, will be possible with the laser-scanned 2,000-by-2,000-element display that "we feel we can see our way to." The group's initial system has only 500 elements on a side—a limitation imposed by the quality of the lenses and not by either the LC material or the laser, claims Dewey.

35-mm slide. The display basically comprises a liquid-crystal cell about the size of a 35-millimeter slide, an injection laser, a pair of galvanometer-driven mirrors that scan the

laser beam across the cell, and a light source and lenses for projecting the image at a 25X magnification. While being scanned across the cell, the laser beam turns on and off, forming the characters by heating up the liquid crystal and causing it to switch. It writes one character at a time, scanning the 10-micrometer-square area in a twentieth of a second.

An M6800 microprocessor controls both the modulation and the scanning of the laser beam. The modulation creates the characters, and here the M6800 works from a text stored in about 1 kilobyte of random-access memory. The scanning is directed by the M6800 through two digital-to-analog converters that control the galvanometer servo system.

To erase the display, an alternating voltage is applied to the cell. Alternatively, areas can be erased selectively, by heating them with an electrostatic field so that their threshold changes and then aiming the laser beam at them. "The main thing we proved is that we can produce a nice-looking display," Dewey says. "The characters are sharply defined and are black on white." □

Military

Army speeds application of hybrids and microprocessors to battlefield

Hybrids and microprocessors head a good-sized list of projects at the chief research and development arm of the U. S. Army's Electronics Command. "Over half the Army's [electronic] equipment to be built from here on out will use hybrid circuitry, both thin- and thick-film," predicts Clare Thornton, the new director of the Electronics Technology and Devices Laboratory at Fort Monmouth, N. J.

In microprocessors, his group is seeking both to qualify commercial units for military requirements and to develop a high-speed but low-power device built with complementary-MOS-on-sapphire technology [*Electronics*, March 31, p. 47].

Those are only two of the areas in which Thornton's 340-person lab can expect to spend a healthy $25 million this year. Its other programs include the development of charge-coupled devices for radar signal processing, better fabrication methods for gallium-arsenide devices used for high-speed signal processing in electronic intelligence and radar processing systems, and lithographic resists more sensitive to electron beams than those available now.

The military would like to be able to buy standard hybrid parts from industry and then simply run go/no-go tests to see if they work as they do on other kinds of components, Thornton points out. But getting to this point "poses a problem because there's no coherent industry base, but lots of small hybrid houses each doing their own thing."

Failure modes. His lab is researching failure modes and mechanisms associated with every known hybrid process and establishing a "Hybrid Microelectronics Process and Quality Control Guide" that will be "our bible for determining whether a vendor's process and parts will be suitable for a specific system's requirements." A draft of the guide is now out to several manufacturers, with their comments expected back shortly. Thornton says the first edition will be published "within a few months and updated as new knowledge is obtained."

As for microprocessors, he says, they are already having "a tremendous impact on the price and performance" of military hardware, often slashing its cost by 90%. Keeping costs low is why he hopes to qualify commercial devices instead of developing special military types. He also notes that "the C-MOS-on-sapphire microprocessor will be complemented by a range of special-purpose LSI parts, also on sapphire, to perform special functions such as high-speed frequency synthesis and signal processing." Incidentally, his lab has already developed a low-temperature C-MOS-on-sapphire fabrication process that Thornton hopes also to see adapted commercially.

Thornton has only good words as far as his R&D budget level is concerned. Though this year's $25 million is up only slightly from 1976, he points out that the Department of Defense wants "each of the services to increase funding for device research by at least 10% beyond inflation. We expect to get back into a real growth mode in 1978 with about $30 million."

This upbeat in funding is in marked contrast to the situation when Thornton joined the lab in 1972 as director of its Semiconductor Devices and Integrated Electronics area. He came after a 17-year hitch with Philco-Ford's Microelectronics division, leaving as its director of research and engineering. Both industry and Government were then slashing research to nearly a quarter of what it had been, he recalls. Moreover, applied research was elbowing out basic research—a kind of atmosphere that is not healthy for the long pull, he says.

Director. Army's Clare Thornton is pleased at upturn he expects in funding for R&D.

One area he feels should have had more development effort is an old

Here's the laboratory

Clare Thornton's Electronics Technology and Devices Laboratory at the Electronics Command at Fort Monmouth, N.J., is divided into five broad R&D areas: semiconductor devices and integrated electronics, frequency control and signal processing, electronic materials, power sources, and display and storage devices. In these areas, the laboratory is charged with taking the lead in developing the Army's technological base, both within its own organizations and outside in industry. The Electronics Command is now in the 3-year process of being restructured into three new commands [*Electronics*, April 14, p. 12]. However, the devices laboratory will remain at Fort Monmouth, although it is set to report to the new Electronics Research and Development Command (Eradcom) which will be in Adelphi, Md., the site of Harry Diamond Laboratories. Thornton expects his group will remain virtually unchanged, with perhaps only a 5% cutback, mostly through attrition.

one—microwave-tube technology. "When you're trying to protect our aircraft from the enemy's large radars, present solid-state technology falls far short of the power levels required," he says. So he seeks to fund industry to develop new fabrication techniques for production of high-frequency microwave tubes for low-cost jammers. □

Consumer

Infrared sensor built into watch measures the wearer's pulse rate

Commuters running for a train can now worry about more than the time—with a new Pulse/Time Computer strapped to one wrist, they will also be able to check their racing pulses.

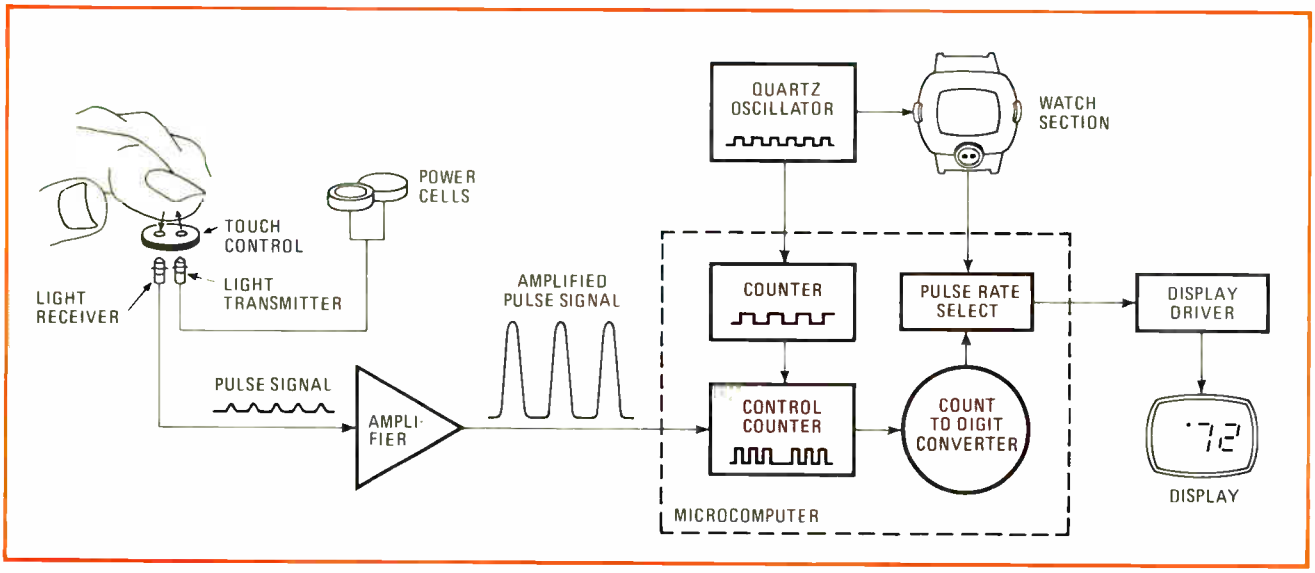
Two years in development, the $500 combination of watch and pulse-rate monitor was placed on the market this month by Time Computer Inc., the Pulsar watch people in Lancaster, Pa. It reads pulse rate with an infrared sensing unit that detects blood surges in the capillaries of a finger and serves up the data to a microcomputer.

The infrared transmitter and receiver are built into the top of the device. A finger placed over this section triggers the transmitter, which aims an infrared signal at the finger. The capillaries beneath the skin then reflect the pulse back to the receiver—a phototransistor.

Expand, contract. During a blood surge in a capillary, the vessel expands, absorbing more of the infrared and reflecting less back to the receiver. As the vessel contracts between surges, however, it absorbs less light and reflects more. The system measures these differences in signals, counts the intervals between them, amplifies the data 10,000 times, and feeds it to the pulse-rate microcomputer.

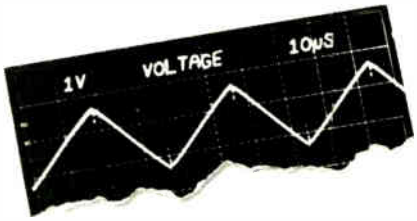
The microcomputer, a dedicated two-chip complementary-MOS set, digitizes the data. It counts each pulse beat represented by the surge signal, continuously averages the result of every two beats, and displays the average pulse rate on a light-emitting-diode readout. With its four batteries, the pulse-rate monitor and watch should handle 25 time and pulse interrogations a day for one year before requiring the owner to change the battery.

Buyers of this watch, says Time Computer president John Bergey, will include the growing number of



Pulse watch. Infrared signals reflected from capillary are sensed, then counted by microcomputer to yield pulse rate that's shown on LED display of Pulsar timepiece.

If you're only measuring voltage, you're only getting half the picture



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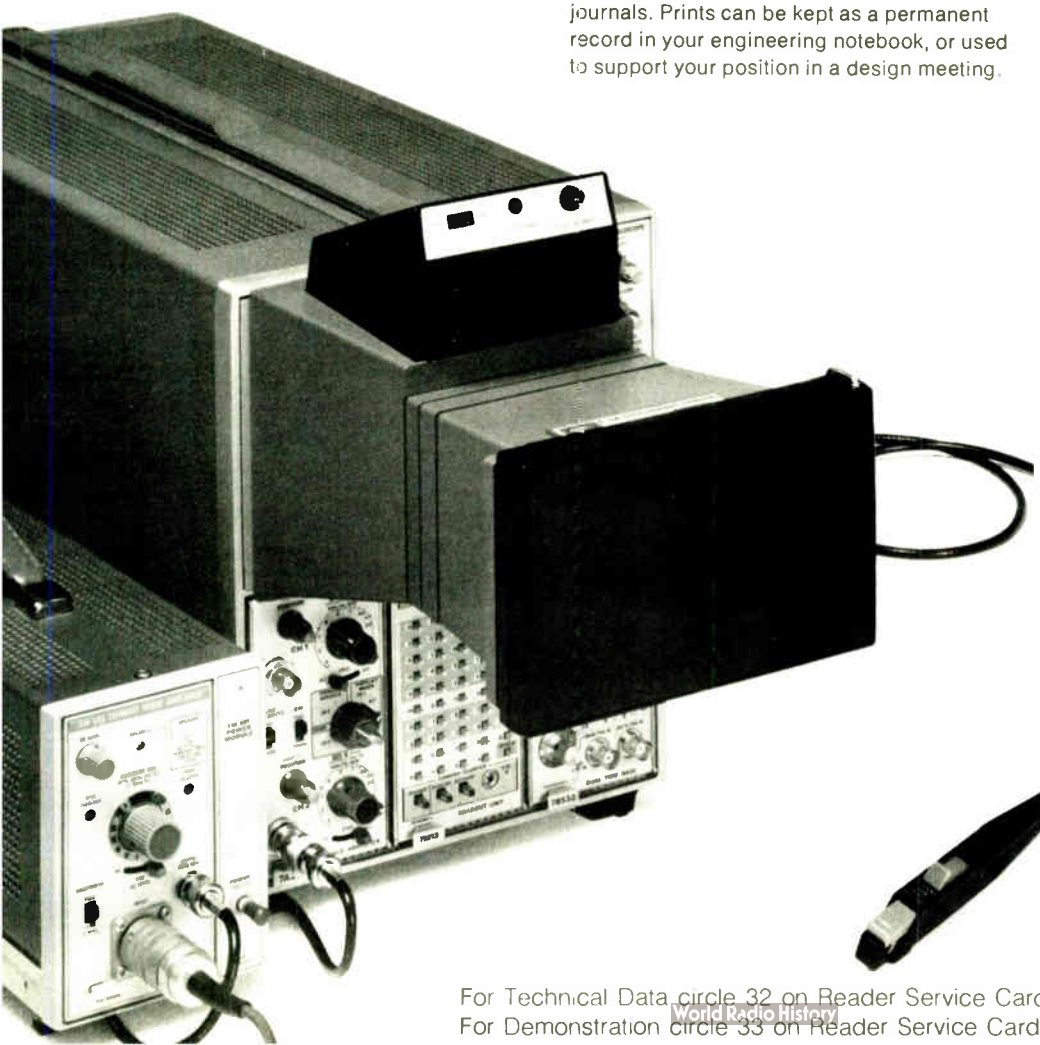

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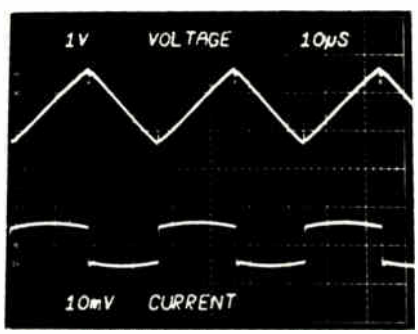

Once you get the whole picture, save it with a scope camera

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people interested in physical fitness. "We estimate the market for a stainless steel, $500 model to be in the tens of thousands," he says.

Good interfacer. The IR sensor, according to Bergey, interfaces well with the user and the microcomputer. Its drawback is its extreme sensitivity to light, so that both the transmitter and receiver have to be covered completely in order to get an accurate reading. In addition, too hard a pressure on the sensor tends to cut down the flow of blood to the capillaries, inducing a false reading.

The two-chip complementary-MOS processor is supplied by RCA Solid State division and was developed by the RCA Advanced Technology Center. Both chips are basically logic arrays but also contain encoders, decoders, an analog-to-digital converter, and squaring circuitry. The display drivers and the pulse IR signal amplifier are separate discrete devices. Also, the watch does contain a separate C-MOS time chip for those who simply want to know the time. □

Military

Darpa seeks 19% boost in R&D

To fund some of the more avant-garde of the nation's electronic technologies, the Defense Advanced Research Projects Agency is asking Congress for a hefty 19% boost in R&D funds for fiscal 1978—to $280.5 million. Taking high priorities are programs for high-energy space lasers, space surveillance, optics, and antisubmarine warfare.

To win over congressional military R&D subcommittees, agency director George H. Heilmeier presented the programs in such extensive detail that some congressional and military staffers expressed concern about the disclosures. But a supporter of his on the Pentagon's R&D staff declared that "while there is a lot of fresh detail" in the presentations, there is nothing "Soviet intelligence could benefit from and probably doesn't already know."

Justifying his claim for a $3.75 million boost in space-based high-energy laser programs to $24.9 million, Heilmeier says their potential could be "Sputnik-like" in influencing how foreign countries perceive the U.S. leadership in defense technology. Darpa has already demonstrated small-scale, hydrogen-fluoride chemical lasers operating in the 2.7-micrometer region "as the most promising candidate (for space) because of (their) high power per unit system weight," Heilmeier says. Next year, he wants to scale them up to demonstrate high-precision, long-range tracking of space objects.

Further along. For the longer term, Darpa is developing electrically excited, high-energy, single-pulse lasers in the ultraviolet region instead of the chemical hydrogen-fluoride infrared type "because of optical-system design penalties imposed by longer wavelengths." In the UV/visible-light lasers, Darpa has gained courage from its success last year in pushing the output of rare-gas halide lasers from 1 joule per pulse to over 350 J/pulse with a 10% electrical efficiency. Heilmeier called the development "a breakthrough" that provides "substantially increased confidence that such devices are feasible."

Problems with high-power UV/visible lasers, however, lie in the system optics, notably mirrors and windows to control the beam. "Pulses are so intense," Heilmeier points out, "that antireflection and reflection-enhancement coatings are frequently blown off with a single laser pulse. If they are not, the components may optically distort and defocus the laser beam." To counter this, Darpa is accelerating a materials program for dielectric-enhanced mirrors, antireflection-coated windows," and other critical optics.

Surveillance. To maintain the U.S. lead over Soviet space-surveillance technology, Darpa wants $52.9 million to push a variety of programs using new applications of charge-coupled devices, microprocessors, and lightweight optics. To sort out weak target signals, Heilmeier says Darpa wants "tens of thousands" of CCD signal processors on a single chip and integrated with CCD imagers. "We call this concept CCD^2," he explains. The integration of signal-detection and processing functions on the same chip should enable targets to be extracted from clutter automatically, eliminating the cost and delay of using large ground-based computers for clutter suppression. At the same time, Darpa is developing new special filters to pass specific target radiation characteristics while blocking out natural background noise.

As for its proposed $25 million investment in antisubmarine warfare technology, Darpa expects a significant return from its Project Seaguard, which attempts to define the limits of ocean acoustics and acoustic arrays. Seaguard is focusing on large acoustic arrays, for use as hydrophones and for telemetry, deployment, and mooring, and signal processing, including the automatic underwater search, detection, and recognition of sounds. Darpa's lead acoustic research center to accelerate ASW signal-processing research at Moffett Field, Calif., has real-time access via satellite to several operating ASW arrays. This is coupled to a massive, real-time computational capability in Illiac IV, the world's largest computer. □

Communications

High-speed fax meets proposed spec

The first high-speed digital facsimile machine to meet international standards proposed for sub-minute facsimile transmissions came forth this month from 3M Co. This represents the first important step toward a network of compatible fax machines that could communicate quickly throughout the world.

The 3M Co.'s machine, the Express 9600, was developed by the company's Information Management department in St. Paul,

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Circle 35 on reader service card

Minn. It sends a 300-word letter—about what fills up a standard typewritten page—in about 20 seconds when transmitting at the unit's top 9,600-bit per second rate. It meets the transmission standards proposed by the CCITT (the multinational Consultative Committee International Telephone and Telegraph) based in Geneva. When approved, the standards will tie down key specifications for high-speed fax.

The major areas covered by the standards are: resolution (200 lines per inch horizontal by 96 lines/in. vertical with an option of 192 lines vertical); signalling protocol (high-level data-link control and redundancy code); data compression to speed transmission using Huffman coding (an encoding scheme that looks at a line being scanned, evaluates the amount of black and white information it contains, and decides on the best way to send it), and a standard modem that data-communications equipment makers proposed to CCITT.

Electronic mail. "By the year 1982, high-speed digital facsimile systems will have become a reality in many parts of the world, built around a new generation of microprocessor- and LSI-implemented facsimile- and word-processing terminals," says Howard Anderson, president of the Yankee Group, a consulting and market research firm in Cambridge, Mass. "And these terminals will be fast enough to usher in electronic mail systems which, by then, will be used by at least 35% of the Fortune 500 companies." Even more significant, Anderson continues, is that the electronic mail systems operated by the individual companies will also be connected to those provided by the U. S. Postal Service and other communications common carriers.

The CCITT proposed the facsimile standards late last year. They are circulating among the national groups making up the organization for their approval, a process that could take several years. In the meantime, other facsimile-machine makers like 3M Co. are understood to be developing units to meet specs

News briefs

IBM introduces System/34

A low-cost distributed data processing system has been introduced by International Business Machines Corp.'s General Systems division in Atlanta. Called the System/34, the small computer system consists basically of a central processing unit, disk storage of 8.6 megabytes, and a one-sided diskette drive. It includes 32,768 words of main storage (made up of metal-oxide-semiconductor integrated-circuit packages), with an access time of 600 nanoseconds, and a controller to allow attachment of up to eight display stations or tabletop printers. Compatible with IBM's earlier stand-alone System/32 small computer, the System/34 costs $34,700, with first deliveries scheduled for January 1978. The computer's CPU contains multiple microprocessors to support a portion of the supervisor program and input/output control, and controllers for driving specific I/O devices.

Microfair: the show will go on

Microfair International, the trade show set for Chicago next October that is aimed at new and unsophisticated users of industrial microprocessors, will be taken over from Wema, the electronics trade association, by the original promoter and owner of the show name—Golden Gate Enterprises Inc., Sunnyvale, Calif. Wema decided to drop its sponsorship, after investing some $15,000 in preparations, when five major members of its semiconductor device group formed the Semiconductor Industries Association and said they would not participate [*Electronics*, April 14, p. 50]. Bill Hickey, vice president at Golden Gate, says he has 20 companies already signed up and hopes to enlist some top Japanese microprocessor makers and users.

Sperry gets $50 million for fire control

Sperry Rand Corp.'s Sperry division in Great Neck, N.Y., has received a U. S. Navy contract valued in excess of $50 million for a new lightweight gun and missile radar fire-control system. The MK-92, as the system is called, permits a ship to respond swiftly to airborne or surface threats with either its gun battery or its defensive missiles.

McLucas, former FAA chief, named Comsat General president

John L. McLucas, former Federal Aviation Administration chief, has been named president and a board member of Comsat General Corp., Washington, succeeding John A. Johnson, who moves up to board chairman and chief executive. Johnson takes his new post from Joseph V. Charyk, president of Comsat General's parent, Communications Satellite Corp., who will now serve as chairman of the subsidiary's executive committee. McLucas headed the FAA under President Ford, holding the post from 1975 until this month. Earlier he was secretary of the Air Force (1973-75).

Two RCA European units fined for unlicensed exports

Two RCA Corp. subsidiaries in England and Belgium have been fined $7,500 for illegal re-exports of U. S. avionics and semiconductors to Czechoslovakia and Yugoslavia, according to the Commerce Department. The shipments did not affect U. S. security, the Government says, noting that RCA itself voluntarily reported the failure to get the required U. S. authorization on learning that RCA Ltd., Sunbury-on-Thames, and RCA S. A., Liege, inadvertently made the shipments without the licenses required.

Motorola sources Mostek microprocessor

Motorola Semiconductor has agreed to second-source Mostek Corp.'s MK 3870 microprocessor (see p. 135), making the Mostek single-chip version of Fairchild's F8 microprocessor the first one-chip computer with an alternate source. The agreement allows Motorola access to Mostek masks and technology and brings Motorola's strengths in the industrial control and automotive markets to the Mostek part. Earlier, Motorola had negotiated a similar arrangement with Fairchild for the F8 family; now it will not bring the Fairchild multi-chip F8 versions to market.

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Fluke 8600A **HP 3465A** **Keithley 172**

	Fluke 8600A	HP 3465A	Keithley 172
Functions & Ranging:			
dcV	Auto/Manual	Manual	Auto/Manual
acV	Auto/Manual	Manual	Auto/Manual
dcI	Manual	Manual	Auto/Manual
acI	Manual	Manual	Auto/Manual
ohms	Auto/Manual	Manual	Auto/Manual
Basic Accuracy (dc volts @ 25°C ambient)	±0.02% reading + 1 digit	±0.02% reading + 1 digit	±0.01% reading + 1 digit
Full Range Display (Counts)	19999	19999	29999
HI/LO Ohms	No	No	Yes
Ohms Configuration	2 terminals	2 terminals	2 or 4 terminals
Lighted Function Indicator	No	No	Yes
Price	$549	$510	$525

Comparison based on manufacturers' published specifications. Prices are domestic U.S. for ac line-operated instruments.

It's easy to make your own comparison. Use coupon. Or call (216) 248-0400.

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- ☐ Bring in a Keithley 172 so I can make a side-by-side comparison.

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People are beginning to see the light...

Corning is helping them do it!

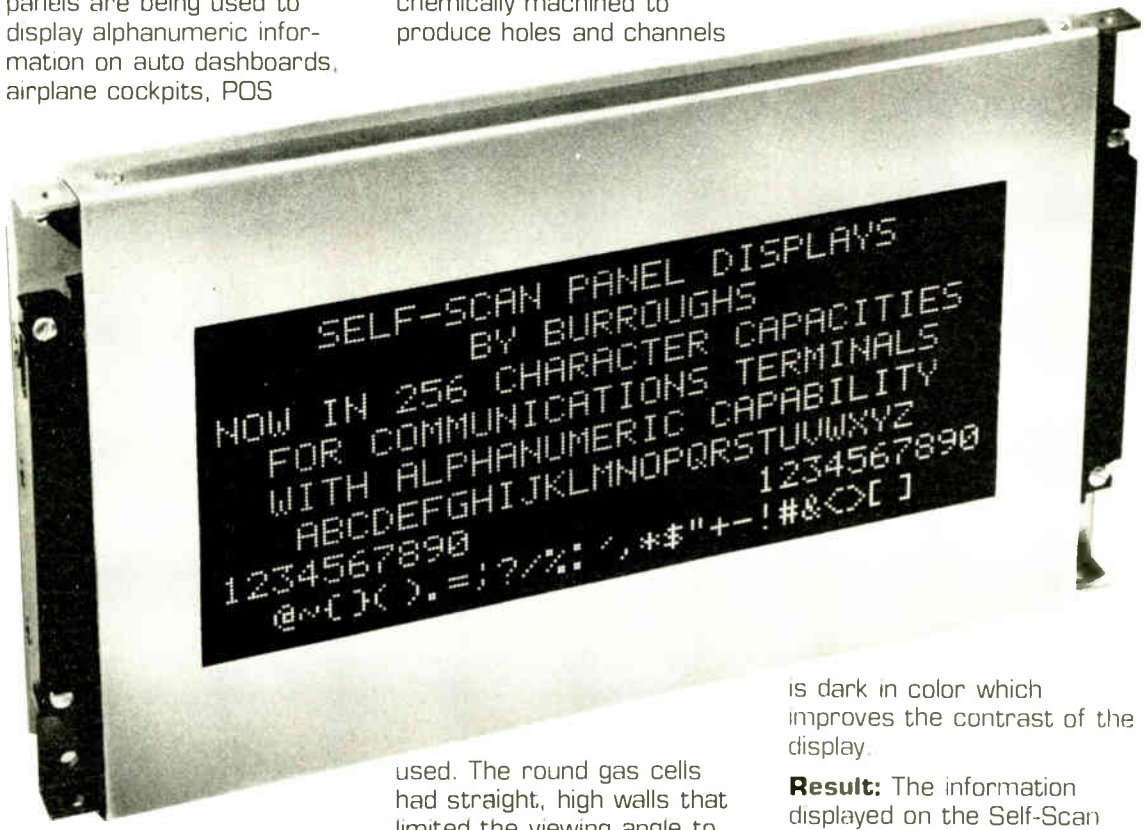
Today, compact electronic panels are being used to display alphanumeric information on auto dashboards, airplane cockpits, POS terminals, and in many other areas where CRT's were used.

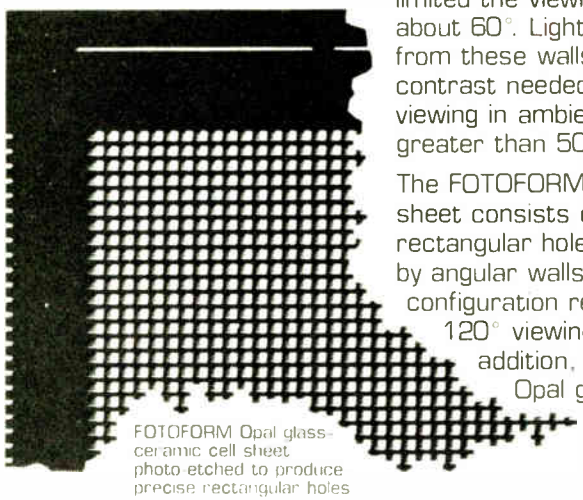
Problem: The numbers and characters must be clearly visible from a wide viewing angle under a variety of lighting conditions.

Corning FOTOFORM® Opal, a glass-ceramic, helped solve the problem.

FOTOFORM materials can be chemically machined to produce holes and channels of almost any size and shape, with precise tolerances of ±0.001 inch. And they have excellent electrical properties. Engineers at the Electronic Components Division of Burroughs Corporation took advantage of these characteristics to produce the new Self-Scan® panel displays.

Previously, a white material with limited machinability was used. The round gas cells had straight, high walls that limited the viewing angle to about 60°. Light reflections from these walls limited the contrast needed for good viewing in ambient light greater than 50 footcandles.





FOTOFORM Opal glass-ceramic cell sheet photo-etched to produce precise rectangular holes

The FOTOFORM Opal cell sheet consists of rectangular holes separated by angular walls. This configuration results in a 120° viewing angle. In addition, FOTOFORM Opal glass-ceramic is dark in color which improves the contrast of the display.

Result: The information displayed on the Self-Scan panel is clear and sharp through a wide range of lighting conditions.

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CORNING

Electronics review

they feel will be in the final version.

Others. Except for 3M, only Rapifax Corp., Fairfield, N. J., markets a sub-minute facsimile machine, which it introduced a few years ago. In addition, Kousai Denshin Denwa Co. of Tokyo recently demonstrated a unit called Quick-fax. However, neither machine, both developed in Japan, was designed to meet the proposed standards.

In these digital fax systems, material is scanned using solid-state light sensors composed of phototransistors or charge-coupled devices. Unlike the slower analog fax approach that can reproduce gray scale, the digital approach only senses black and white content in the interest of speed.

A data-compression scheme eliminates redundant information and the bit stream that results is sent to a modem. With amplitude- and phase-modulation techniques, the information goes out over voice-grade telephone lines.

In addition to the transmission rate of 20 s per page at 9,600 b/s, the Express 9600 needs an initial 15- or 20-s "electronic handshaking" period to set up the transmission. The unit's line-quality checking circuitry automatically adjusts transmission speed (9,600 b/s, 7,200 b/s, 4,800 b/s, and 2,400 b/s) to assure acceptable quality under varying line conditions. The unit is a floor console measuring 38 in. high, 36 in. wide, and 22 in. deep and weighing 325 pounds. It will lease for $295 a month with additional charges depending upon use. It can also function as a standard office copier. □

Speedy. Digital fax from 3M Co. sends a page in 20 seconds, doubles as a copier when not transmitting or receiving.

Packaging & production

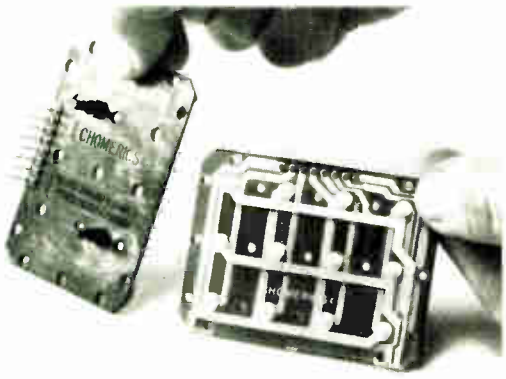
How to make a case out of circuit boards

Why can't printed-circuit boards, the primary building blocks of electronic equipment, serve a structural purpose, as well as carry the components and printed wiring? They can—if they are made of the right material—says Chomerics Inc., a small manufacturer of conductive elastomers and keyboards for calculators and tone-signaling telephones.

That right material may be polysulfone, a durable general-purpose plastic used in the electronics industries for such things as connectors, integrated-circuit carriers, and coil bobbins, says Richard Seeger, operations vice president of the Woburn, Mass., firm.

Keyboard. Seeger's engineers have used polysulfone in the telephone keyboard shown in the photograph on page 40. Its holes, posts, and connector housing are molded when the board is shaped. Such molded-in features, Seeger points out, led to easier and cheaper board manufacture. For example, with holes already in place, expensive drilling and routing operations used on conventional laminated boards of glass epoxy or glass polyester are eliminated. So are the separate assembly steps that would otherwise be needed for adding hardware like connectors and mounting posts.

Off in the future, Chomerics' work might lead to cases and circuit boards molded in one piece for such things as calculators and instruments, Seeger says. Printed-circuit conductors could either be additively plated onto the polysulfone or, more simply, screened on with conductive inks. Adding circuitry should not be difficult. For example, instrument-maker Tektronix Inc. in Beaverton,



Molded keyboard. Chomerics molds holes, posts and connector housing in keyboard made of polysulfone. Flexible-circuit keys are attached to connector pins (right). The back of a similar board is at left.

Ore., is additively plating conductors onto polysulfone circuit boards it is using in high-frequency equipment because of the material's low dielectric constant.

In the Chomerics assembly, a folded flexible circuit with the pattern for a short-key-travel keyboard is fastened to one side of the board, shown at the right, by pins pushed through the molded connector and soldered in place. A five-second solder bath at 450 F fixes the pins to the flexible circuit's conductors. Seeger points out that polysulfone can take this extremely hot temperature for a short period, although that point is considerably above its 345 F heat-deflection temperature where the material begins to droop.

Better properties. Overall, polysulfone has excellent electrical properties, and its low dielectric constant is combined with a low dissipation factor. Unlike conventional board materials, polysulfone maintains these properties over a wide temperature/frequency range. It also has a high resistance to moisture, on a par with the moisture resistance of a "quality" epoxy-glass board.

Chomerics has also been experimenting with screening thick-film conductive inks onto a polysulfone board. Seeger says he has had good luck with it, adding that the screened patterns have a higher peel strength than on the glass-polyester boards he has also used. □

1977 PRODUCT GUIDE

MICRO ELECTRONICS

GENERAL INSTRUMENT CORPORATION · MICROELECTRONICS

CALCULATORS

FUNCTION	DESCRIPTION	9V LED	9V FLUOR.	9V LED (DIRECT)	15V FLUOR.	15V LED
8 DIGIT BASIC	4 functions and percent key.	C-683	CF-683	C-683D	CF-583	C-583
	4 functions, percent key, one-key or multi-key memory.	C-685	CF-685	C-685D	CF-585	C-585
8 DIGIT ALGEBRA	4 functions, percent key, x^2, $\sqrt{x}$, 1/x, +/-, one-key or multi-key memory, choice of 20 to 29 keys.		CF-687	C-687D	CF-589	C-589
	4 functions, percent key, x^2, $\sqrt{x}$, 1/x, +/-, one-key or multi-key memory, brackets, inch-centimeter conversion, choice of 24 to 30 keys.		CF-689	C-689D	CF-689HV	—
9 DIGIT BASIC	4 functions and percent key.				CF-593	C-593
	4 functions, percent key, one-key memory.				CF-594	C-594
	4 functions, percent key, multi-key memory.				CF-595	C-595
9 DIGIT SCIENTIFIC	Basic 4 functions, scientific notation, sin, cos, tan, arc sin, arc cos, arc tan, memory, square root, pi, natural logs, 1/x, e^x, memory exchange, degrees and radians, exponent range ± 99, choice of 19 to 35 keys.				CF-596	C-596
	All the above plus: 0 to 10^{99} degree trig range, $\log_{10}$, y^x, extended digit accuracy of trancendentals, choice of 21 to 38 keys.				CF-598	C-598
	All the above plus: two levels of parenthesis, x^2, %, +/-, choice of 24 to 41 keys.				CF-599	C-599

FUNCTION	DESCRIPTION	PART NUMBER	PACKAGE	FEATURES
8 DIGIT PRINTING	Basic 4 functions and percent, automatic constant in multiply and divide, repeat add/subtract, decimal select mode, and other features. Interfaces with the Olivetti Pu1100 dot matrix printer. Option for use with thermal printing version of Pu1100.	*C-716	40 DIP	Accumulator and 4 key memory
12 DIGIT PRINTING	Basic 4 functions and percent, automatic constant in multiply and divide, repeat add/subtract, decimal select mode, memory-in-use indicator, rounding options, non-add (#)/date key, and other features. Interfaces with the Shinshu Seiki Model 310 impact printer.	C-717	40 DIP	Accumulator and Grand Total Memories.
		C-717X		
		C-718		Accumulator, item counter, and four-key independent memory.
PRINTER-DISPLAY INTERFACE	Adds display capability to the C-717X and C-718 printing calculator circuits.	C-719	28 DIP	For both LED and flourescent displays.
	Adds display capability to the C-716 printing calculator circuit.	*C-720		

*For Future Release.

CLOCKS

FUNCTION	DESCRIPTION	PART NUMBER	DISPLAY TYPE	FLASHING SECONDS	ZERO BLANKING	50/60 Hz OPERATION	PACKAGE	FEATURES
4 DIGIT	12/24 hour clock	AY-5-1200A	7-SEGMENT FLUORESCENT		✔	✔	24 DIP	Direct fluorescent display drive.
		AY-5-1202A	7-SEGMENT FLOURESCENT	✔	✔	✔	24 DIP	Direct flourescent display drive.
		AY-5-1203A	BCD OUTPUTS	✔		✔	24 DIP	See AY-5-8320 TV circuit.
		AY-5-1204A	7-SEGMENT FLUORESCENT	✔		✔	24 DIP	Direct fluorescent display drive.
		AY-5-1224A	BCD OR 7-SEGMENT LED		✔	✔	16 DIP	Zero blanking in 12 hour mode only.
4 DIGIT WITH ALARM	12 hour clock, 24 hour alarm	CK3000	7-SEGMENT PLASMA	✔	✔	✔	40 DIP	Snooze alarm, individual digit drive.
		CK3100	7-SEGMENT LED	✔	✔	✔	40 DIP	Snooze alarm, individual digit drive.
	12/24 hour clock, 24 hour alarm	CK3200	7-SEGMENT PLASMA	✔	✔	✔	28 DIP	Snooze alarm, duplexed digits.
		CK3400	7-SEGMENT LED	✔	✔	✔	28 DIP	Snooze alarm, duplexed digits
4 DIGIT CLOCK RADIO	12/24 hour clock, 24 hour alarm	CK3300	7-SEGMENT LED	✔	✔	✔	28 DIP	Snooze alarm, duplexed digits, sleep-timer, timeswitch, battery standby capability
4 DIGIT AUTOMOBILE CLOCK	12 hour clock	CK3500	7-SEGMENT LED		✔	CRYSTAL INPUT	28 DIP	Operates directly from a 3.58MHz TV crystal. Direct drive of LED display.

CALCULATOR MODULES

FUNCTION	DESCRIPTION (SEE ABOVE)	PART NUMBER	FEATURES
8 DIGIT CALCULATOR	Same as C-683D	M-683	Self-contained module which requires only the addition of a keyboard and battery to produce a working calculator.
	Same as C-685D	M-685	
	Same as C-687D	M-687	
	Same as C-689D	M-689	

CLOCK MODULES

FUNCTION	DESCRIPTION (SEE ABOVE)	PART NUMBER	FEATURES
4 DIGIT CLOCK	Same as CK3400	M-3400	Self-contained module which requires only the addition of switches and a power source to produce a working clock.
4 DIGIT CLOCK RADIO	Same as CK3300	M-3300	
4 DIGIT AUTO CLOCK	Same as CK3500	M-3500	

MICROELECTRONICS

RADIO

FUNCTION	DESCRIPTION	PART NUMBER	AM/MW/SW IF OFFSET	FM/VHF IF OFFSET	POWER SUPPLIES	PACKAGE	FEATURES
FREQUENCY COUNTER/ DISPLAY	Counts & displays MW, SW, and VHF frequencies	AY-5-8100	460KHz	10.7MHz	GND, -17	28 DIP	4½ digit display: MW 2999KHz, SW 29.995MHz, VHF 299.95MHz, 0 to 99 FM channel indication (European standard).
		AY-5-8102	455KHz				
FREQUENCY COUNTER/DISPLAY WITH 4 DIGIT CLOCK	Counts & displays AM/FM frequencies with a 12 hour clock	AY-5-8110	262.5KHz	PROGRAM-MABLE	+10 to +16, GND	28 DIP	Easy time set controls, low power consumption, on-chip intensity control. Clock functions down to +5V.
		AY-5-8112	455KHz				
NEW STEREOMEGA*: PHASE LOCK LOOP DIGITAL TUNING SYSTEM	Control circuit: accepts inputs to control and program system.	AY-3-8115	455KHz	10.7MHz	+10 to +16, GND	40 DIP	Tune up, tune down; search local, distant, stereo only; scanning mode; pre-program 10 favorite stations (5AM/5FM).
	Memory circuit: see ER 1400 EAROM description on page 9.	ER 1400	—	—	+12, -24	8 TO	
	Clock circuit: supplements the control circuit to provide time display.	*AY-3-8116	—	—	+5 to +16, GND	24 DIP	

*For Future Release

*STEREOMEGA is a trademark of General Instrument Corp.

TELEVISION

FUNCTION	DESCRIPTION	PART NUMBER	POWER SUPPLIES	PACKAGE	FEATURES
OMEGA®: 82 CHANNEL DIGITAL TUNING SYSTEM	Control circuit: accepts keyboard/remote inputs to control and program system.	T-1001	+12, GND	40 DIP	Scan mode or search mode may also be selected.
	Display circuit: displays selected channel number.	T-1101	+12, GND	40 DIP	Decodes and drives BCD or LED displays.
	D/A converter circuit: converts output to coarse and fine tune outputs.	MEM 4956	VREF, +12, GND	14 DIP	14 bit accuracy for precise varactor tuning.
	Memory circuit: see ER 1400 EAROM description on Pg. 9	ER 1400	+12, -24	8 TO	100 × 14 bit memory
	Optional channel selector interface circuit: permits preset favorite channel selection.	T-1201	+12, GND	40 DIP	Up to 20 channels; pre-set and/or customer selection.
ECONOMEGA® I: 16 CHANNEL DIGITAL TUNING SYSTEM	Control circuit accepts direct/remote inputs to control/program system	AY-3-8203	+12, GND	40 DIP	16 programs, 14 bit accuracy with coarse and fine tune.
	D/A converter circuit: converts output to coarse and fine tune outputs	MEM 4956	VREF, +12, GND	14 DIP	14 bit accuracy for precise varactor tuning.
	Memory circuit: see ER 1400 EAROM description on Pg. 9.	ER 1400	+12, -24	8 TO	100 × 14 bit memory.
NEW ECONOMEGA® II: 20 CHANNEL DIGITAL TUNING SYSTEM	Control/memory circuit: accepts direct/remote inputs to control/ program system.	*AY-5-8290	+17, GND, -20	40 DIP	Contains both control logic and EAROM memory in a single chip; 20 programs.
	D/A converter circuit: converts output to coarse and fine tune outputs	MEM 4956	VREF +12, GND	14 DIP	14 bit accuracy for precise varactor tuning.
ON-SCREEN CHANNEL/TIME DISPLAY SERIES	Various circuits in series to display channel numbers on TV screen with some additionally featuring either separate or simultaneous time display. Selection of display position on screen, automatic display recall, BCD time inputs (see AY-5-1203A clock circuit).	AY-5-8300	+17, GND	14 DIP	Channels 0-15
		AY-5-8301			Channels 1-16
		AY-5-8310		24 DIP	Channels 0-15 or 00-99 or time.
		AY-5-8311	+12, GND		
		AY-5-8320	+17, GND		Channels 1-16 and/or time. Upper right screen display.
		AY-5-8321	+12, GND		
		AY-5-8322	+13, GND		Channels 1-16 and/or time. Lower center screen display.
		AY-5-8324	+13, GND		
NEW ON-SCREEN TUNING SCALE	Provides an electronic on-screen tuning scale for varactor tuned TV sets.	AY-3-8330	+12, GND	16 DIP	4 bands, mask programmable band or channel number display, mask programmable display positions.

*For Future Release

*OMEGA & ECONOMEGA are trademarks of General Instrument Corp.

REMOTE CONTROL

FUNCTION	DESCRIPTION	PART NUMBER	POWER SUPPLIES	PACKAGE	FEATURES
R/C SYSTEM I	30 Channel Transmitter	SAA 1024	9V BATTERY	16 DIP	30 ultrasonic control channels, 34-44KHz. Utilizes a 4.4MHz TV crystal for accuracy.
	30 Channel Receivers	SAA 1025-01	+18, GND	16 DIP	Power on/off output, 16 TV channel selection (& 5 spares), 3 analog outputs (8 functions).
		SAA 1025-02			
R/C SYSTEM II	23 Channel Transmitters	AY-5-8410	+15, GND	18 DIP	23 channels, either local control at receiver or remote control.
		AY-5-8411	9V BATTERY		
	31/63 Channel Receiver	AY-5-8420	+15, GND	14 DIP	5 or 6 bit modes, error-detection.
R/C SYSTEM III	30 Channel Transmitter	AY-5-8450	9V BATTERY	16 DIP	30 ultrasonic control frequencies, interfaces directly with a 5×6 matrix keyboard.
	16 Channel Receivers	AY-5-8460	+12, GND, -6	18 DIP	Interfaces directly with OMEGA 10 digit keyboard inputs plus on/off, recall, 2 analog controls (4 functions).
		AY-5-8461			

GIMINI TV GAMES

The General Instrument game repertoire offers game manufacturers a choice of approaches to the marketplace: GIMINI dedicated game chips and the GIMINI cassette programmable game set.

The dedicated game chips for 1977 include a choice of Ball and Paddle games with true game rules, realistic courts, and individual player identification. The Battle game offers all the thrills and excitement of its popular arcade big brother.

The programmable game set based on a variant of GI's CP1600, an advanced 16-bit single chip microprocessor, provides maximum flexibility in implementing a programmable system. The game "program" ROM, which can be incorporated in a cassette, connects directly to the system address and data busses. With this ROM/cassette approach, a library of game ROMs can be developed encompassing a multitude of game families.

Additionally, since the heart of the programmable system is based on the powerful 16-bit CP1600 microprocessor, expanded capabilities beyond a "game" function are possible — including home interactive teaching systems, data storage and retrieval systems...in effect, a true "home computer."

DEDICATED TV GAMES

FUNCTION	DESCRIPTION	GAMES	PART NUMBER	LINE STANDARD	PACKAGE	FEATURES
BALL & PADDLE I	Six selectable games for one or two players, with vertical paddle motion.	Tennis Soccer Squash Practice Rifle Game I Rifle Game II	AY-3-8500	625	28 DIP	Automatic on-screen scoring. Sound generation (hit, boundary, score). Selectable paddle size, ball speed, rebound angles.
			AY-3-8500-1	525		
BALL & PADDLE IA	Six selectable games for one or two players, with horizontal and vertical paddle motion.	Tennis Soccer Squash Practice Rifle Game I Rifle Game II	AY-3-8550	625	28 DIP	All features of the AY-3-8500/8500-1 with the addition of full two-axis player motion, color-coding of score and player, and "hit" and "miss" scoring in Practice game.
			AY-3-8550-1	525		
W COLOR CONVERTER I	Converts the black & white video outputs of either the AY-3-8500-1 or AY-3-8550-1 to a single color composite video signal.	—	AY-3-8515-1	525	16 DIP	Colors of the background and paddle outputs are selectively changed directly by the "game select" inputs. Also provides, as an output, a 2.045MHz clock for the game circuit.
BALL & PADDLE II	Eight selectable games for one or two players, with horizontal and vertical player motion	Tennis Hockey Soccer Squash Practice Gridball Basketball Basketball Practice	AY-3-8600	625	28 DIP	Automatic on-screen scoring. Sound generation (hit, boundary, score). Selectable paddle size, (individually selectable for each player), ball speed, rebound angles. Full two-axis player motion. Color-coding of score and player. Realistic ball service and scoring. Flashing score as "end of game" indication.
			AY-3-8600-1	525		
W COLOR CONVERTER II	Converts to the black & white video outputs of the AY-3-8600-1 to a single color composite video signal.	—	AY-3-8615-1	525	24 DIP	Colors of the background and paddle outputs are selectively changed directly by the "game select" inputs. Also provides, as an output, a buffered 3.579MHz clock for the game circuit.
BATTLE I	A two player "tank battle" game where each player has a completely steerable tank with forward and reverse speed control and a firing button.	Tank Battle	AY-3-8700	625	28 DIP	The on-screen "battlefield" includes anti-tank barricades and exploding mines to retard each tank's progress. Unlimited ammunition to a scoring limit of 31 "hits."
			AY-3-8700-1	525		

CASSETTE PROGRAMMABLE TV GAMES

FUNCTION	DESCRIPTION	GAMES	PART NUMBER	PACKAGE	FEATURES
W GIMINI® PROGRAMMABLE GAME SET	The GIMINI chip set provides the basis for a user-programmed game series for up to eight players and featuring: up to eight user-controlled moving objects, 64 selectable moving objects, up to 240 programmable background locations, movable background field, and display in up to six colors plus black and white.	User game design for such as: Ball & Paddle, Aggression, Gambling, Racing, etc.	CP1601-G	40 DIP	A variant of the GI CP1600 microprocessor, the CP 1601-G is 16-bit unit utilizing 8 general purpose registers for fast and efficient processing of all game data.
			RO-3-20480	40 DIP	The "program" ROM organized as 2048 × 10, contains all game "rules", symbol locations, color, velocity and direction data.
			AY-3-8900	40 DIP	The "STIC", Standard Interface Chip, provides the video signals including sync and blanking and the manipulation and interaction of all graphics data in a non-interlaced pattern for the TV.
			AY-3-8900-1		
			RO-3-9316A	24 DIP	The "graphics" ROM organized as 2048 × 8, contains a series of 8 × 8 dot matrices for a large variety of game symbols, background/field data, and 64 alpha-numeric characters.
			RAM	24 DIP	The "working" memory during game operation. A total of five 256 × 4 RAMs are required for a combined 256 × 12 and 256 × 8 memory complement.

*GIMINI is a trademark of General Instrument Corp.

MICROELECTRONICS

MOSFET TRANSISTORS - Contact any GI Sales Office for details on other available MOSFET Transistors

TYPE	PART NUMBER	V(BR)DSS VOLTS MIN.	V(BR)GSS VOLTS MIN.	IDSS nA TYP.	IGSSF nA TYP.	VGS(th) VOLTS MIN/MAX.	rDS(on) OHMS TYP.	Yfs MHO TYP.	Ciss pF TYP.	Crss pF TYP.	CASE
P-CHANNEL ENHANCEMENT MODE	MEM806	-40	-40	-1.0	-0.1pA	-2/-5.5	150	2,800	4.5	1.0	TO-72
	MEM807	-40	-40	-0.5	-0.1	-2/-5.5	150	2,800	4.5	1.0	TO-72
	MEM817	-45	200	-0.1	-0.05pA	-2.5/-6.5	150	2,000	3.5	1.2	TO-72
	3N183	-25	-25	-2.0	-0.3	-2/-6	50	9,000	15.0	10.0	TO-72

TYPE	PART NUMBER	V(BR)DSS VOLTS MIN.	IGSSF nA TYP.	VGS(th) VOLTS MIN/MAX.	rDS(on) OHMS TYP.	Yfs MHO TYP.	Cgs pF TYP.	Crss pF TYP.	Yfs RATIO TYP.	|VG1S-VG2S| mV TYP.	CASE
DUAL P-CHANNEL ENHANCEMENT MODE	MEM550C	-25	-0.2	-3/-6	250	800	2.0	2.0	0.8	100	TO-77
	MEM551C	-25	-1pA	-3/-6	250	750	1.5	1.5	0.85	70	TO-77
	MEM954	-30	-0.03	-2/-5	100	1000	2.0	1.5	0.95	50	TO-77
	MEM955	-35	-0.02pA	-2/-5	100	1000	2.0	1.5	0.95	50	TO-77

TYPE	PART NUMBER	BVDSS MIN. VOLTS	V(BR)GSS VOLTS MIN.	IDSS nA TYP.	IGSSF nA TYP.	ID(on) mA TYP.	VGS(th) VOLTS MIN/MAX.	rDS(on) OHMS TYP.	Yfs MHO TYP.	Ciss pF TYP.	Crss pF TYP.	CASE
N-CHANNEL ENHANCEMENT MODE	MEM562	+20	30	1	1pA	15	0.5/4	150	2,500	3	0.3	TO-72
	MEM711	+25	30	1	0.1	40	0.5/1.5	50	3,000	4.5	0.5	TO-72
	3N177	+20	30	5	50pA	15	1/3.5	300	1,500	5	0.5	TO-72

TYPE	PART NUMBER	V(BR)DS VOLTS MIN.	V(BR)G1S VOLTS MIN.	V(BR)G2S VOLTS MIN.	IDSS mA TYP.	IGSS nA TYP.	VGS(off) VOLTS MAX.	rDS(on) OHMS TYP.	Yfs MHO TYP.	Ciss pF TYP.	Crss pF TYP.	Gps dB TYP.	NF dB TYP.	CASE
N-CHANNEL DEPLETION MODE	MEM557	+20	10	—	5	.01	-4	200	10,000	3	0.32	18	2.5	TO-72
	MEM616	+25	6	6	10	20	-4	—	18,000	5.4	.02	18	3.0	TO-72
	MEM636	+20	6	6	15	50	-4	—	16,000	6	.02	22	3.5	Plastic
	MEM655	+20	6	—	4	10	-4	30	10,000	4	0.32	22	2.5	TO-72
	MEM670	+20	100	—	3	.05pA	-4	—	2,000	2	0.3	—	—	TO-72
	MEM680	+25	6	—	4/30	50	-4	—	18,000	5.4	0.2	21	2.5	TO-72

MUSIC

FUNCTION	DESCRIPTION	PART NUMBER	MAXIMUM FREQUENCY	POWER SUPPLIES	PACKAGE	FEATURES
MASTER FREQUENCY GENERATOR/ TOP OCTAVE GENERATOR	Generates a complete octave of musical frequencies	AY-1-0212	1.5 MHz	+12, GND	16 DIP	250KHz minimum frequency
		AY-1-0212A	2.5 MHz			
		AY-3-0214	4.5MHz	+10 to +16, GND	16 DIP	12 outputs, 50% duty cycle
		AY-3-0215				13 outputs, 50% duty cycle
		AY-3-0216				13 outputs, 30% duty cycle
LATCHING NETWORK	Establishes priority level of 13 latch inputs/outputs	AY-1-1313	20KHz	GND, -12, -27	40 DIP	Stackable for expanded latching/ priority function
RHYTHM GENERATOR	Generates 6 rhythms, drives 8 instruments	AY-5-1315	10KHz	GND, -15	18 DIP	Resets for coupling chords to rhythm. 32 beat pattern. Mask programmable.
CHORD GENERATOR	Produces major, minor, 7th chords, walking bass	AY-5-1317A	50KHz	GND, -15	40 DIP	Mixed outputs, sustain, top key priority
PIANO KEYBOARD	Electronically simulates piano operation and sound	AY-1-1320	—	GND, -10, -27	40 DIP	12 keys per unit, loudness proportional to key press velocity.
FREQUENCY DIVIDERS	4 stage	AY-1-5051	1MHz	GND, -13, -27	10 TO	Arranged 2 + 1 + 1
	5 stage	AY-1-6721/5	1MHz	GND, -13, -27	10 TO	Arranged 3 + 2
	6 stage	AY-1-6721/6	1MHz	GND, -13, -27	12 TO	Arranged 3 + 2 + 1
		AY-1-1006	50KHz	GND, -12, -27	14 DIP	Arranged 3 + 2 + 1
		AY-1-2006	50KHz	GND, -12, -27	14 DIP	Arranged 2 + 2 + 1 + 1
	7 stage	AY-1-5050	1MHz	GND, -13, -27	14 DIP	Arranged 3 + 2 + 1 + 1
		AY-1-1007B	50KHz	GND, -12, -27	14 DIP	Arranged 3 + 2 + 1 + 1, power-on reset
	2^{16} I²L Counter/Divider	AY-9-1000	Operation is a function of current through a resistor from V_{CC} to Injection input		8 TO, 16 DIP	Crystal/RC oscillator input; divide by 2^{16}, 2^{15}, 2^{12}, 2^{11}, 2^{10}, or 2^{7}.

APPLIANCES

FUNCTION	DESCRIPTION	PART NUMBER	POWER SUPPLIES	PACKAGE	FEATURES
CLOCK TIMER	24 hour programmable repeatable on/off time switch with 4 digit clock.	AY-5-1230	GND, -12 to -18	28 DIP	50Hz input (50 or 60Hz on AY-5-1231). BCD or 7-segment direct fluorescent display drive outputs, zero blanking, 24 hour display (12 or 24 hour on AY-5-1231).
		AY-5-1231		40 DIP	
		AY-5-1232		28 DIP	
		AY-5-1233		28 DIP	
NEW COOKER TIMER	Appliance timer with clock. Full control of "start" time, "stop" time, or "duration".	*AY-5-1250	+9, GND	28 DIP	Two timed outputs (3 on the AY-5-1251), "minute minder" feature, 12/24 hour system, temperature setting on AY-5-1251.
		*AY-5-1251			
NEW COINBOX CIRCUIT	A coin memory/credit accumulator for use in coin-operated equipment.	AY-1-8622	GND, -12, -27	40 DIP	Seven different coin inputs, credit and "bonus" features.

*For Future Release

TELECOMMUNICATIONS

FUNCTION	DESCRIPTION	PART NUMBER	POWER SUPPLIES	PACKAGE	FEATURES
PUSH BUTTON TELEPHONE DIALLER CIRCUIT	Converts push button input to rotary dial pulses	AY-5-9100	SEE DATA SHEET	18 DIP	Programmable timing, one-call memory. Optional redial and access pause capability (except on AY-5-9118).
		AY-5-9106			
		AY-5-9110			
		AY-5-9118		14 DIP	
		AY-5-9120		18 DIP	
REPERTORY DIALLER	Stores ten telephone numbers	AY-5-9200	SEE DATA SHEET	16 DIP	Complements AY-5-9100 to enable storage of up to ten 22-digit telephone numbers. Stackable.
COINBOX CIRCUIT	Controls the operation of a standard pay telephone.	AY-5-9300	SEE DATA SHEET	24 DIP	Up to 3 coin denominations recognized, 16 selectable coin ratios.
DUAL TONE MULTI-FREQUENCY GENERATOR	Generates DTMF/tone telephone frequencies.	AY-3-9400	+5, GND	14 DIP	With a low cost ceramic resonator, generates 12 tone pairs.
		AY-3-9401	+5, GND	16 DIP	Same as AY-3-9400 but generates 16 tone pairs for data transmission.
		AY-3-9410			
C-MOS GENERATOR	Generates 2-phase clocks from a single power supply.	AY-5-9500	SEE DATA SHEET	14 DIP	Generates 2-phase clocks for AY-5-9100 & AY-5-9200.
MULTI-FREQUENCY RECEIVER	Detects and converts DTMF/tone telephone frequencies.	AY-5-9800 SERIES	GND, -8.5, -17	28/40 DIP	Choice of output codes: 4 bit, 1 of 16, 2 of 8, binary, custom programmable.

HYBRID ACTIVE FILTERS

FUNCTION	PART NUMBER	DESCRIPTION
UNIVERSAL ACTIVE FILTER	ACF 7032C ACF 7092C	The ACF 7032C and the ACF 7092C filters are low cost devices which can be used to generate any filter response. Low pass, Band pass, Band Rejection, High pass, and All pass filter responses are available by means of external connections. The design provides for independent control of Frequency, Q, and Amplifier Gain, and is usable throughout the frequency range of 10Hz to 10KHz.
3825Hz LPF	ACF 7110C	The ACF 7110C filter provides for low pass filtering of speech frequencies while attenuating the 3825Hz signaling frequency to a minimum attenuation of 43dB. The reference 1.0KHz gain of this filter is 0dB with a maximum in-band ripple specification plus or minus 0.1dB.
PCM TRANSMIT LPF	ACF 7170C	The ACF 7170C filter has been designed for PCM transmit applications. This 0dB gain filter provides for a minimum 39dB attenuation at 4.6KHz and an in-band ripple specification of plus or minus 0.125dB.
PCM TRUNK TRANSMIT LPF	ACF 7173C	The ACF 7173C filter has been designed for PCM "Trunk" transmit applications. This variable gain, 0dB to 29dB, low noise filter is capable of exceeding the A.T. & T. D3 Channel Bank Compatibility specification. This filter provides a minimum attenuation of 32dB at 4.6KHz, a maximum in-band ripple of plus or minus 0.1dB, and 14.5dB minimum attenuation at 60Hz.
PCM TRUNK RECEIVE LPF & PAM GATE	ACF 7174C	The ACF 7174C filter has been designed for PCM "Trunk" receive applications. This variable gain, -16dB to +3.5dB, low noise filter is capable of exceeding the A.T.&T. D3 Channel Bank Compatibility specification. This filter has a self contained Pulse Amplitude Modulation (PAM) Gate and Sample and Hold Capacitor for demodulating and holding the input signal. The filter has been compensated for a Sin X over X correction and provides a minimum attenuation of 28dB at 4.6KHz and a maximum in band ripple of plus or minus 0.1dB.
PCM TRUNK TRANSMIT LPF	ACF 7175C	The ACF 7175C filter has been designed for PCM "Line" transmit applications. This fixed gain, 8.25dB, low noise filter is capable of exceeding the A.T.&T. D3 Channel Bank Compatibility specification. This filter provides a minimum attenuation of 30dB at 4.6KHz and a maximum in band ripple of plus or minus 0.3dB and also provides for DC blocking.
PCM LINE RECEIVE LPF & PAM GATE	ACF 7176C	The ACF 7176C filter has been designed for PCM "Line" receive applications. This fixed gain, 8.2dB, low noise filter is capable of exceeding the A.T.&T. D3 Channel Bank Compatibility specification. This filter has a self contained Pulse Amplitude Modulation (PAM) Gate and Sample and Hold Capacitor for demodulating and holding the input signal. The filter has been compensated for a Sin X over X correction and provides a minimum attenuation of 28dB at 4.6KHz, and a maximum in band ripple of plus or minus 0.3dB.
BAND PASS FILTER & FULL WAVE DETECTOR	*ACF 7300C *ACF 7301C *ACF 7302C	The ACF 7300C/7301C/7302C each consists of a full wave detector and a four (4) pole fixed band width band pass filter. factory tunable over a center frequency (Fo) range: ACF 7300C - 540Hz to 1980Hz; ACF 7301C - 700Hz to 1700Hz; ACF 7302C - 2280Hz to 3825Hz.
2600Hz BPF	ACF 7310C	The ACF 7310C is a sharply tuned filter designed to detect and pass the 2600Hz signaling frequency. This filter provides for a minimum attenuation of: 30dB plus and minus 200Hz, 50dB plus and minus 500Hz, and 70dB plus and minus 1000Hz from the center frequency of 2600Hz.
3825Hz BPF	ACF 7311C	The ACF 7311C is a sharply tuned filter designed to detect and pass the 3825Hz signaling frequency. This filter provides for a minimum attenuation of 40dB, plus and minus 200Hz from the center frequency of 3825Hz.
300-3400Hz BPF	ACF 7320C	The ACF 7320C is a 0dB, 300Hz to 3400Hz band pass filter with an in band ripple specification of plus or minus 0.15dB maximum. The filter provides for a minimum attenuation of 15dB at 170Hz and 3750Hz.
DTMF TONE DETECTION BPF	ACF 7323C ACF 7363C ACF 7383C	The ACF 7323C/ACF 7363C/ACF 7383C Band Pass Active Filters are factory pre-tuned filters designed specifically for tone receiver applications. These two pole constant Q filters are available in the standard AT&T tone frequencies and in the standard multifrequency steps.
DIAL TONE BAND SUPPRESSION FILTER	ACF 7401C	The ACF 7401C is a dual tuned band suppression filter which has been designed to reject frequencies of 350Hz and 440Hz, which are present on a telephone line. The unit is totally self contained and requires no external components for proper operation. The filter provides for 0dB insertion loss in the pass band of 697Hz through 1633Hz, the normal DTMF tone frequencies. The filter also provides for 60Hz attenuation for low noise operation.
2600Hz BAND SUPPRESSION FILTER	ACF 7410C	The ACF 7401C is a sharply tuned filter designed to reject the 2600Hz signaling frequency. This filter provides for a minimum attenuation of 60dB plus and minus 15Hz from the center frequency of 2600Hz.
60Hz NOISE SUPPRESSION FILTER	*ACF 7480C	The ACF 7480C is a sharply tuned filter for 60 Hertz suppression. It provides a minimum attentuation of 40dB plus or minus 0.25Hz from the center frequency. The filter is self contained and requires no external components for proper operation.
DTMF BAND SEPARATION FILTER	ACF 7711C	The ACF 7711C is a dual filter which has been designed to provide channel isolation between the low frequency group of the tone (DTMF) frequencies of 941Hz, and the high frequency group of 1209Hz through 1633Hz. This filter provides for a minimum attenuation of 30dB for the adjacent frequencies of 941Hz and 1209Hz, 0dB in the pass bands, and 25dB out-of-band attenuat on.

*For Future Release

MICROELECTRONICS

DATA COMMUNICATIONS

FUNCTION	DESCRIPTION	PART NUMBER	REPLACES (PIN-FOR-PIN)	BAUD RANGE	MAX. FREQ.	TEMP. RANGE	POWER SUPPLIES	PACKAGE	FEATURES
UAR/T®	Complete 5-8 bit serial/ parallel, parallel/serial interface.	AY-3-1015	AMI S1757 SIG 2536 SMC COM2505 TI TMS6011 WD TR1402A WD TR1602A	0 to 30KB	480KHz	0 to 70	+5, GND	40 DIP	1, 1.5, or 2 stop bits
		†AY-6-1013		0 to 22.5KB	360KHz	-55 to +125	+5, GND, - 12	40 DIP	1 or 2 stop bits
		AY-5-1013A		0 to 40KB	640KHz	0 to 70			
		AY-3-1014A		0 to 30KB	480KHz	0 to 70	+5 to +14, GND	40 DIP	1, 1.5, or 2 stop bits
NEW P/SAR	A programmable receiver that interfaces variable length serial data to a parallel data channel.	*AY-8-1472B	WD1472B	0 to 100KB	100KHz	0 to 70	+5, GND, -12	40 DIP	Data conversion to formats compatible with all standard Synchronous, Asynchronous, & Isochronous data communications media.
NEW P/SAT	A programmable transmitter that interfaces variable length parallel data to a serial data channel.	*AY-8-1482B	WD1482B	0 to 100KB	100KHz	0 to 70	+5, GND, -12	40 DIP	

*For Future Release. †Also available with MIL STD 883 screening (add suffix TX to part number).
*UAR/T is a trademark of General Instrument Corporation.

MULTIPLEXERS

FUNCTION	DESCRIPTION	PART NUMBER	PEAK-PEAK SIGNAL INPUT RANGE	ON RESISTANCE	TEMP. RANGE	SUFFIX/ PACKAGE
RANDOM/ SEQUENTIAL ACCESS MULTIPLEXER	Multiplexes 16 analog channels, with on-chip logic control.	AY-5-1016	20 Volts	500 ohms	0 to 70	40 DIP
		†AY-6-4016			-55 to +125	
MOSFET ANALOG GATES	4 CHANNEL	MEM 851	30 Volts	100 ohms	-65 to +85 (Plastic Dip) -65 to +125 (Ceramic DIP, Flat Pack)	P/14 Plastic DIP D/14 Ceramic DIP F/14 Flat Pack
	6 CHANNEL	MEM 855	25 Volts	350 ohms		
		MEM 856	40 Volts	1000 ohms		
	8 CHANNEL	MEM 857	25 Volts	150 ohms		P/24 Plastic DIP D/24 Ceramic DIP F/24 Flat Pack
	10 CHANNEL	MEM 853	25 Volts	150 ohms		

†Also available with MIL STD 883 screening (add suffix TX to part number).

INDUSTRIAL

FUNCTION	DESCRIPTION	PART NUMBER	MAX. COUNT FREQUENCY	OUTPUT CURRENT	POWER SUPPLIES	PACKAGE	FEATURES
4 DIGIT COUNTER	Counts, stores & decodes four decades to BCD outputs.	AY-5-4057	500KHz	—	+5, GND, -12	16 DIP	BCD outputs
4 DIGIT COUNTER/ DISPLAY DRIVER	Counts (up or down), stores & decodes four decades to 7-segment outputs.	AY-5-4007	600KHz	25 mA/V	+5, GND, -12	24 DIP	BCD outputs, true/ complement control
		AY-5-4007A				40 DIP	Includes features of AY-5-4007 & 4007D
		AY-5-4007D				24 DIP	Serial count output, three carry outputs
3½ DIGIT DVM	DVM logic incorporating dual ramp integration	AY-5-3507	40KHz	6 mA	GND, -15	18 DIP	Range to 1999, 7-seg. outputs
		AY-5-3510		—		16 DIP	Range to 1999, BCD outputs
3¾ DIGIT DVM	DVM logic incorporating dual ramp integration.	AY-5-3500	200KHz	6 mA	GND, -7.5, -15	28 DIP	3 ranges: 999, 1999, 2999. Dual polarity, BCD & 7-seg. outputs
4¾ DIGIT DVM	DVM logic incorporating dual ramp integration	AY-3-3550	400KHz	2.5 mA	+5, GND	40 DIP	Auto-range, auto-zero, auto-polarity, 7-segment/ BCD outputs, counter mode.
10 BIT D/A CONVERTOR	Ladderless D/A converter	AY-5-5053	SEE DATA SHEET	—	+5, GND, -12	24 DIP	Employs stochastic techniques
A/D CONVERTOR CONTROL	With AY-5-5053, performs A/D with transmitter facility.	AY-5-5054	SEE DATA SHEET	—	+5, GND, -12	24 DIP	For use in remote sensing applications.
NEW SEQUENTIAL BOOLEAN ANALYZER	A simple, single bit processor which can directly evaluate a set of Boolean equations.	*SBA	800KHz CLOCK	20 mA TOTAL	+12, +5, GND	40 DIP	A microprogrammable circuit which forms the basic controlling element for many systems requiring timing and control functions.

*For Future Release.

SERIES 1600 MICROPROCESSOR

FUNCTION	FEATURES	DESCRIPTION	APPLICATIONS	PART NUMBER	PACKAGE
16 BIT SINGLE CHIP MICRO-PROCESSOR	■ 8 program accessible 16-bit general purpose registers ■ 87 basic instructions ■ 4 addressing modes ■ Unlimited interrupt nesting and priority resolution ■ 16-bit 2's complement arithmetic & logic ■ Direct memory access (DMA) for high speed data transfer ■ 64K memory using single address	The CP 1600 utilizes third generation mini-computer architecture with eight general purpose registers. The 16-bit word enables fast & efficient processing of alpha-numeric or byte oriented data. The 16-bit address capability permits access to 65,536 words in any combination of program memory, data memory, or peripheral devices.	The CP 1600 Microprocessor is designed for high speed data processing & real time applications. Typical applications include programmable calculator systems, peripheral controllers, process controllers, intelligent terminals & instruments, data acquisition and digital communications processors, numerical control systems, programmable TV game systems.	CP 1600	40 DIP
INPUT/ OUTPUT BUFFER	■ Single 16-Bit or Dual 8-Bit Ports for Bidirectional Input/Output ■ Parity Check Logic on Both Ports ■ Three Levels of Priority ■ Automatic Handshake Logic and Signals ■ Control Register	The IOB 1680 is a byte oriented programmable input/output buffer which provides comprehensive interfacing facilities for the CP 1600 microprocessor. Data is transferred to and from the peripheral on 16 bidirectional lines, each of which can be considered to be an input or output.	The IOB 1680 enables efficient interfacing between a peripheral and the CP 1600 by the use of six 8-bit registers and a 16-bit programmable timer.	IOB 1680	40 DIP
DUAL DIGITAL TO ANALOG CONVERTER	■ 10 bit bidirectional data bus ■ Synchronous/Asynchronous loading ■ Manual input mode	The DAC 1600 contains four registers which can be loaded or read through a 10-bit I/O data port.	The DAC 1600 Digital to Analog Converter has been designed to interface to a process control loop.	DAC 1600	40 DIP
18 CHANNEL ANALOG MULTIPLEXER	■ Connects 1 of 18 analog inputs ■ Address latch on-chip ■ 0 to 6 volt input range ■ Analog output controlled by chip select signal	The MUX 1600 is a binary addressed 18 channel analog multiplexer. The MUX 1600 includes on-chip address latches and separate address strobe and chip select signals.	The binary address selection of the 18 input channels provides for simplified direct control of analog signals by the CP1600 microprocessor chip.	MUX 1600	28 DIP
GIMINI MICRO-COMPUTER SYSTEM	■ Built around the CP 1600 Microprocessor ■ Complete microcomputer system ■ Separate Data, Address and Control Buses ■ Up to 65K memory space. ■ Unlimited DMA channels ■ Nested interrupt system with full priority resolution.	The GIMINI utilizes a totally modular design for maximum configurability. The system provides direct addressing to 65K words, unlimited DMA channels, and a multi-line multi-level nested interrupt system with full priority resolution and self-identifying addresses. All control & timing signals as well as data & address busses are fully buffered.	To simplify microprocessor hardware and software development, speed the product design cycle & support product prototyping, a microcomputer development system and its associated components are a must. The Series 1600 family fills these requirements with the GIMINI Microcomputer.	GIMINI	—
GIMINI SINGLE CARD MICRO-COMPUTER	■ 16K words of RAM ■ 4K words of PROM ■ Up to 32 input and 32 output lines ■ Two UAR/T-RS232 Serial I/O channels ■ Real time clock	The SC1600 GIMINI Single Card Microcomputer provides full 16-bit processing power on a single card. The SC1600 uses the CP1600 microprocessor with all circuitry for a complete operating system.	In industrial usage, the SC1600 can serve as the kernel of a modular expandable processing system with other cards added as required. In consumer applications, the SC1600 can serve as the basis for many user-programmable systems such as TV games, home TV terminals, etc.	*SC1600	—

*For Future Release

SERIES 8000 MICROPROCESSOR

FUNCTION	FEATURES	DESCRIPTION	APPLICATIONS	PART NUMBER	PACKAGE
8 BIT MICRO-PROCESSOR	■ 2 Chip Minimum System (plus clock) ■ 48 Accessible 8 Bit Registers ■ 48 Basic Instructions ■ Binary and Decimal Arithmetic ■ Direct and Indirect Input/ Output Capability ■ Automatic subroutine nesting on memory devices.	The LP 8000 Logic Processor Unit is a complete 8-bit single chip MOS-LSI Microprocessor. It has a modern computer architecture with forty eight general purpose internal registers. The 8-bit Data highway is supplemented by a 6-bit Address bus to give a 14-bit address capability which permits access to 16,384 words.	The Series 8000 Logic Processor System is designed to perform any digital function using far fewer packages than a TTL or CMOS implementation. Typically a 100 package system can be reduced to a three chip solution of LP 8000 Processor, LP 6000 Program Memory and LP 1030 Clock Generator. Also available: LP 1010 I/O Buffer, LP 1000 Memory Interface.	LP 8000	40 DIP
				LP 6000	40 DIP
				LP 1030	8 DIP
				LP 1010	40 DIP
				LP 1000	40 DIP

PIC SERIES MICROCOMPUTER

FUNCTION	FEATURES	DESCRIPTION	APPLICATIONS	PART NUMBER	PACKAGE
8 BIT SINGLE CHIP MICRO-COMPUTER	■ User Programmable ■ 32 8-Bit Registers ■ 512x12-Bit ROM for Program ■ Arithmetic Logic Unit ■ 4 Sets of 8 User Defined TTL-compatible Input/Output Lines ■ Real Time Clock Counter ■ Self contained Oscillator ■ Access to RAM Registers inherent in instruction.	The PIC 1650 MOS/LSI circuit array is a byte oriented programmable controller The array is a complete chip controlled with an internal customer-defined ROM program specifying the overall functional characteristics and operational waveforms on each of the general purpose input/ output lines.	The array can be programmed to scan keyboards, drive multiplexed displays, control vending machines, traffic lights, printers and automatic gasoline pumps Since it contains ROM, RAM, I/O as well as the central processing unit on one device, the PIC 1650 is truly a complete 8-bit microcomputer on one chip	PIC 1650	40 DIP
8 BIT SINGLE CHIP DEVELOPMENT MICRO-COMPUTER	■ PIC 1650 microcomputer without ROM. ■ ROM address and data lines brought out to pins. ■ Can be stopped or single stepped via a HALT pin.	The PIC 1664 circuit is exactly the same as the PIC 1650 except that the ROM portion of the PIC 1650 has been removed. Any external RAM or PROM can be used to aid in the development of a final PIC 1650 configuration.	The PIC 1664 has been designed as a useful tool for engineering development and prototyping and for initial field trial and demonstrations of systems which will utilize the PIC 1650	*PIC 1664	64 DIP

*For Future Release.

MICROELECTRONICS

STATIC RANDOM ACCESS MEMORIES

BITS	MEMORY ORGANIZATION	PART NUMBER	REPLACES (PIN-FOR-PIN)	ACCESS TIME/ CYCLE TIME	POWER SUPPLIES	PACKAGE	FEATURES
1024	256x4	RA-3-4256	—	500ns/500ns	+5, GND	24 DIP	Power down mode.
		RA-3-4256A	—	650ns/650ns	+5, GND	24 DIP	Power down mode.
		RA-3-4256B	—	650ns/650ns	+5, GND	22 DIP	
4096	4096x1	RA-3-4200	SEMI 4200	215ns/400ns	+12, -5, GND	22 DIP	TTL output
		RA-3-4402	SEMI 4402	200ns/350ns	+12, GND, -5	22 DIP	Differential output.

ELECTRICALLY ALTERABLE READ ONLY MEMORIES

	BITS	ORGANIZATION	PART NUMBER	READ ACCESS	ERASE TIME/MODE	WRITE TIME/MODE	POWER SUPPLIES	PACKAGE	FEATURES
NEW	512	32 x 16	ER2050	10μs	100ms/16 bit word	10ms/16 bit word	+5, -28	28 DIP	10 year data storage @ +70°C.
			*ER2051	3μs	50ms/16 bit word	50ms/16 bit word			
	1024	256 x 4	ER1105	2μs	100ms/32x4 block	5ms/4 bit word	+12, -12	24 DIP	
	1400	100 x 14	ER1400	2.8 μs	16ms/14 bit word	16ms/14 bit word	-35	8 TO/DIP	
	4096	1024 x 4	ER2401	2 μs	100ms/1024x4 block	10ms/4 bit word	5, -14, -24	24 DIP	
			*ER3400	650ns	10ms/4 bit word or 1024x4 block	1ms/4 bit word	+5, -12, -30	22 DIP	
NEW			ER3401	950 ns					
	8192	2048 x 4	ER2800	2.6μs	100ms/2048x4 block	10ms/4 bit word	5, -14, -24	24 DIP	
NEW			*ER2805	2μs					

*For Future Release.

READ ONLY MEMORIES

	BITS	MEMORY ORGANIZATION	PART NUMBER	REPLACES (PIN-FOR-PIN)	ACCESS TIME	CLOCKS/ VOLTAGE	POWER SUPPLIES	PACKAGE	FEATURES
	1024	256 x 4	RO-7-1024/4	—	1μs (typ.)	STATIC	+5, GND, -12	16 DIP	RO-6 versions available for -55°C to +125°C.
		128 x 8	RO-7-1024/8	—	1μs (typ.)	STATIC	+5, GND, -12	24 DIP	
	2048	256 x 8	RO-5-1302	INTEL 1302	1.5 μs (typ.)	STATIC	+5, GND, -12	24 DIP	Masked version of 1702
			RO-7-2048/8	—	1.5 μs (typ.)	STATIC	+5, GND, -12	24 DIP	RO-6 versions available for -55°C to +125°C.
		512 x 4	RO-7-2048/4	—	1.5 μs (typ.)	STATIC	+5, GND, -12	24 DIP	
	2560	512 x 5	RO-3-2560	—	450 ns	STATIC	+5, GND	18 DIP	
	4096	512 x 8	RO-3-4096	—	500 ns	STATIC	+5, GND	22 DIP	
	5120	512 x 10	RO-3-5120	EA 4000	500 ns	STATIC	+5, GND	24 DIP	
	8192	2048 x 4	RO-5-8192	AMI S8865	1.2 μs (typ.)	2/TTL	+5, -12	24 DIP	
	16384	2048 x 8	RO-3-8316A	INTEL 8316A AMI S6831A	850 ns	STATIC	+5, GND	24 DIP	
			RO-3-8316B		450 ns				
NEW			RO-3-8316C		400 ns				
			RO-3-9316A	INTEL 8316E AMI S6831B MOT 68317	850 ns	STATIC	+5, GND	24 DIP	Replaces two 2708 or 8708 UV PROMs.
			RO-3-9316B		450 ns				
NEW			RO-3-9316C		400 ns				
		4096 x 4	RO-3-16384	AMI S8996	1 μs	STATIC	+5, GND	24 DIP	Address/Chip Select latch
	20480	2048 x 10	*RO-3-20480	—	850 ns	STATIC	+5, GND	24 DIP	
	32768	4096 x 8	*RO-3-9332A	—	850 ns	STATIC	+5, GND	24 DIP	

*For Future Release.

Note: All Read Only Memories are mask-programmable.

KEYBOARD ENCODERS / CHARACTER GENERATORS

	BITS	MEMORY ORGANIZATION	PART NUMBER	REPLACES (PIN-FOR-PIN)	ACCESS TIME	CLOCKS/ VOLTAGE	POWER SUPPLIES	PACKAGE	FEATURES
	2376	88 x 3 x 9 KEYBD. ENCOD.	AY-5-2376	SMC KR2376	10-100kHz Scan Rate	1/TTL or INT. OSC	+5, GND, -12	40 DIP	2 key rollover, 88 keys, 3 modes.
NEW	3600	90 x 4 x 10 KEYBD. ENCOD.	AY-5-3600	SMC KR3600	10-100KHz Scan Rate	1/TTL or INT. OSC.	+5, GND, -12	40 DIP	2/N key rollover, 90 keys, 4 modes.
			AY-5-3600PRO	—					
	2240	64 x 5 x 7 CHAR. GENER.	RO-5-2240S	MK 2302 FSC 3257	1 μs (typ.)	1/TTL for Scanning	+5, GND, -12	24 DIP	5x7 char. column output, on-chip scanning.
	2560	64 x 8 x 5 CHAR. GENER.	RO-3-2513	SIG 2513	450 ns	STATIC	+5, GND	24 DIP	5x7 characters, row output.
	5184	64 x 9 x 9 CHAR. GENER.	RO-5-5184	—	5 μs (typ.)	1/TTL for Scanning	+5, GND, -12	24 DIP	9x9 characters, on-chip left/right scanning.

Note: All Keyboard Encoders and Character Generators are mask-programmable. Standard patterns are available

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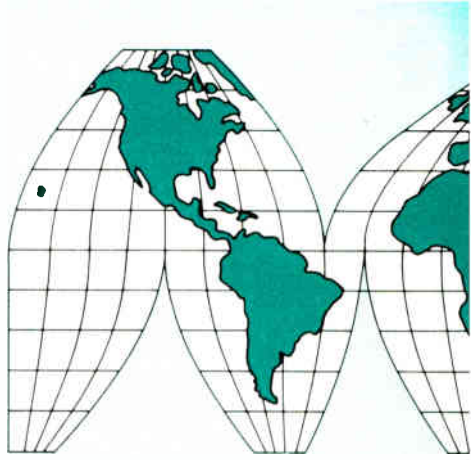

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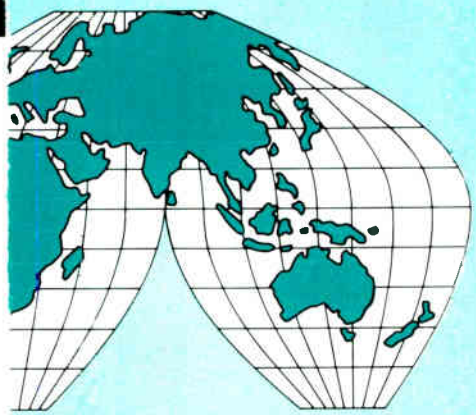

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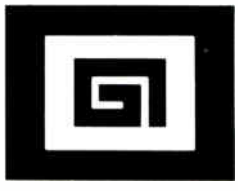

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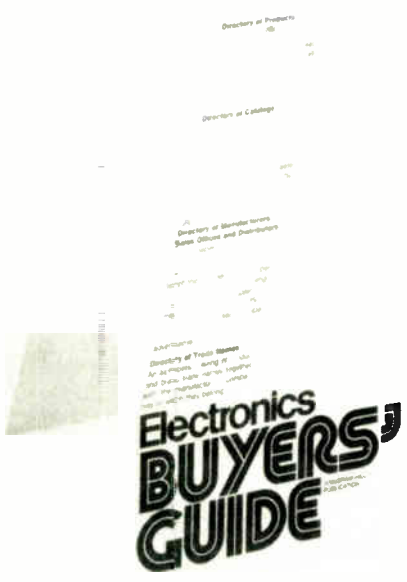

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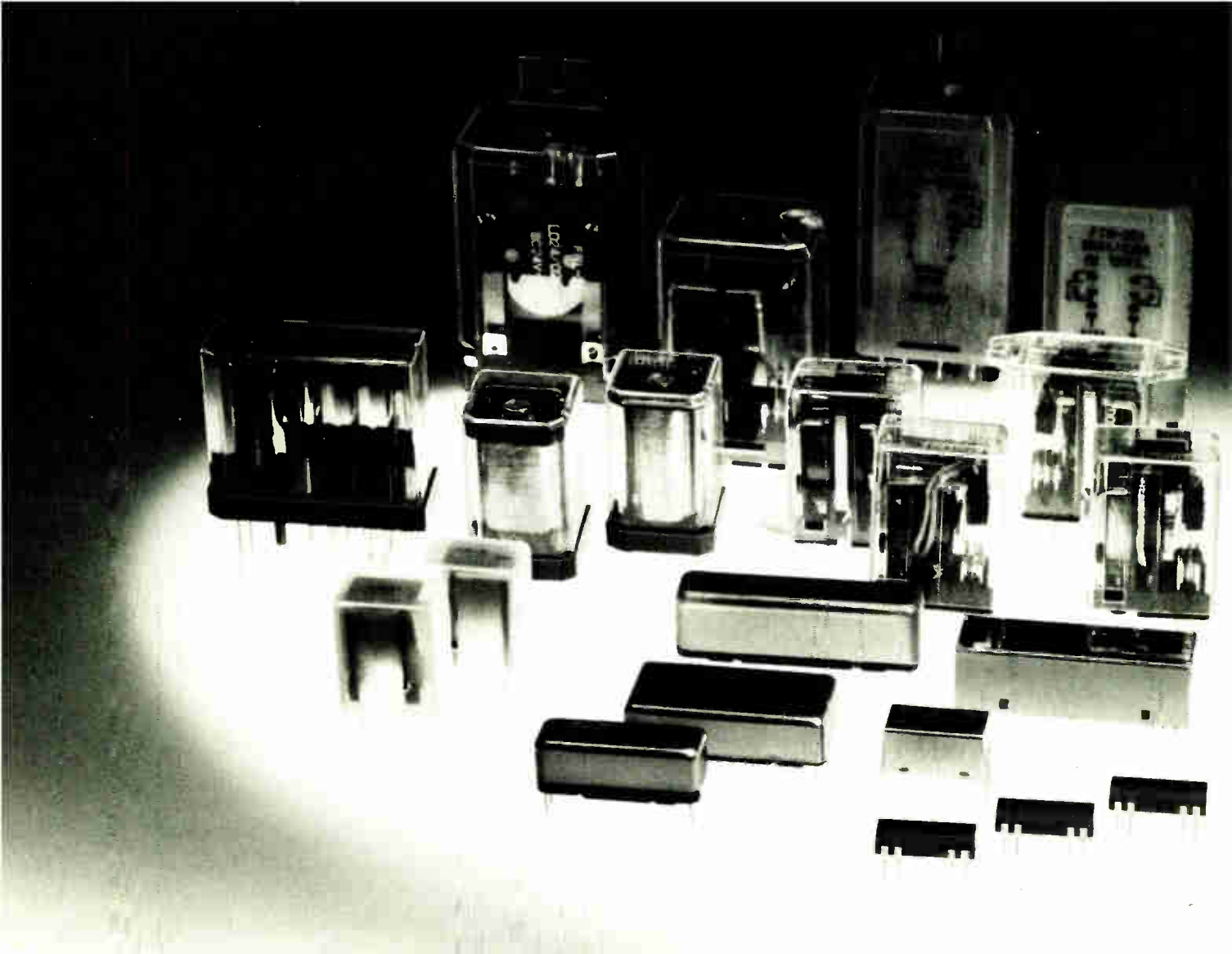

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Fujitsu flat package relays

The Fujitsu lineup of flat package relays offers exceptional coverage and the advantages of flux-contamination-immunity. Within the lineup are our FRL 410-series low-profile and our BR-series miniature GP models. The former are available in both DPDT and 4PDT contact arrangements and coil voltage ratings to 48V DC enabling the widest selection to meet demanding applications including those for communications. And our BR-series models offer you similar wide choice including 0.5A ultra-miniature models that enable exceptional component densities for solid savings in both equipment size and cost.

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Fujitsu general-purpose relays

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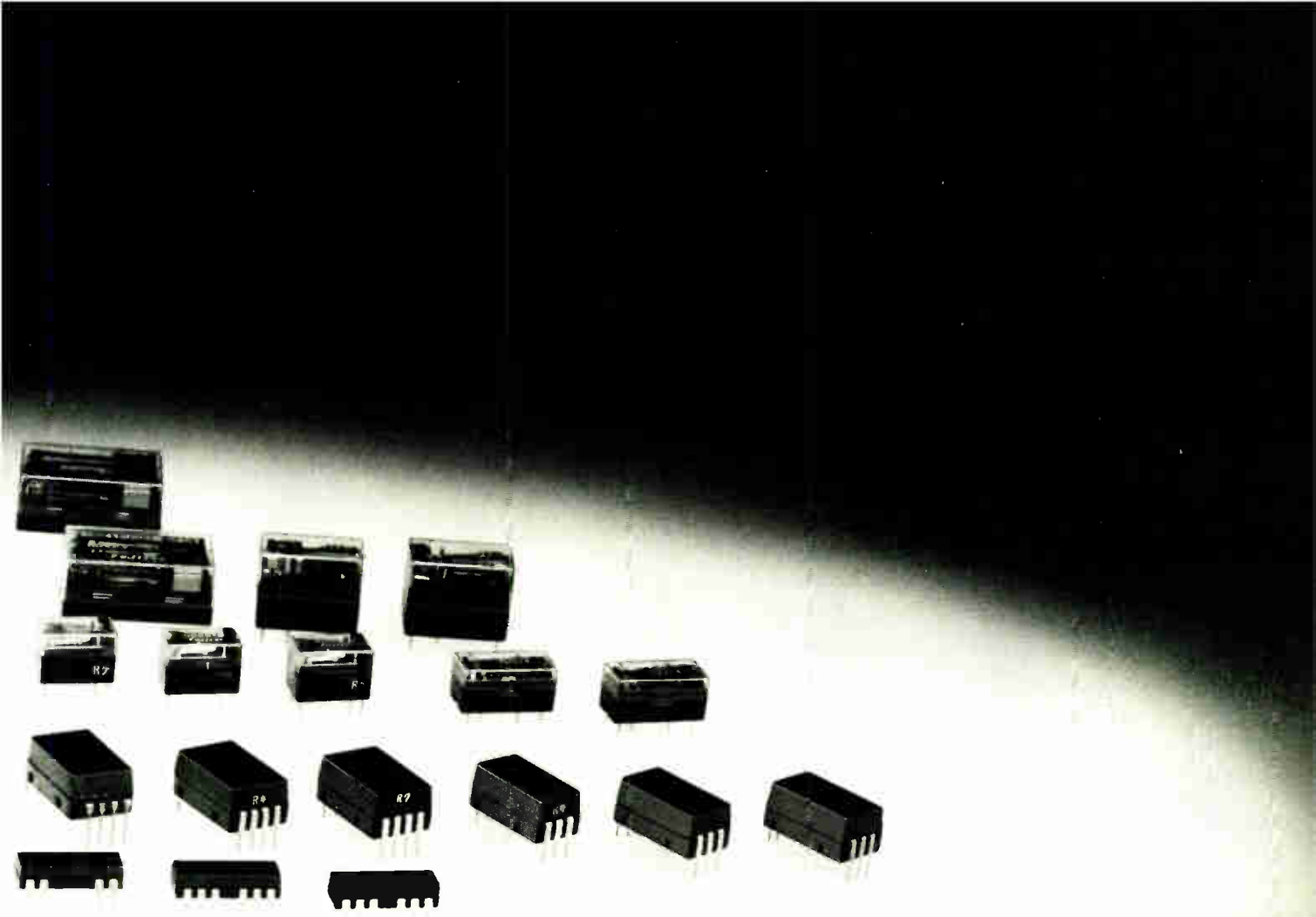

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Washington newsletter

First solar electric factory by ERDA set for Georgia

Even as President Carter battles to sell his new energy program, producers of solar electric systems and other manufacturers are watching the Energy Research and Development Administration's plan to fund **the nation's first production plant to derive all its power requirements from the sun.** The plant, which makes knitwear, will be in Georgia.

ERDA is beginning the selection process for one or more design contractors for the plant. Construction will start in the new town of Shenandoah in September 1979 for completion in March 1981. The factory, to be operated by Wilhelm Bleyle K.G. of West Germany, will initially occupy 25,000 square feet, employing about 70 people, and eventually grow to 42,000 ft^2, employing about 300. Electric power requirements will be about 200 kilowatts, plus up to 1,200 kw of heat energy.

GE, Garrett to build electric cars for ERDA

"Proof-of-concept" models of two electric cars, **one with new electronic controls and the other with a flywheel for better acceleration,** will be forthcoming from General Electric Co., Schenectady, N.Y., and Garrett Corp.'s AiResearch Manufacturing Co., Torrance, Calif. Next month, ERDA will award contracts for two models each: the flywheel cars from AiResearch, the electronic-controls models from GE.

Both of the four-passenger designs are for urban driving and will have a 75-mile range and top speed of 55 mph, using advanced lead-acid batteries. They will have microcomputer control, to prevent jackrabbit starts or other driver abuse that might waste energy or damage batteries, ERDA says. The two-year contracts will total $3 million to $5 million.

FAA begins 25-kHz channel spacing for air communications

Airliners and high-performance general-aviation aircraft that operate above 18,000 feet will have double the number of vhf air-traffic-control channels, the Federal Aviation Agency has decided. The move to **halve radio-frequency spacing at high altitudes to 25 kilohertz** is the result of a five-year study on ATC channel congestion. The planes must be equipped with 720-channel radios to get maximum benefit of the new channels.

Aerospace jobs to reverse slide, rise through 1978

Jobs in U. S. aerospace firms, including those for engineers and scientists, **will rise to 916,000 by December, up 2% from the year before,** and continue upward in 1978 to 935,000 another 2.1% boost. The Aerospace Industries Association bases this projection on a survey of 45 companies. "The projected increase reflects a reverse of recent trends," AIA says, noting that aerospace jobs reached a low of 895,000 last September, from the peak of 1.5 million in 1968.

Commercial transport and helicopter production will account for much of the increase, according to the survey. The missile and space side is not as bright for 1977, although a 1978 gain is predicted as Space Shuttle activity accelerates.

Engineering and scientific employment, pegged at 165,000 last December, will move gradually upward, reaching 171,000 by year's end, a 3.6% rise for the year. The 1978 forecast of 175,000 would mark another 2.3% rise from this year. Engineering and scientific jobs in the aircraft and parts industry will rise 4% to 75,000 by this June from 72,000 at the close of 1976 and remain nearly stable through 1978, the association predicts. Missiles and space engineering scientific employment will continue at 47,000, then rise slightly to 48,000 in 1978.

Washington commentary

Keeping NATO safe for America

What sounds and smells like the beginning of an electronics trade war between U. S. producers of consumer, semiconductor, and telecommunications products and their counterparts in Asia now appears to worry makers of military electronics selling to Europe, particularly to the North Atlantic Treaty Organization.

That is the message from the Electronic Industries Association's Government division, whose members say, "Safeguards are necessary to ensure that competition will be conducted under equitable conditions." Although the EIA division says Government spokesmen have assured it that foreign contractors will be subject to the same procurement regulations, audits, and inspections as U. S. contractors and would be judged on an equal basis, the EIA is proposing "safeguards" anyway. If adopted by the Department of Defense, the "safeguards" would indeed make the military electronics marketplace safe for American companies since they would in effect prohibit foreign entry.

Protecting the 10:1 share

The EIA, which formed an Export/Import Special Task Force on military imports, perceives manufacturers in NATO countries as its greatest threat. These manufacturers' earlier grumbling over the alliance's military outlays has escalated to shouting as NATO's 8:1 dollar ratio in favor of American suppliers has widened to 10:1. It may very well be that most EIA military manufacturers have large consumer operations, too, and corporate managements have now decided that they will not see their military markets go the way of television, radio, and stereo components. That threat seems very real since Defense Secretary Harold Brown told his NATO counterparts not long ago that there will be more buys of European military hardware, along with a more intensive DOD effort to standardize U. S. and NATO weapons.

Also distressing to EIA's members is the U. S./UK Memorandum Of Understanding, soon to be implemented, that eliminates, among other things, the "buy American" requirement for new weapons. EIA's task force wants a special industry briefing on just how that new treaty document will be put into effect.

But that is the least of EIA's demands. Topping the task force list of demands is the requirement "that DOD provide written assurance that if suppliers are recipients of subsidies from their government, or benefit from nontariff trade subsidies, they are not to be considered eligible to compete with U. S. industry." That, of course, would effectively eliminate just about every West European producer from competition, since their governments have long identified such military development spending as "subsidies," rather than employ such American linguistic sugarcoatings as independent research and development or such R&D euphemisms as "advanced" or "exploratory." As one DOD observer familiar with the EIA's proposals puts it: "It looks like they're going for the whole hog."

Another EIA recommendation specifies that "if DOD authorizes release of technical data developed by U. S. industry and owned by the U. S. Government, it must establish monitoring and control procedures to preclude such data being transferred to third countries." That requirement seems no more than reasonable for protection of U. S. data, but it is likely to have a significant secondary effect: discouraging service project offices from working with Europeans if they can possible avoid it, since their already strained staffs would then be obliged to take on a significant new workload with the "monitoring and control" job.

Prolonging the agony

The EIA task force also wants DOD to insure reciprocity in contracting affiliations so that "when a foreign country requires a U. S. firm to have a local affiliate or licensee in order to compete in that country's defense market, DOD should require that a reciprocal arrangement be applied to that country's industry when bidding for the U. S. market." That requirement is certainly reasonable, but may be tough for DOD to enforce. Europeans are perhaps more protective of their own defense industries' interests than America has had to be, simply because they rightly envision the U. S. as the dominant industrial force. Still DOD should push for it.

Next to last on EIA's list is its call on DOD to require its foreign allies to grant "expedited release of requests for proposals" to U. S. manufacturers if DOD does the same—as it sometimes does—for foreign producers who may compete for a NATO buy. Again, reasonable but perhaps not enforceable. If that proves to be the case, then it will prove one more barrier to Brown's pledge to buy more offshore.

But the kicker in EIA's proposals is the one that calls for EIA to help DOD draft the language "for the specific contractual requirements that foreign sources must meet for inclusion in the ASPR"—the Armed Services Procurement Regulation. "That would be laughable," says one DOD official, "if I didn't know that they are very serious about this."

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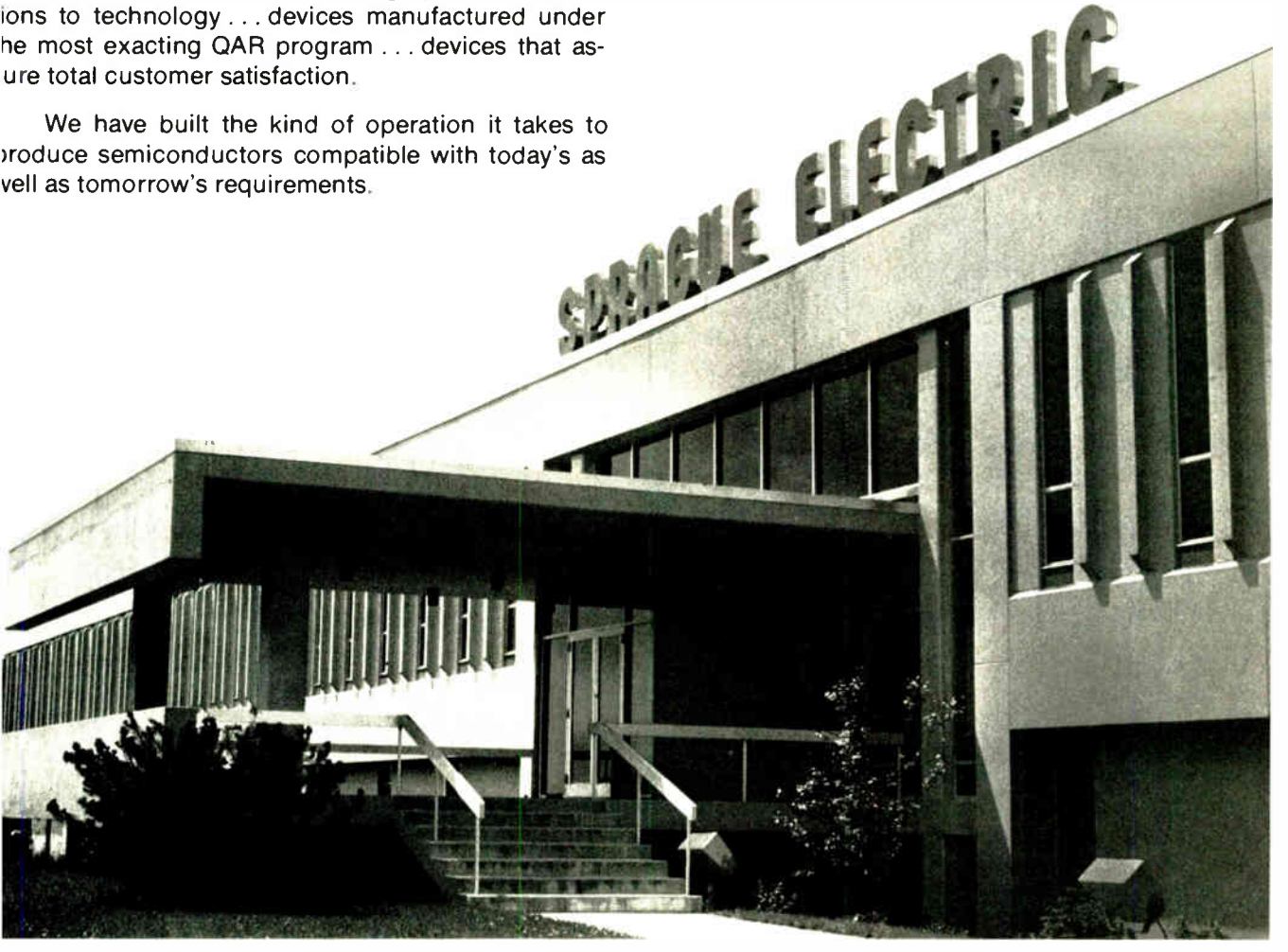

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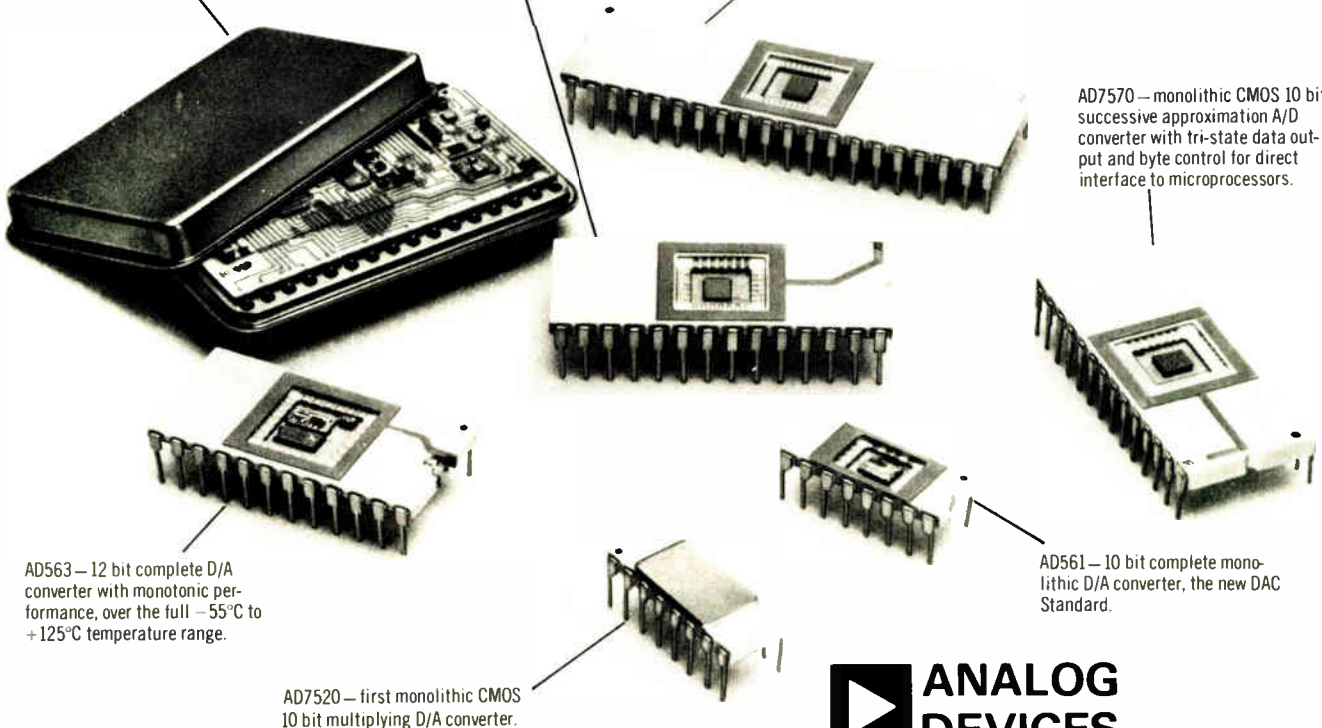

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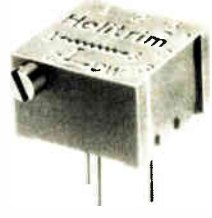

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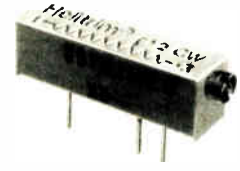

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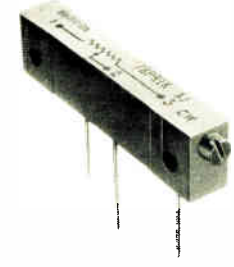
- Resistance range: 10 Ω to 2 meg Ω



Model 78
- Military performance, industrial price
- 1¼" rectangular, 0.195" wide
- Sealed
- 3 terminal styles: flex leads, P.C. pins, solder lugs
- Power rating: 0.75 watt at 70°C
- 22 turns of adjustment
- Resistance range: 10 Ω to 2 meg Ω

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International newsletter

BPO to install fiber-optic test bed

Following the unveiling by Standard Telephones and Cables of a 140-megabit-per-second optical-fiber link [see Electronics International], the British Post Office expects to soon announce a versatile 12-kilometer testbed between telephone exchanges at its research labs in Martlesham Heath and Ipswich, Suffolk. Although BPO researchers primarily designed the link to test 8.48-Mb/s local exchange traffic, **they already have transmitted at the 140-Mb/s rates to one repeater installed 5.75 kilometers along and plan to test that high speed over the whole hop.**

Blood-pressure test unit goes to LSI

Add another item to the list of products boasting LSI circuitry—blood-pressure measuring gear. Matsushita Industrial Equipment Co. is starting shipments of an electronic sphygmomanometer in which **all logic circuits have been integrated on a single p-channel MOS LSI chip measuring about 3.5 millimeters square.** The unit, which is based on a cuff with a capacitor microphone inside, pumps up and releases cuff pressure automatically. It displays blood pressure and pulse rate digitally and uses the pulse rate data for gating of logic circuits to eliminate errors caused by noise. The new instrument, an updating of a non-LSI version the company has been selling since October 1975, sells for about $1,450.

Sinclair launches $29.95 programmable scientific calculator

Sinclair Radionics Ltd. of Great Britain takes a new turn in the calculator price war by introducing a $29.95 programmable version of its small Cambridge scientific model. Targeted for the huge engineer and student market, the instrument has 19 multifunction keys plus such features as a 36-step program memory, conditional and unconditional branch instructions, program self-check, and an optional library of 294 programs. **Key to the 3-ounce unit is a National Semiconductor 5799 4-bit microprocessor chip operating from a Sinclair-developed program.**

Software aids equip Level 64 computer for competition

The Franco-American computer company, CII-Honeywell Bull, has given its French-developed Level 64 computer a more aggressive look with the announcement of software aids for conversion to it from competitive systems including IBM, NCR, ICL, and Philips. CII-HB expects Honeywell Information Systems to follow with similar announcements in the U. S. and other HIS territories, but these are likely to be tailored to local market requirements.

The new aids are aimed at helping users convert from systems such as the IBM 360/370 and ICL 1900 to the Level 64. The main application areas are file and program conversion. The Level 64 has also been beefed up with more memory, peripheral, and telecommunications capabilities, as well as other software, including text-editing programs.

Quartz clocks run on sunlight or room light

Telenorma GmbH, a subsidiary of Frankfurt-based Telefonbau und Normalzeit, has readied two quartz-driven clocks that can be kept charged by sunlight or room light greater than 700 lux. One is a table-top version with a liquid-crystal display, the other a wall clock with a conventional analog time indication. **Their power supply consists of high-efficiency, single-crystal-silicon solar cells capable of storing enough energy to keep the clockwork going through the night.** The time deviation for the two models is no more than ±30 seconds per year.

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British firm to inaugurate 140-Mb/s transmission cable over 9-kilometer route

What is the commercial potential for optical-fiber telecommunications? A two-year field trial of a 9-kilometer, 140-megabit-per-second transmission link north of London is a starting point for the answer to that question. Standard Telephones and Cables, which is installing the trial link in British Post Office phone ducts, also hopes the project will give it a leg up on its worldwide competition [*Electronics*, April 14, p. 65].

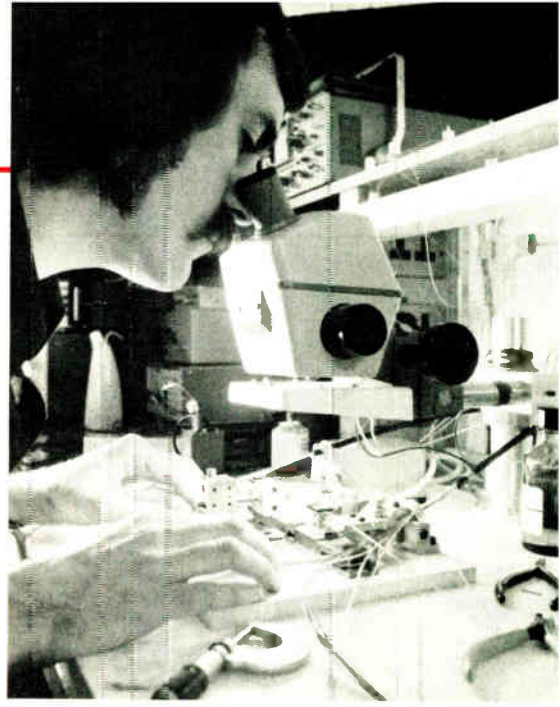
The International Telephone & Telegraph subsidiary hopes that its field trial will stake a claim to commercial leadership in high-speed optical transmissions with the BPO and overseas telecommunications authorities. It also gives the company "a specific target to bring things out of the lab environment and into the real-life world outside," declares S.B. March, technical director.

Aside from the technical challenge, STC chose the stiff 140-Mb/s rate because economic studies showed that this international standard speed would be cost-competitive with coaxial cable. The trial hookup will initially carry simulated telephone traffic between two BPO exchanges when it begins operating this summer, but STC expects the Post Office to switch in some live traffic soon after. The link can carry as many as 1,920 simultaneous phone conversations or two color-television signals.

Mostly a private venture among STC and other ITT companies, the project is estimated to cost several hundred thousand dollars. The BPO supplied the ducting and space for the digital multiplexing equipment in the Stevenage and Hitchin exchanges. The pulse-code-modulation systems contain:

- Multimode graded-index fibers of germanium-doped silica, a commercial offering from STC using chemical vapor deposition [*Electronics*, Nov. 25, 1976, p. 6E].
- Cable 7 millimeters in diameter from ITT's Standard Telecommunication Laboratory containing a central strain member that supports four copper wires to feed power to the repeaters, one dummy strand as a filler, and three 100-micrometer-diameter optical fibers, one a spare.
- Six gallium-aluminum-arsenide double-heterostructure lasers from STL operating at a wavelength of 850 nanometers for special purity. Marsh says STL has done more than 20,000 hours of life testing on the design.
- Two STL-made repeaters placed 3 km apart to rejuvenate the signal. Marsh says that it now looks as if one repeater would be enough.
- At each exchange, standard high-order multiplex equipment supplied by Bell Telephone Manufacturing Co. (an ITT company in Belgium not affiliated with AT&T in the U. S.), and the Italian Fabrica Apparecchiature per Communicazioni Elettriche Standard SpA.

After the trial, STC hopes that the BPO will buy a system for its field trial, which could lead to orders for commercial systems. □



Making ready. Top: optical fiber being spliced. Middle: terminal equipment in one of telephone exchanges. Bottom: engineer adjusts terminal equipment.

West Germany

Shorter CCD chip has more cells

More light-sensing cells per millimeter: that could mean shorter length and lower production costs or higher resolution for the linear charge-coupled service image sensors used in page-scanning and facsimile transmission systems.

At present, only laboratory versions exist of the so-called quadri-

linear imager developed by H. J. Pfleiderer and Heiner Herbst at West Germany's Siemens AG, and further development is necessary before Siemens will make a decision on volume production. But their work to date has convinced two researchers that the standard 1,728-cell imager can be shortened by 30%—to 17.5 mm from the normal 25 mm [*Electronics*, March 20, 1975, p. 25].

The other route would be to pack many more than 1,728 cells into a 25-mm-long imager—more than 2,500, investigation indicates. That, Pfleiderer notes, translates into a big improvement in image resolution that would be useful in, say, remote picture sensing from satellites.

The quadrilinear imager uses four shift registers instead of the usual two. As a result, its information readout is more efficient, and it can use smaller sensing cells.

A conventional page-scanning imager has just two CCD shift registers, one on either side of the row of MOS-capacitor sensing cells. The charge that is produced when light impinges upon these cells is transferred into the registers and then shifted down the line of CCD elements to the output. All odd-numbered cells are connected to, say, the lower CCDs, while all even-numbered ones are hooked to the upper CCDs.

One drawback of such a bilinear imager, Pfleiderer points out, is that most charges must undergo many shifts before reaching the output. This leads to some degrees of signal distortion, which impairs resolution. To be sure, this problem can be solved by replacing the normally used surface CCDs with bulk CCDs, which exhibit a better charge transfer behavior. But fabricating the bulk type is more complicated.

Further, Pfleiderer contends, the device could be produced at less cost if it were smaller—that is, if the sensing-cell density were higher. But in the bilinear imager, that density is limited by the length of the CCD elements. With the 5-micrometer structures possible today, the total imager length cannot be made much less than 25 mm, however.

This is where the quadrilinear imager comes in. In this device, there are two CCD shift registers along each side of the cell row. In the charge-transfer process the contents of all cells are first shifted to the inner CCD elements. Then, every other charge packet in these elements is moved to the outer CCDs. Finally, all charges are transported to the output.

The use of four instead of two shift registers virtually halves the number of transfers from one CCD element to the next, so that there is less signal distortion and hence higher resolution. That means that even long sensing-cell rows can be made with simple surface-CCDs. □

Around the world

TV set is system's input/output terminal

Despite company-sponsored microprocessor courses and seminars and a host of development systems, the number of engineers who know how to program microprocessors is still relatively small. The trouble is that many instruction methods either do not provide sufficient hands-on software experience or are beyond an individual user's financial means. Now, though, out of West Germany's Black Forest comes a simple, relatively inexpensive system that uses any black-and-white TV receiver as the input/output terminal. Developed by Franz Morat KG, a 250-man metal products company, the system enables the user to learn all about microprocessor programming right in his living room and at his own pace.

The heart of Morat's TV-Computersystem 6800/8080 is a microprocessor—either a 6800 version from Motorola or Intel's 8080—backed up with a 1-kilobyte random-access memory, electronic control unit, power supply, and light pen for controlling the display on the TV screen. The price tag: a mere $540. For $275 or so more, the user can add a cassette control and interface unit for reading or writing memory data on any commercially available tape at the rate of 1 kilobyte in less than 90 seconds.

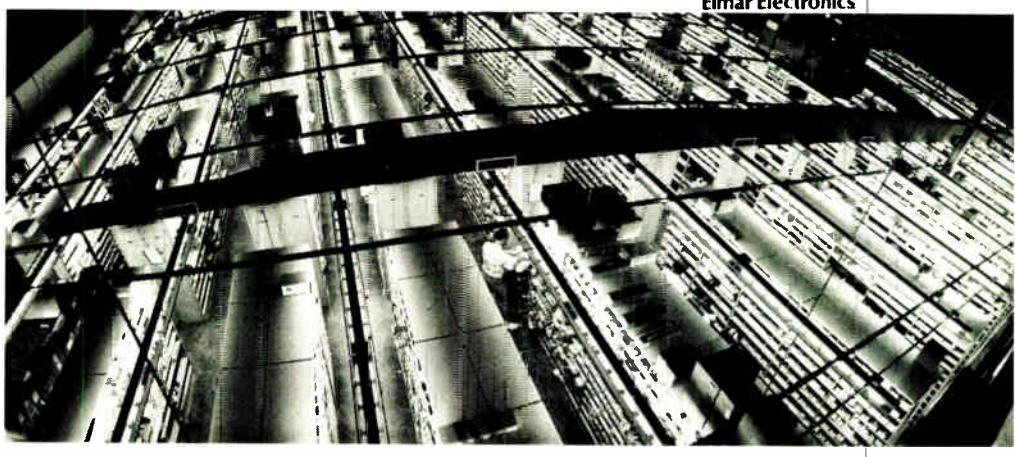
4-company effort yields 65-k RAM

American semiconductor makers are not alone in closing in on the 65,356-bit random-access memory—a joint Japanese development effort has yielded a 65-k RAM that could be commercially available in two to three years. Small geometry and a thinner oxide between them cram the 65-k dynamic RAM on a chip a little larger than that used for many of today's 16,384-bit memories. The device was built at the Musashino Electrical Communication Laboratory of Nippon Telegraph and Telephone Public Corp. in a joint project with Nippon Electric Co., Hitachi Ltd., and Fujitsu Ltd. The commercial versions would be used in telephone exchanges, computers for on-line services offered by Nippon Telegraph, video communication, facsimile, and intelligent terminals, as well as in commercial applications.

Central data base cuts costs

Putting the data base in a central memory and relegating all processing tasks to peripheral microprocessors with direct access to the memory is an unusual way to set up a data-management system. But it is a system that takes advantage of the low cost of microprocessors while providing the power to combine real-time processing with off-line key-to-disk, remote-job-entry, or batch processing. Following through on the bright idea, Hyperion Data Systems Ltd. is launching two products. The Micro-Cell 101 is a general-purpose system to be unveiled in late May at the International Minicomputers, Microcomputers, Microprocessors 77 exhibition in Geneva.

The $15,000 version comes with one visual-display-unit terminal, a 150-character-per-second printer, and 25 megabytes of disk memory. The $77,000 version has eight visual-display units, two printers, and 100 megabytes of on-line memory. The Dentron D8000, a specialized form of the concept designed to store up to 35,000 dental records, already has attracted interest from dentists all over the world, the company reports.


Elmar Electronics

The electronics technology marketplace and the electronic distributor

Gathering in Las Vegas the first week in May for National Electronics Week will be the representatives of a $4 billion segment of the electronics community—some 9,000 individuals, including: manufacturers of electronic components, equipment, and accessories; their field sales forces, among them a substantial number of independent manufacturers' representatives; and the distributors through whom these manufacturers bring their goods to market.

The Las Vegas visitors will be participating in the annual NEWCOM Show—often described as the "vital meeting place and marketplace for the world of electronic component distribution." This is a world which has played an indispensable role in helping bring a new era in electronic technology. Distribution has been responsive to and reflective of the changes, but also has been a critical force in facilitating the expansion and sophistication of the technology.

This is therefore an appropriate moment at which to review the evolution of electronic distribution and in particular to call attention to the emerging role of the industrial electronic distributor in selling electronic components and equipment, and providing service to those that buy them. It has been estimated that today there are some 2,000 industrial electronic-distributor locations (main offices and branches) in the United States, serving approximately 40,000 industrial electronics-buying locations. Nobody quarrels with the estimate that this figure will reach 100,000 locations by 1983. It has further been estimated that some 350 industrial distributor firms now sell over $2 billion worth of electronic components and parts annually to the OEM, MRO, and R&D markets.

Technology proliferation, accelerated by the potentials offered product designers by LSI and microprocessor technology, strengthens and accentuates the role of the industrial electronic distributor as the most efficient, if not the only, way to keep pace with electronics' burgeoning penetration into such areas as mechanical, hydraulic, electrical, as well as electronic product design.

For many component-manufacturing companies, products sold through the industrial distributor account for up to 60% of their total sales volume. As the LSI and microprocessor technology continues its penetration into new market areas, distributors' share of the component sales dollar volume is likely to increase in answer to the demand.

It's not easy to draw a profile of industrial distribution as it operates today. There are probably as many different profiles and combinations of product mix, service orientation, and territorial coverage as there are industrial distributions—even more as many of the so-called "general-line distributors," whose traditional orientation was the radio and TV service parts business, begin to provide coverage of bits and pieces of the industrial market.

In zeroing in on the exclusively industrial electronic distributors, you can begin to classify them by the type of customers they serve, the type of products they carry, and by their range of geographical coverage. Within these differentiations and categorizations, there are further overlaps and hybrids.

Perhaps the most obvious differentiation among industrial distributors is geographic. These range from the large

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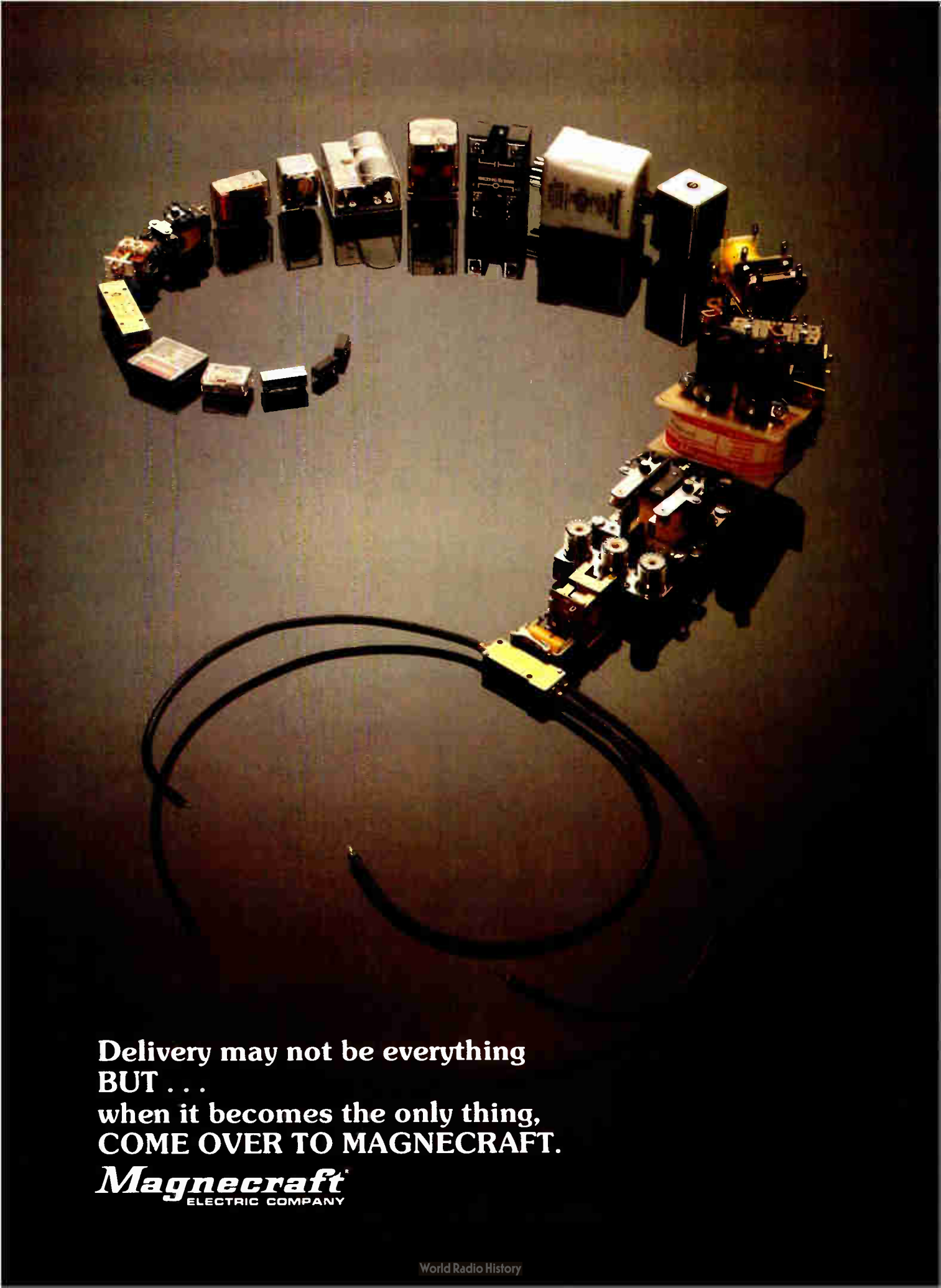

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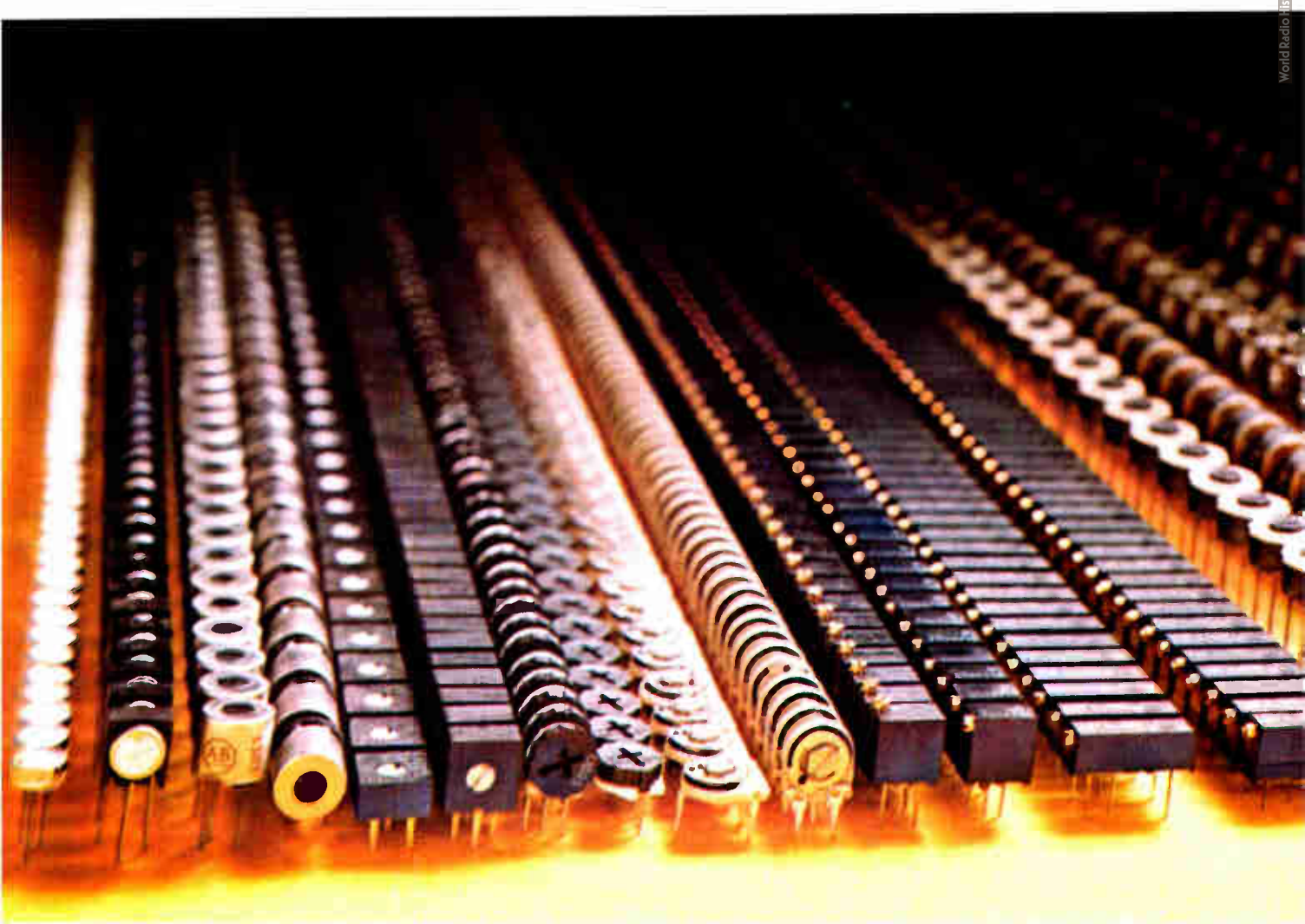

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Type Y: ½" dia., single turn, 100 ohms to 5 megs ±10% or 20%, 0.25W at 50°C, dust/splash resistant, 5 styles, non-linear tapers, Pub. 5209. **1000 piece price $0.90 to 1.59.**

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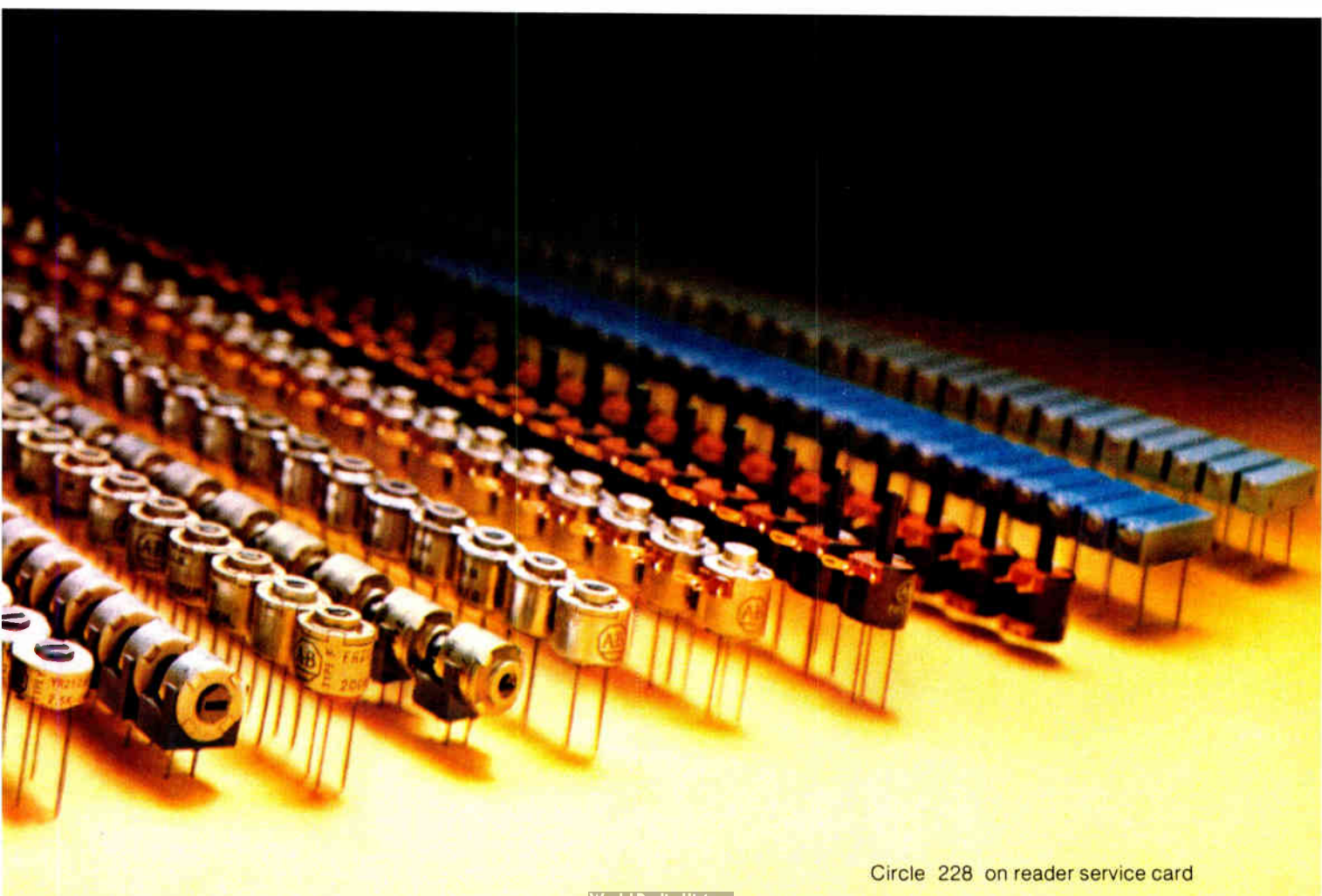

Circle 228 on reader service card

national chains (the biggest of which claims annual sales in excess of $230 million) to strong regional networks, to highly effective local distributors.

Obviously, the local distributor will perform all sales and warehousing functions from a single location. The national is likely to maintain large and deep inventories in a few major markets, augmented by back-up stocks strategically located in between and sales offices which extend the reach even further. The regional distributor generally offers many of the sophisticated systems and services of his national-chain counterpart, combined with the shorter lines of communication and closer customer contact that are the forte of the local.

Product mixes differ as well. Many distributors, particularly those that trace their roots back as radio parts jobbers, tend to take a broad-line approach, carrying as many as 70,000 different items from as many as 250 vendors, many of them competitive with one another. Then there is the limited-line approach, offering a wide range of products within a limited number of brands, but only one brand in a product category. There also is the specialist, who carries very deep inventories of a comprehensive grouping of lines of a single product type.

A topic that has evoked considerable discussion in the industry—but that does not fall within the scope of this report—is that of franchises, whereby one or two distributors have exclusive rights to offer a given line in a given territory. However, many distributors have cooperative working arrangements with one another. As a matter of fact, the last year or so has begun to see the emergence of super-distributors, whose sole business is fulfilling other distributors' special component needs.

The industrial electronic distributor, as a distinct entity, is a relatively new phenomenon. Industrial electronics distribution, like the rest of the electronics industry, is an outgrowth of the radio business, specifically the radio parts business. From the experimenters, hobbyists and hams of the 1920s and 1930s, and the explosion of radio as a primary entertainment device during the early Roosevelt era, emerged the radio parts jobber. World War II accelerated the growth of electronics technology for non-entertainment applications, but even in the late 1940s and early 1950s, the parts jobber was still primarily concerned with selling tubes and other replacement parts for radios and television sets.

In the middle 1950s, pioneer distributors like Sam Poncher of Newark Electronics were considered visionary when they said, "There is a customer for electronics every place there is a smokestack." But this gospel spread, and by the early 1960s, manufacturers were beginning to develop full-scale marketing programs offering off-the-shelf delivery from local distributors, in small-run production quantities with prices equivalent to the factory's.

This was the key to the revolution, the *sine qua non* for today's industrial electronic distribution to flourish as it does: the recognition that the distributor was not a customer to whom the component manufacturer should sell, but a conduit to the end user, a vital part of the marketing team performing important value-added services for both the maker and user of components.

The distributor revolution was under way!

Today, in particular, a number of new market factors are in the picture, causing the role of distribution to flourish and expand. From the product designer's standpoint, one sees greater penetration of LSI into the existing component marketplace—consumer white goods, TV, consumer entertainment products, as well as a wide range of microprocessor-based industrial and commercial systems. Tied to this is increased awareness of the critical role components play in practical LSI system designs as well as a reduction in the number of engineers having critical influence on product design in both traditional and nontraditional sales situations.

While in any given buying location there may be fewer people making fewer of the so-called small decisions, there has been and will be a dramatic increase of unknown buying locations, created by high-technology-oriented engineers developing new products. This expanding customer base will surpass the capacity of current direct-sales coverage techniques.

Fortunately, the emergence over the last decade of the industrial electronic distributor as an OEM-quantity supplier, particularly in the nontraditional area, has already equipped him to fill the gap. When technology changes, the market changes; when the market changes, it's imperative to take new looks not only at who sells what to whom, but at how they do it. This report provides some insights into the role of distribution in today's marketplace and how the role of the industrial distributor is likely to function in the electronic-technology marketplace of the future.

Within the broad electronics community, those members of the population who are primarily concerned with distribution form a vital and significant subcommunity of their own. Thus, we will also provide a description of some of the ways in which the distribution community operates and of the machineries through which its members communicate with one another.

Super-modern offices and warehouses, frequently in industrial park settings, as well as advanced order-processing equipment such as shown at Hamilton-Avnet, are characteristic of distributor operations.

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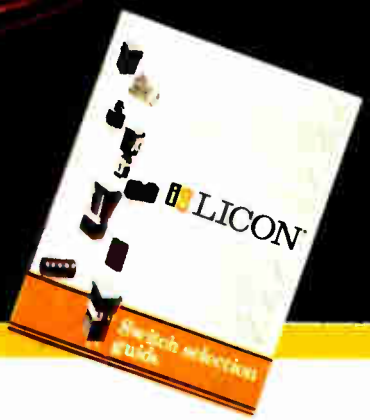

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The distributor—the engineers' friend

Much has been written about the role the modern electronic component distributor plays in the marketing of electronic components, particularly as it applies to his relationship with the engineer or component specifier.

Historically, the distributor's relationship with the customer has been through the customer's purchasing department—with generally sporadic contact with the engineering groups—while the major contact with engineers and specifiers has been more or less assigned to the manufacturers' independent representative or direct factory salesman. This is in keeping with the general consensus that the distributor's role is to service a demand created by the manufacturer or his representative by providing local product availability to the customer.

From the more practical standpoint, not every distributor salesman has the technical expertise to discuss component application, nor does he always have the time to spend in that function. Most distributor salesmen are paid commission on volume, and their time is money. However, the distributor today does, can, and wants to provide services to engineers that are meaningful, time-saving, and important. And in many instances, he *is* technically equipped to do so. More and more distributor sales personnel today can boast EE degrees; and more and more distributors have product specialists on staff to furnish additional back-up.

Of the benefits that the OEM customer and its purchasing department receive when they buy through the industrial electronic distributor, the most obvious and most important is the quick local off-the-shelf availability of product. There are many implications of this key distributor service that should be explored further.

The distributor provides his OEM customer with the convenience of one-stop shopping. This shows up in the ease of ordering—a reduction in paperwork and a reduction in expediting—not to mention the incalculable benefit of helping the purchasing department eliminate product search time. Furthermore, if the distributor encounters an out-of-stock situation, he can frequently suggest and offer an equivalent alternative product.

Although typically the distributor sells at the same price as would the factory for a given number of components (the so-called protected quantity—which may range from 9 to 9,999 or more pieces), he will usually absorb the delivery cost, reflecting an actual dollar savings to the OEM customer. This direct economic benefit is buttressed by the opportunity for additional discounts from the distributor when an order is placed for multiple products at the same time.

Knowing that the distributor has a product in inventory gives the purchasing department greater flexibility in ordering, reduces the cost of warehousing, and cuts both the cost and handling of inventory. Dealing with a distributor, the customer often has the option of buying components in smaller quantities. The back-up stock on the distributor's shelf improves not only improves inventory control but also cash flow.

Many OEMs today find benefits in using the distributor as their second source on a product where the factory is the first source. They order factory-direct on their production runs, but buy the equivalent product from the distributor for prototypes and short runs, as well as to fill in on low items as a production backstop. In a growing number of cases, in fact, even production-run quan-

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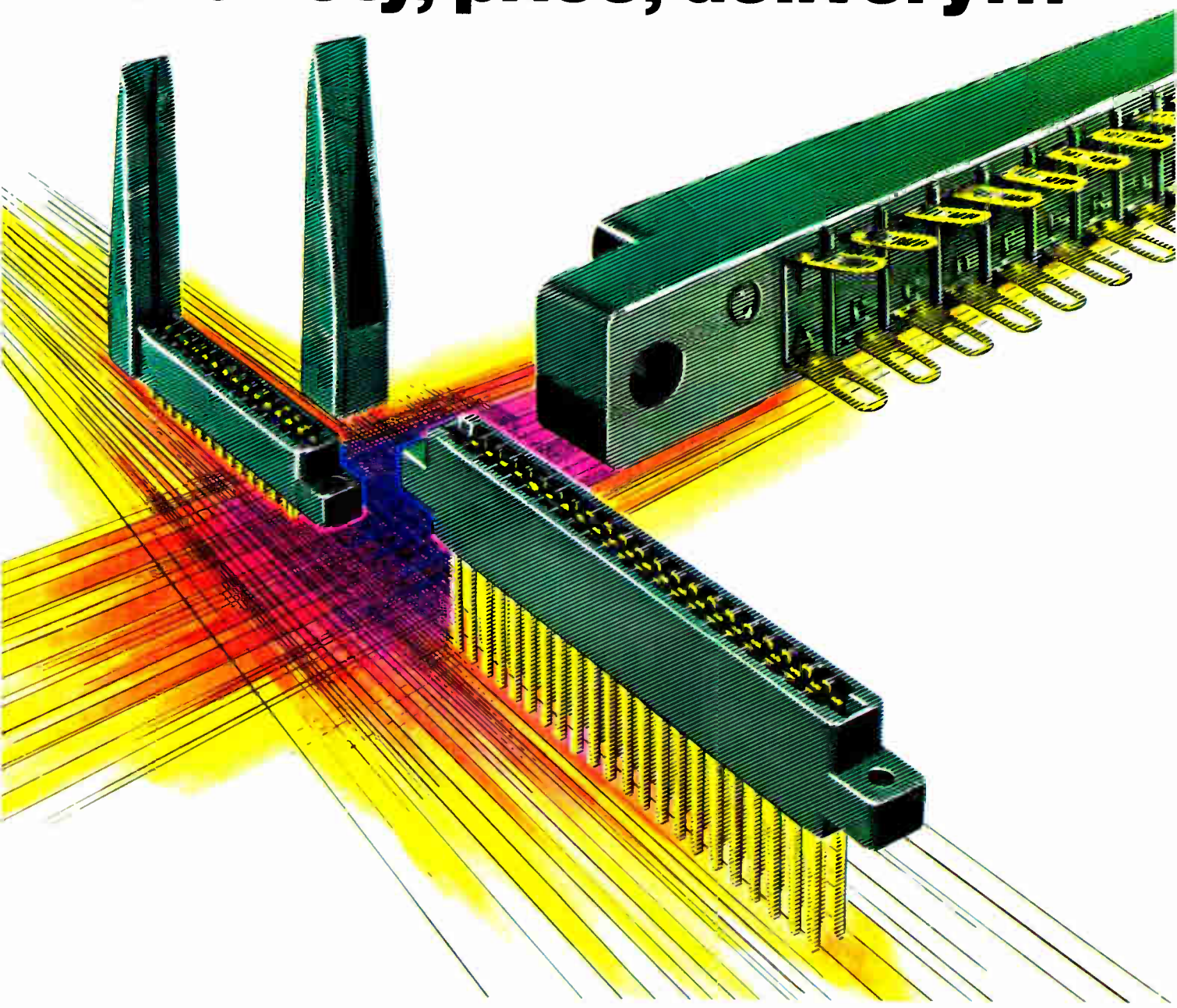

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For price and delivery information, call your nearest TRW Cinch Connectors distributor—your edge connector specialist. Or call your local TRW/ECD field sales office, listed with our distributors in EEM. Or contact TRW Cinch Connectors, An Electronic Components Division of TRW Inc., 1501 Morse Avenue, Elk Grove Village, Illinois 60007; phone: (312) 439-8800

CD-7701

TRW CINCH CONNECTORS

Circle 237 on reader service card

ANOTHER PRODUCT OF A COMPANY CALLED TRW

Secondary parts processing is one more way today's industrial electronic distributor customizes his service to the engineer's needs. Here, at Liberty Electronics, an operator installs contacts in coaxial connectors.

tities are being handled through distribution with economic benefits in production scheduling, warehousing costs, and inventory control accruing both to the component vendor and the OEM user.

One of the paramount advantages that the function derives from dealing with the distributor is in terms of information services. Most industrial distributors maintain active direct-mail programs. These keep the engineers on their mailing lists up to date on new products and technology, as well as on availability.

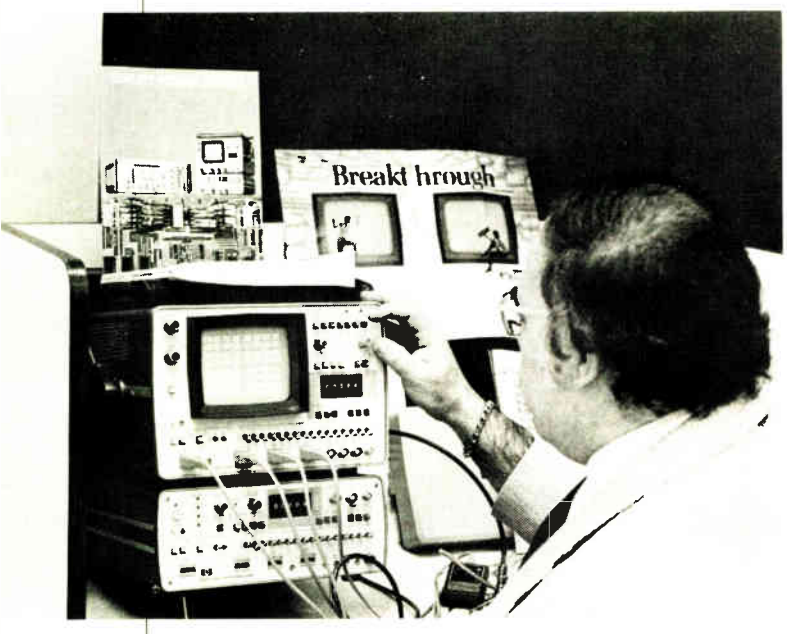
In addition, a good distributor maintains complete and extensive literature files. The engineer who wants to review a number of options can get information from one source, rather than having to call a number of sales representatives or manufacturers. Even if the distributor does not have the needed data on hand, he knows precisely whom to call to get the information. The engineer or purchasing agent who calls the factory is all too likely to find himself transferred from department to department before he finds someone who can send him the information he requires.

Many of these services are equally available from the sales representative, and the technically competent sales rep can probably give as fast or faster turnaround than can the distributor on the specific product he sells. The broad-line distributor, however, is much better able to provide an objective view of competitive lines, and to advise on tradeoffs, options, and alternatives. In addition, distributor telephone and purchasing personnel are always available, not out making calls.

Fortunately for both buyers and sellers, the electronic-component industry is moving at an accelerated pace towards the team-marketing concept. When the same sales representative organization calls on both OEM and distributor accounts, they work together rather than vying for the identical order. In such situations, the distributor can call on the rep for technical backup when the customer requires it. Everybody keeps in mind the separate functions each segment provides on the marketing team. The rep services the distributor and the major OEM accounts. The distributor adds "reach" to the smaller customers. The engineering department makes a serious and potentially expensive mistake in underestimating and underusing the product knowledge available through the distributor sales, purchasing, and product management personnel.

Another important benefit the distributor provides the engineering community is in sampling. While the distributor is not in the give-away business, he many times has arrangements with his vendors to replace material he furnishes as samples from his shelf stock. Particularly with low-ticket items, he is likely to provide what is needed, and provide it fast, without paperwork or charge.

All this shows that the distributor's ability to react and to shortcut many routines in serving all his customers and all their departments is an important plus. The distributor offers quick deliveries, quick reaction time, and quick follow-up. And yet, in today's electronic marketplace, many of these important features pale in importance compared with the key advantage of buying from the industrial electronic distributor. Obviously, when the OEM is buying from the distributor, he is buying standard parts, rather than proprietary components. The ability of the industrial electronic distributor to supply standard components in industrial quantities has gone hand in hand with



Distributor microprocessor design centers are equipped with highly sophisticated simulation, program analysis, editing and debugging equipment for design verification. This center is at Schweber Electronics.

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the engineering community's recognition of the short- and long-term benefits of specifying standard components.

In prototyping and in research and development, the standard component is frequently selected because it is immediately available. If the standard item stays in the production design, the customer develops a cost advantage and a reduction in lead time. He also gains a confidence or experience factor in utilizing a component that has been on the market for a period of time and has worked successfully for other people. Moreover, he holds on to down-the-line benefits when a component goes out of repair; a product will not be subject to lengthy down time, because the replacement component is easily available. The end-use customer for a product will appreciate the ease of service and repair that readily available parts provide.

In addition, the distributor's capability to provide modification services, as discussed previously, gives the best of two worlds. Frequently the specialist distributor, with his depth of knowledge about a given component category, can develop and assemble "specials" out of standard components, at a realistic price, even in relatively small quantities.

In the areas of passive components and the established semiconductor areas, the patterns for using standard components are well established. In microprocessor specification, we are still dealing with current events rather than history. The long-term prevalence of the standard versus the dedicated product is still emerging. At this juncture, it seems reasonable to assume that for larger-volume markets, product will be customized and will tend to go factory-direct. Lower-volume applications will clearly use standard chips, and the distributor will be involved.

The special sophistication and investment involved in microprocessor distribution indicates that many local distributors will continue to opt out of this market, as with the rest of the semiconductor market, and the lion's share of the distributor microprocessor business will be handled by the large chain operations, both national and regional.

The top 25 industrial electronic distributors, the major chains, are now estimated to handle over three quarters of the total semiconductor business, and to be doing more than half their volume in solid-state products. The investments involved in handling the new technology seems likely to demand that the big semiconductor houses will concentrate more than ever on this segment.

Distributors have already responded to the microprocessor market by involving themselves in systems selling. Beyond developing programming capabilities, microprocessor centers and showrooms, and even microcomputer hobby shops, the systems-oriented distributor now offers a wide range of peripherals, including a-d converters, printers, CRTs, floppy disks, and input/output units—again contravening the myth of "that product is too technical to go through distribution."

The local distributor will thus concentrate on passive components, will exploit his capabilities for close, direct, personal service, and will continue to be a choice source for capacitors, resistive components, connectors, relays, switches, test instruments, etc.

One thing that is certain is that whether the components being purchased are active or passive, they will be supplied by active distributors, actively involved in helping the user.

Selling products through distribution

Electronic distribution in 1977 is big business. Today, about 3,000 manufacturers of electronic components, equipment, and accessories are offering their products for sale through distribution. The National Electronic Distributors Association estimates that distributors now sell in the vicinity of $2 billion worth of active and passive components for OEM, MRO and R&D applications. Distributors, who just three years ago were selling only some 30% of all electronic components, are now estimated to be selling about 65%, and are expected to be selling 70% or more by 1980.

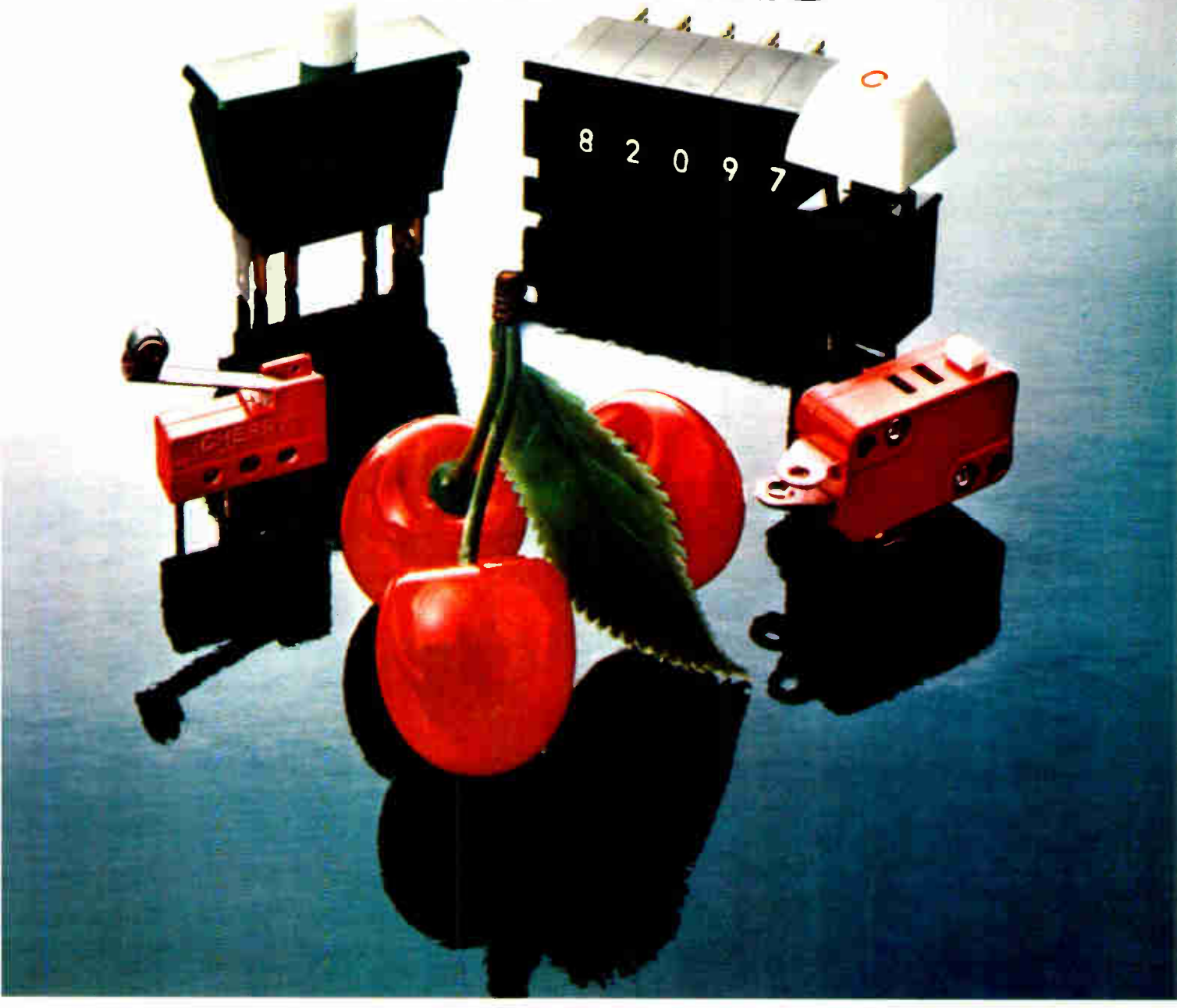
Yet some knowledgeable observers claim there may be as many as 6,000 manufacturers—possibly more—whose products could be offered through the distribution route but whose marketing has not yet gone in that direction!

Clearly, not all electronic products are appropriate for sale through distributors. Some products will always be too technical, too complex, or too specialized and limited in the number of customers who utilize them. But distributors have repeatedly confounded the world by getting involved—and being successful—with products originally deemed "too technical." The microprocessor is merely the latest example.

But even among skeptics, one thing is generally acknowledged. The distributor is not an extraneous middleman, but a functional link providing significant added-value functions in the process of bringing products from the manufacturer to the user.

First and foremost of these is physical coverage of the market. No manufacturer, whether he is selling components or end-use equipment, can field a large enough sales force to contact the conservatively estimated 40,000 buying

ANOTHER VINTAGE YEAR FOR CHERRYs



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Circle 241 on reader service card

locations where there are users or potential users of electronic components. Virtually every industrial electronic distributor, even the smallest, has at least three salesmen, and the larger distributors have many times this number. A large component manufacturer may field a sales force of factory salesmen and/or independent reps of about 100 to 150 people, including clerical back-up. Such a sales force typically may sell directly to less than 1,000 accounts. However, adding in a network of 200 distributors expands the sales force to 3,000 sales people and the reach to over 50,000 accounts, most of which were far too small to be economically viable factory-direct customers! And, of course, the factory incurs no sales expense when the distributors' salesmen push its product in the marketplace.

Distributors also warehouse the product, with a distributor network providing national coverage, and thus obvious additional cost benefits to the manufacturer. In addition to the savings on warehousing costs, there is also a savings on the burden of carrying inventory and improved cash flow.

The component manufacturer is money ahead because the distributor extends credit to his customers. Since the distributor is local and has the benefit of local information and personal knowledge of his accounts, he will be more willing to extend credit to, and thus serve, customers that the factory would have to turn down.

A manufacturer who sells his product through distribution also eliminates costly manufacturing runs on small orders. He always produces his standard product at profitable quantity levels.

What does it cost you to handle an order? Whether the order covers 50 pieces or 5,000 pieces, you still have to (1) receive the order, (2) open the envelope, and (3) route it to the appropriate department. There it must be (4) entered, and (5) a shipping ticket made out. The order must (6) be sent to the shipping room which (7) must pull the merchandise, (8) wrap it, (9) make out the shipping label. Somebody has to (10) make out an invoice, (11) mail it to the customer, and (12) send an invoice to the bookkeeping department for entry on the books. (13) Statements must be mailed to the customer, (14) payments must be received and entered. What's the cost to you for each of these transactions? Then ask yourself at what quantity level it becomes profitable for you to sell. You don't want to not supply a good customer or, by turning down the prototype order, risk losing the production run. This is just one demonstration of the financial or economic benefits which a distributor program offers.

Nor are small-quantity orders unusual. Small quantities of components are needed for engineering designs, for prototype runs, as replacements, as well as for small production orders. And in most instances, the customer wants the product right now, without waiting 12 or 14 weeks for delivery from the factory.

More and more engineers are thus learning to design around standard products. Thus, very frequently, if the item that first came to mind isn't available for immediate delivery, the customer specifies an off-the-shelf alternate. That's the product that goes on the print and which is ordered in quantity when the production order comes up.

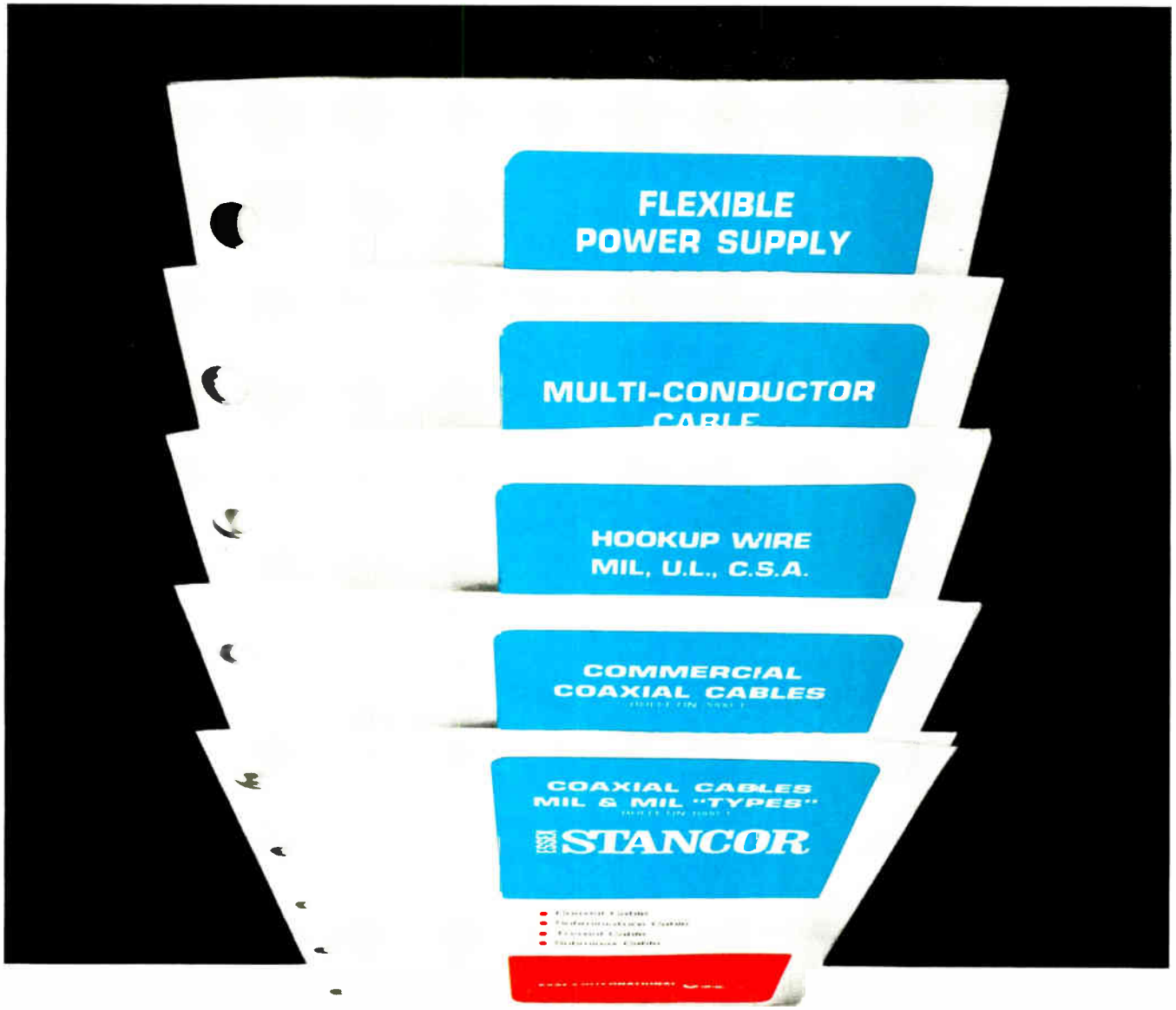
While your product may have been the point of departure, you end up at best the second source. Thus, it is clear that the distributor already plays a significant role in the marketing process—a role that will expand. The distributor has been depicted in the past as being unwilling or unable to create demand. This will become less true as both products and distributors become more sophisticated. Nobody can question the distributor's impact on creating brand preference . . . if only because brand preference is so frequently related to what is available for delivery today.

Many of the value-added services that the distributor provides for this vendor can be measured in terms of direct economic benefit. But there are intangibles, too. Your distributor sales force is out in parts of the world where you might never get, gathering local information, interpreting it, and passing it on. Not only that, your distributor salesman also establishes a personal relationship with the key buyers in his territory. He knows what's what; he knows who's who. He's a valuable addition to your team.

Warehousing, expediting, extension of credit, and similar services have long been identified as the value-added functions that distribution offers. William Englehaupt, executive vice president of the National Electronic Distributors Association, likes to guard the phrase jealously to denote only those classic distribution functions. However, many of his constituents have extended the term to refer to their ever-growing activities in modification services, assembly services, testing services, programming, and the like.

Many of these distributor activities in secondary parts processing started out as an economic device whereby the distributor could hold down his inven-

Computerized information systems, such as this one at Sterling Electronics, link the sales desk with regional warehouses, so the salesman knows instantly what is in stock, how much it costs, where it is and when more will arrive, so he can get components en route on the same day the order is placed.



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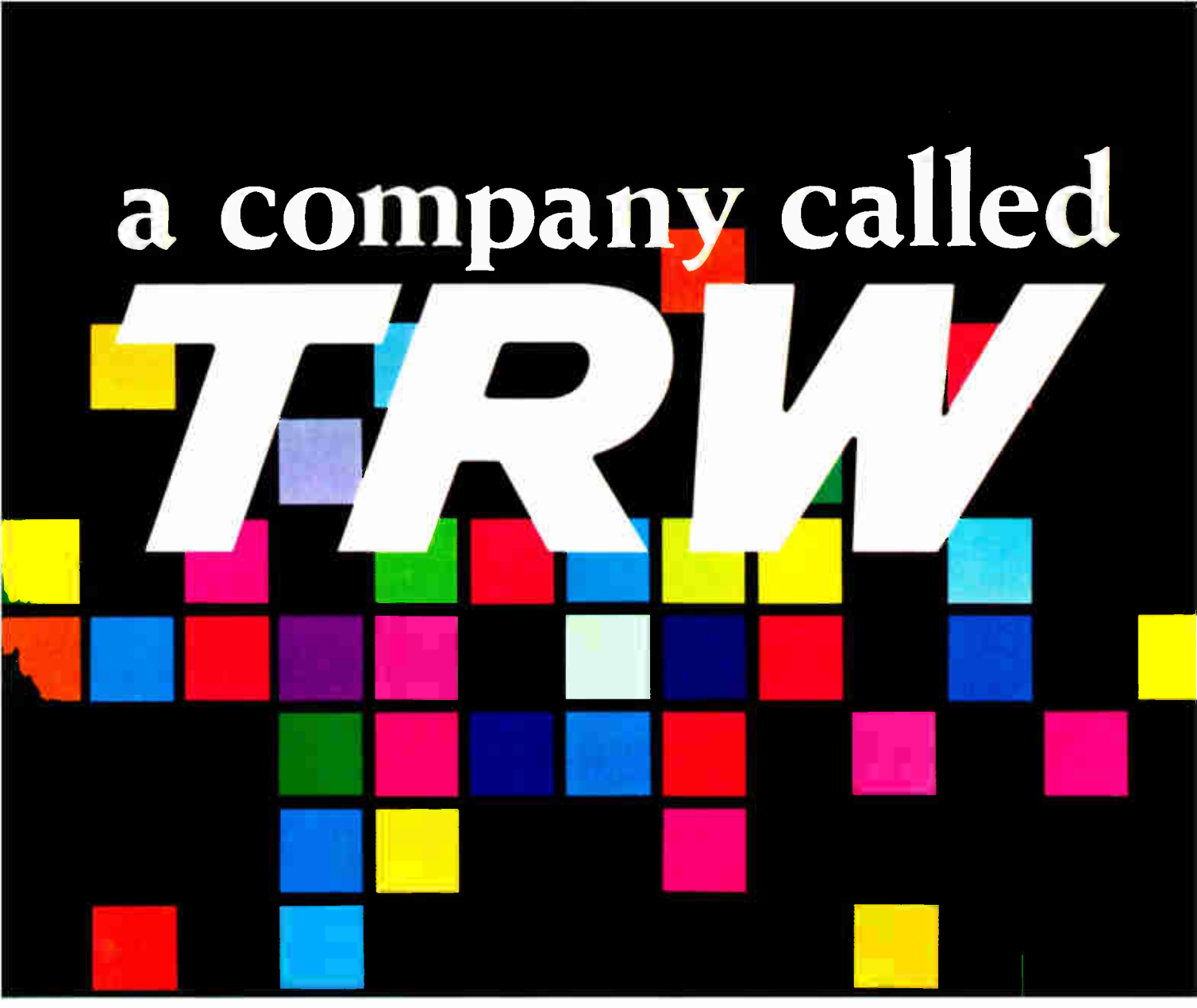


believes the electronic distributor is the most effective and efficient way to supply the marketplace

That's why all of the TRW Electronic Components Divisions who manufacture standard products make them available through a nationwide network of electronic distributors.

Whatever quantities of products you need from these organizations, you can get them fast, from stock, from a TRW distributor.

For a complete list of these distributors and a product catalog, use the reader service number below.

TRW CAPACITORS
TRW CINCH CONNECTORS
TRW GLOBE MOTORS
TRW IRC RESISTORS
TRW SEMICONDUCTORS
TRW UTC TRANSFORMERS

T-701

TRW ELECTRONIC COMPONENTS DIVISIONS
10880 Wilshire Boulevard. Los Angeles. CA 90024

For additional information, circle reader service card number: 230 for capacitors, 231 for connectors, 232 for motors, 233 for resistors, 234 for semiconductors. 235 for transformers

tory. Rather than stocking a wide range of part numbers and variations, he stocked basic components and provided assembly service as needed, to fill customer orders. Today there's not an industrial distributor without a bench and a mini-production line for connector assembly, programming operations, customer labeling and product identification, testing, and the like.

As the industrial electronic distributor equipped himself for the assembly of standard components, he discovered a serendipitous by-product. He had the capability to *modify* components to the customer's specific needs. Technically knowledgeable distributors, working closely with customers' engineers, now routinely develop specials out of standard components, to create products that are basically not available anywhere as standards. Furthermore, the distributor provides these services at a realistic price, whereas the factory in most instances would not touch them at any price.

These services call attention to the technical capability of today's industrial electronic distributor. He is part of the factory's marketing conduit with a particular mission to cover the second-, third-, and fourth-tier accounts that the factory sales force does not reach. Thus the distributor must equip himself to provide or secure the same kind of technical support for his factory as would the rep or the factory man.

In reviewing the many things the distributor can do for the manufacturer in selling the product, it must be remembered the distributor's major job is to service the market, not to develop the market. The manufacturer still has to create the demand and still has to select distribution involved in serving the marketplace where the product is supposed to go.

Companies not now selling through distribution, who read into the maturation of the new technology that they can enhance their market share or sell more economically by participating in the distributor marketplace, will have to reflect this in total programming, not just in pricing strategy. Although distributors *can* co-exist with a manufacturer who competes with them by filling orders directly in "distributor quantities," they can't co-exist with a manufacturer who undersells them. Thus pricing must be geared to compensate the distributor for maintaining inventory, extending credit, processing orders, servicing customers, expediting, absorbing shipping costs, and the like.

Marketing through distribution is not a panacea which will solve everybody's problems of availability and market shares. Nor can anyone set forth a quick and easy formula for establishing a distribution program. But the proliferation of electronics technology into nontraditional markets and the increasing sophistication of industrial electronic distributors in selling high-technology components and systems provide clear indicators that no one should glibly underestimate or dismiss the possibility of today's industrial electronic distributor as part of the marketing team.

Today's representative: a vital link to supplier-distributor

To bolster his service image, the manufacturer's representative is stressing help for the buyer in his relationship with both the manufacturer and the distributor. Today's representative provides the purchaser with a "systems" approach to buying, technological updating, price and availability information, and one-stop shopping.

Under "systems selling," the representative brings product knowledge into play. A representative usually carries a number of compatible product lines, for example, relays, switches, panel meters, lamps, indicators, connectors, and capacitors. Instead of a time-consuming call from a factory man, who is concerned with selling just one product for which a buyer may or may not have an immediate need, the representative can offer knowledge on a number of products—"systems selling."

The value of multiple-line selling goes further. Often a representative is called on to hold in-plant seminars or presentations to make engineers and designers aware of the latest developments in new uses for a particular product or group of products.

A representative can in addition inform a buyer of various economies that exist. Savings on blanket orders, special delivery, or credit terms can many times be negotiated by the independent representative.

The representative also knows which distributor is stocking a given component that might be needed for an emergency production requirement. He is in a better position to offer assistance in finding a component or part that is needed to fit some special or unusual engineering parameter.

Economies can also be provided in expediting or following through on an urgently needed shipment. The representative helps with rejects or early shipping, should they occur.

Because a representative is familiar with many products and product lines, a phone call from him can often uncover that elusive "widget" an engineering department has just specified into its latest design. Here again, multiple-line selling demonstrably benefits both purchasing and engineering alike.

Moreover, if the representative does not himself carry the particular brand or component you need, he will probably know someone who does. His competi-

tive-literature library comes in handy when a buyer needs to cross-reference part numbers for a bid as well.

In working with distributors for the components and materials, the representative again can be used to save time and money. His experience in dealing with numerous distributors for a variety of products provides him with a handle on local inventories and also on back-order situations.

The representative's rapport with local distributors can assure the buyer of quick no-cost samples, replacing the distributor's inventory when as the factory ships.

He can help with credit questions, perhaps recommending even a large OEM-quantity order be placed through a distributor with sufficient inventory to keep production rolling, while his manufacturer clears credit and goes into the production of your order.

The role of the representative with the distributor is really twofold. He not only helps the distributor move products, but he also makes the distributor aware of local usage for a variety of products. His suggestions keep inventories in line with actual as well as potential demands. This dual role keeps the correct products moving in a steady flow from the manufacturer through the distributor, directly to the buyer's production or MRO requirement.

Representatives help train the distributor salesmen, keeping them abreast of the latest technological advancements in components and materials. Representatives work with the distributors in cataloging and advertising. It is this counsel with the distributor that assures the buyer of literature that is both meaningful and helpful.

Manufacturers' representatives are more than salesmen. They can be used as experienced business consultants for products, providing buyers with technical assistance, product availability, cost information, and credit terms.

The representative is the important link between buyers and the product they need, whether from an industrial distributor or directly from a manufacturer. Acting like a quarterback, the representative is an integral part of the complex marketing system that brings the buyer the products he needs when he needs them.

In short, the representative furnishes a most important ingredient—service.

New horizons for electronic distribution

Advances in the state of the art stimulate change. In the area of technology such change may be and has been radical, even revolutionary. In distribution, however, changes tend to be evolutionary.

Clearly the enormous new range of markets and applications for electronics occasioned by the advent of microprocessor and LSI technology will broaden the base of applications and the base of customers for distribution. It seems certain that, in the not so long run, it will tend to more clearly define distributor types.

Thus we can anticipate being more readily able to classify distributors either as specialists in one or more types of active or passive components or as broad-line distributors, which will more and more come to indicate a wide range of passive components, either with a limited-line profile or with a multiple-brand profile.

In particular, as a result of the impact of the microprocessor, we shall see more distributors involved in systems selling and in enlarging the scope of their operations from the strictly industrial into microcomputer hobby-shop operations.

As indicated previously, the proliferation of electronic gear into usage situations in industry will augment the importance of the backup parts, accessories, and test equipment made available through the MRO distributor. As individual plants become larger and larger customers for electronic products for consumption, we shall see more widespread establishment of the in-plant parts depot as the rack jobbing phenomenon in industrial electronics.

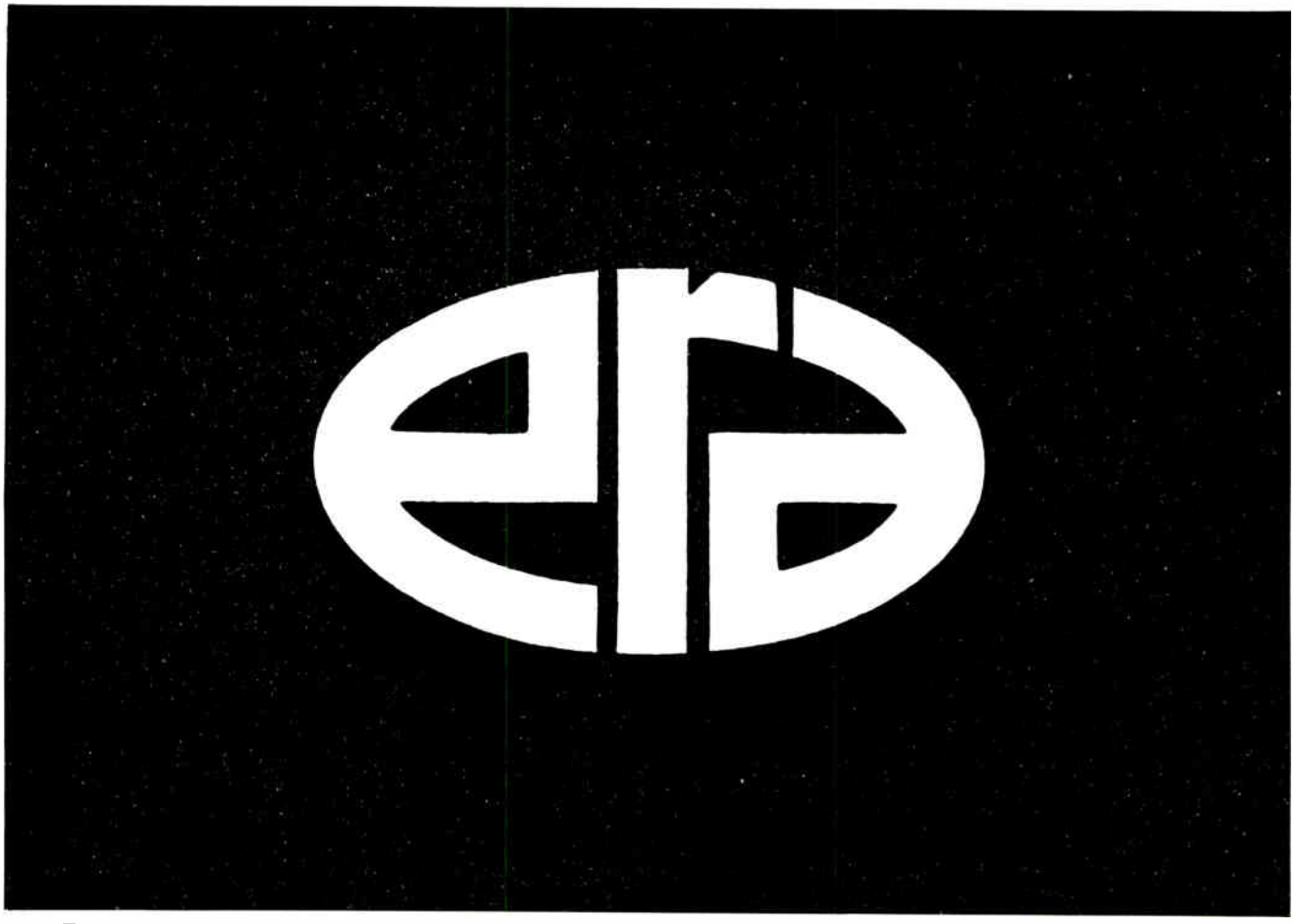
Assembly services will continue to flourish, along with board stuffing, special component development, etc.

As product and application become more sophisticated, the component manufacturer will require more technical support and expertise from his distributor, and it is likely there will be continued emphasis on the limited distribution network, through which the factory can maximize the effectiveness of its communications and sales training. As more and more buyers want the same products, and fewer and fewer distributors are franchised by the factory to sell them, and as more rigorous controls are exerted against the kind of counterfeiting and unauthorized transshipping which has been so much in the recent news, the super-distributor will emerge as an acknowledged entity in the industry.

Even in the traditional product areas, such as passive components that do not require field assembly, the distributor can be expected to play a larger role as a source of supply to the OEM. Where component manufacturers used to develop pricing structures so the distribution would be competitive in quantities up to 99, later to 999, and even 9,999, there will be a continuing trend to increase the protected quantity. OEM suppliers and OEM customers will work with the distributor on scheduled orders, even for 100,000 pieces and more.

Distributors will also be broadening their product lines, including developing involvements in instrumentation, minicomputers, peripherals, etc., which until now have tended to be the province of the direct salesman. This will represent not only the impact of cost reductions, moving such equipment from the capital expenditure category into the realm of operational budgets, but will also be a factor of the distributor's greater technical expertise in understanding and advising on the equipment that the customer is looking for.

Look For The ERA Mark



The ERA Logo Has Become More Than Identification For An Association. It's The Symbol Of An Industry.

In an industry of superlatives. In an industry of change. Manufacturers' representatives have provided the stability necessary for true growth.

With each new surge of technology. With each new product innovation, the manufacturer's representative has translated the needs of his customers to the capabilities and the disciplines of his manufacturer.

MANUFACTURERS' REPRESENTATIVES HAVE COME OF AGE IN THE ELECTRONICS INDUSTRY.
Today the manufacturer's representative is an entity, a company with long range goals and objectives. He works his territory to develop every potential prospect into a profitable customer for his principals. He's not in it for the "fast buck" or a promotion to the home office. His objective is to develop his territory into the best marketplace possible.

MARKET YOUR PRODUCTS THROUGH MANUFACTURERS' REPRESENTATIVES.
They are cost/effective. You not only can expect greater market coverage, but also better customer penetration. And that's a tough combination to beat!

THE MARK OF A PROFESSIONAL
Look for the ERA logo when talking with representatives. It indicates the mark of a professional. He belongs to ERA to learn, and for the opportunity to interface with other representatives like himself. It shows he cares.

It also shows that he is part of a marketing force responsible for selling over seven billion dollars worth of electronic products.

For a complete package of material about why you should be using manufacturers' representatives write or call their association.

More than an association – a philosophy

Electronic Representatives Association
233 E. Erie, Suite 1003
Chicago, Illinois 60611 312/649-1333

Views of future

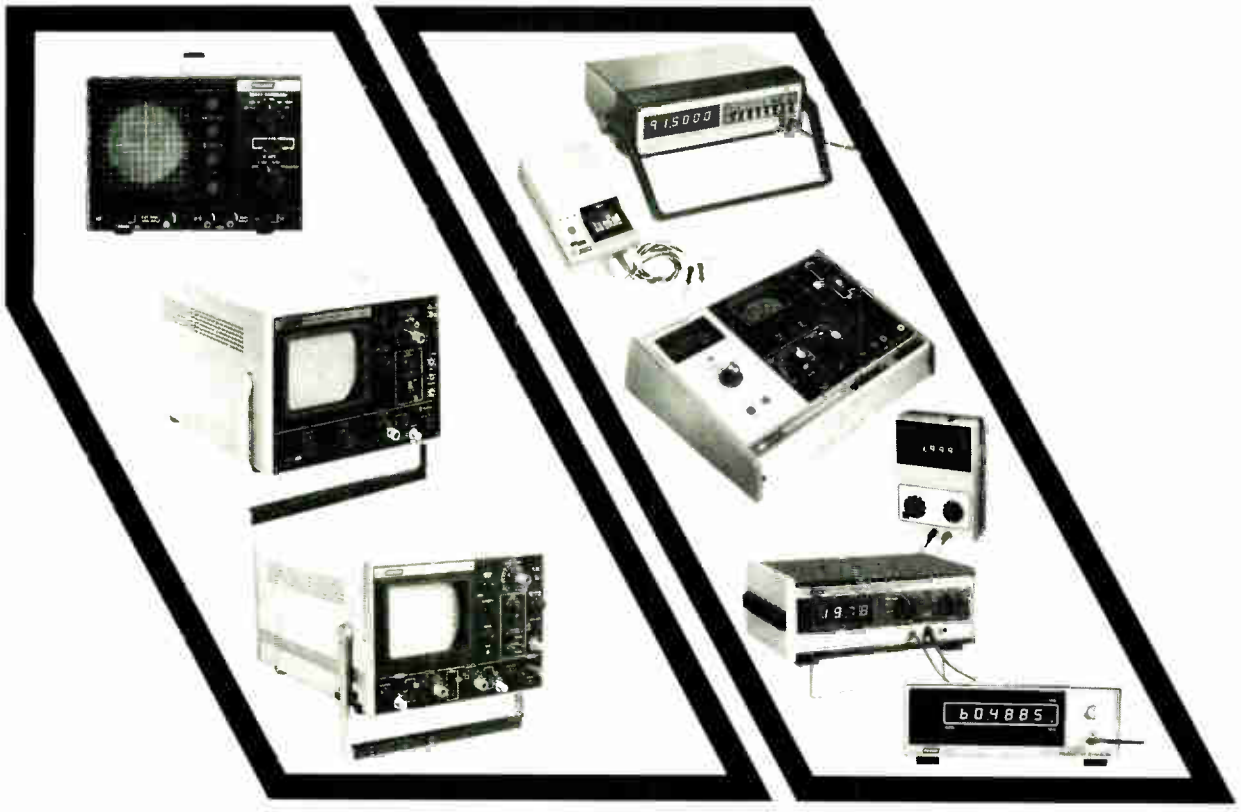
Leonard Cravath
Classic Component Supply
Northbrook, Ill.
The evolving change in electronic distribution is the growing recognition that you can't be all things to all people. More and more, distributors will be positioning themselves in terms of a market niche, where they can buttress their *product* availability with *information* availability and *people* availability. Yesterday's caretaker distributor will give way to the distributor who takes care—who provides his customers with quick responses, who will work as hard over their "garbage" needs as on their big orders, and who has the technical savvy to know and understand the components he distributes and the applications his customers have for them.

Harvey Sampson
Harvey Electronics
Woodbury, N.Y.
The proliferation of technology will force us to change our marketing styles and strategies. In fact, microprocessor business today is definitely going in this direction. With component sales such as we have now, we go to the engineering people. In other markets, we have to sell to top management, especially in non-traditional markets for electronics such as hydraulics, and for this type of selling, you have to have both technical people and applications engineers. More business in the future will be systems business. The component business will still be there, but I think you will find more companies with dual marketing organizations. One will cover commodity sales, the day-to-day components. The other will be a high-technology group making the systems sales, in addition to selling those things related to the system. It's much like the broadcast business of years ago. We would start by selling a tube, then we would sell recorders, consoles, and equalizers, until we ended up selling an entire broadcast system.

Albert Kass
Kass Electronic Distributors
Drexel Hill, Pa.
The basic distributor services are not going to change as much as will the people to whom and for whom the services are provided. Since the industrial use of electronics is no longer the province of relatively few plants, a greater premium exists in the distributor's ability to know his market area . . . to know where the rocks are and to happily dig under them. This ability is not only a boon to the component manufacturer, but to the OEM, MRO and R&D buyer, in anticipating and satisfying his proliferation of source and data requirements. And this will manifest itself also in the distributor is expansion of the breadth and depth of his inventories to cover new product spectrums and new customer horizons.

Don Yates
Genesis Electronics
South Bend, Ind.
There will be a continued proliferation of customers and product, and by the very nature of these numbers, the distributor is going to be increasingly important to all manufacturers. This is going to affect distributors mostly in that the service levels they provide will have to exceed those of the manufacturers. Distributors will have to use the tools of more sophisticated selling techniques, including such things as data processing and increased value-added, testing, and assembly services. In terms of the technical customer, more services will be needed by him also, but I don't know if the distributor will be that involved in the design area. He will most likely service it, but I don't think he will make the market.

James Silverman
Electronic Expeditors
Milwaukee, Wis.
Today's—and tomorrow's—industrial electronic distributor is born out of the marriage between economics and technology. He exists and survives because



B&K PRECISION DYNASCAN CORPORATION

A name you should know... for high performance instruments at practical prices.

Because B&K-PRECISION instruments are sold exclusively by electronic distributors who stock them for fast off-the-shelf delivery. Are generally priced well below similar devices because of increased efficiencies of sales through distributors—not by sacrificing quality or performance. Are value-engineered to combine maximum use, accuracy and value. Within their defined functions, they perform better than any instrument you can buy —regardless of price.

To Get To Know Us Better

Write for our latest catalog or call your B&K-PRECISION distributor or sales representative for a copy.

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International Sales: Empire Exporters, Inc., 270 Newtown Road, Plainview, LI, NY 11803

In Canada: Atlas Electronics, Ontario

he can do things for both buyer and seller more effectively and economically than can the factory. If extraneous factors—like the cost of public liability insurance, to take one example—prevent his continued economic viability, it can be a whole new ballgame. But if normal development is permitted to proceed, we can look for greater technical sophistication and product expertise on the part of the component distributor—the growth of the super-distributor as an institution in electronics marketing—thus reconciling the components manufacturer's desire for a strong franchise program with the buyer's need for ready availability of products from his regular source.

Gordon Graham
Graham Electronics
Indianapolis, Ind.
There's a strong trend toward regional distribution. The customer is demanding more service on a real-time basis, and he is not willing to depend upon the pure economies of the larger national distributor. The customer wants more personal service in the way of systems selling, the distributor knowing the customer's individual needs and professionalism. You can call this a value-added service in that the distibutor's role here would be to take care of the order and ensure an on-time delivery, instead of taking the order with a promise of delivery.

Paul Carroll
Semiconductor Specialists
Chicago, Ill.
Technology is changing at a rapid pace now, and it will continue to change at an ever increasing pace in the future. The life cycle of a product used to be 5 to 10 years. Now it is six months or less, and while this will open new markets for the distributor, it will also require the distributor to sell complete systems, including software and training. To meet the needs of the new markets, the distributor is going to have to increase his productivity and will be using in his own business some of the same systems. Microcomputers will be found in branch offices tied into main computers for a total distributed processing system to control inventories. Eventually, these systems may even be tied directly to the factory.

Kulka

TAKE YOUR PICK

Our distributors are so well stocked that they can give you your pick of hundreds of different Kulka terminal boards, blocks and strips. And if your specs call for the unusual, one of our Mod Centers can probably take care of that, too. Call one today.

Kulka

AUTHORIZED KULKA INDUSTRIAL DISTRIBUTORS LOCATED THROUGHOUT THE UNITED STATES & CANADA

AL	Birmingham, MG Electronics	205 328 4525
AZ	Phoenix, Mountain West Alarm	602 263 8831
AZ	Phoenix, Parts Electronics	602 258 6476
* CA	Los Angeles, Fisher/Brownell	213 532 2170
CA	Los Angeles, Radio Product Sales	213 748 1271
CA	Santa Clara, Fisher/Brownell	408 244 6182
CA	Sunnyvale, Ratel Electronics	408 739 9220
CO	Denver, Denver Wintronics	303 935 2401
CO	Denver, Integrated Electronics	303 534 6121
CO	Denver, Industrial Electronics	303 771 2636
CT	Fairfield, U-Tronics	203 255 4521
CT	Waterbury, Bond Radio	203 757 0546
FL	Ft. Lauderdale, Peerless Radio	305 566 5966
† FL	Miami, Electronic Equipment	305 871 3500
FL	Winter Park, Electronic Equipment	305 644 4833
IA	Cedar Rapids, Deeco	319 365 7551
IA	Des Moines, Mid State Distributing	515 244 7231
IL	Addison, Lectro Components	312 543 1680
IL	Broadview, L-Comp	312 865 7600
IL	Chicago, Merrill Electronics	312 647 0755
IL	Rockford, Mid-West Associated	815 962 8036
* IL	Rosemont, Advent Electronics	312 298 4210
IL	Schaumburg, Control Design	312 882 7232
IN	Indianapolis, Graham Electronics	317 634 8202
IN	Indianapolis, Ra-Dis-Co.	317 637 5571
IN	South Bend, Radio Distributing	219 287 2911
KS	Wichita, Radio Supply	316 267 5213
KY	Louisville, Peerless Electronics	502 637 7677
LA	New Orleans, Radio Parts	504 581 5959
MA	Needham, Gerber Electronics	617 329 2400
* MA	Newton, Greene-Shaw	617 969 8900
MD	Baltimore, Radio Electric Service	301 823 0070
MI	Augusta, Great Lakes Electronics	616 731 4156
MI	Farmington Hill, CMP Distributors	313 477 7700
MI	Grand Rapids, Stotts Friedman	616 459 0216
MN	St. Paul, R. G. Ragon Electronics	612 488 0201
MO	St. Louis, L-Comp	314 647 5505
MS	Newton, May Electronics	601 683 6511
NB	Lincoln, Scott Electronics Supply	402 464 8308
NC	Raleigh, Southeastern Radio Supply	919 828 2311
NC	Winston Salem, Kirkman Electronics	919 722 9131
* NJ	E. Rutherford, Kappe Electrical	201 939 5751
NM	Albuquerque, Walker Radio	505 247 2288
NV	Reno, Electronics Distributing	702 323 2766
NY	Buffalo, Summit Distributors	716 884 3450
NY	Elmsford, Ancar Electronics	914 592 7100
NY	Hempstead, Electronic Equipment	516 538 5510
NY	Lynbrook, Peerless Radio Corp.	516 593 2121
* NY	Mt. Vernon, QAR Industrial Electr.	914 699 2224
* NY	Rochester, Simcona Electronics	716 328 3230
NY	Rochester, Summit Distributors	716 334 8110
* NY	Rockville Center, Midway Industrial	516 764 2400
OH	Cincinnati, Hughes Peters	513 351 2000
OH	Cincinnati, Newark Herrlinger	513 874 5115
OH	Cleveland, Pattison Supply	216 441 3000
OH	Cleveland, R. P. C.	216 461 2280
OH	Columbus, Electronics Marketing	614 299 4161
OH	Columbus, Hughes Peters	614 294 5351
OH	Dayton, John A. Becker	513 226 1341
OK	Oklahoma City, Electro Enterprises	405 478 1752
OR	Portland, Eoff Electric	503 222 9411
PA	Altoona, Allegheny Electronics	814 946 0871
PA	Erie, Advacom	814 455 8110
PA	Erie, Mace Electronics	814 838 3517
PA	Montgomeryville, Pyttronic Indust.	215 242 6700
† PA	Philadelphia, Almo Electronics	215 698 4000
PA	Philadelphia, Simco Electronics	215 229 1880
PA	Pittsburgh, R. P. C.	412 782 3770
PA	Reading, George D. Barbey	215 376 7451
SC	Columbia, Dixie Radio Supply	803 779 5332
TN	Knoxville, Industrial Electronics	615 573 7135
TX	Dallas, KA Electronics Sales	214 634 7870
TX	Dallas, Solid State Electronics	214 352 2601
TX	Fort Worth, Industry Electronics	817 531 2961
TX	Stafford, Southwest Electronics	713 494 6021
UT	Salt Lake City, Ra-Elco	801 487 0571
VA	Charlottesville, Virginia Radio	804 296 4184
† WA	Seattle, Almac/Stroum Electronics	206 763 2300
WA	Seattle, Radar Electric	206 282 2511
† WI	Milwaukee, Electronic Expeditors	414 228 8100
WI	Milwaukee, B. W. Electronics	414 545 8380
WV	Beckley, Halley Electronics	304 253 2151
	CANADA	
† OT	Downsview, Zentronics	416 635 2822
PQ	Montreal, Cesco Electronics	416 661 0220

* Authorized Kulka Modification Centers.
† Authorized Mini Modification Centers.

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Circle 252 on reader service card

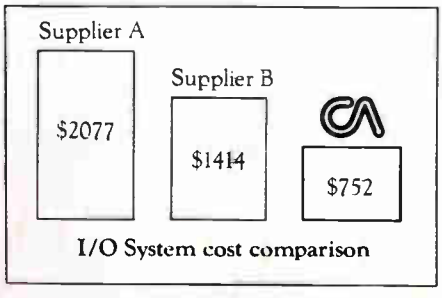
We figured a way to cut the cost of interface in half.

So what?

So OEM's are dancing in the streets, that's so what. At least the pros are.

And what makes it such a big deal is the magnitude of the cost savings – possibly 20% or more per computer system.

One reason is that interfaces are generally long on duplication and short on common sense. Most interfaces, for example, faithfully repeat half or more of the circuitry on all the other interfaces. And with multiple interfaces, that gets to be a pretty expensive proposition.



I/O System cost comparison

So we came up with the solution you see here: The Distributed I/O System. Designed to work specifically with our line of NAKED MINI® computers.

And once you get by its unorthodox appearance, the logic of it becomes pretty appealing. As do the cost savings.

All the basic circuitry is located on a single half-card I/O Distributor, which can be shared by as many as eight "Intelligent Cables." Packaged into every cable is an integral PicoProcessor, which handles the functional control for each interface.

The Distributed I/O System

This arrangement allows much smaller computer packages, since only one I/O board is housed inside the computer cabinet.

And along with a smaller package, comes a smaller price.

The I/O cost comparison at left shows the savings on a typical four-interface system (2 CRT's, 1 line printer and 1 card reader). And since our System handles up to eight interfaces, imagine your savings using its full capability.

Consider ComputerAutomation's Distributed I/O System. It's an uncommonly sensible solution to a commonplace problem. From the price/performance people who brought you the NAKED MINI.®

ComputerAutomation
NAKED MINI® Division
18651 Von Karman, Irvine,
California 92713, (714) 833-8830

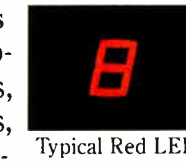
Circle 69 on reader service card

LEDs, make

For most displays, they're up to 8 ways better.

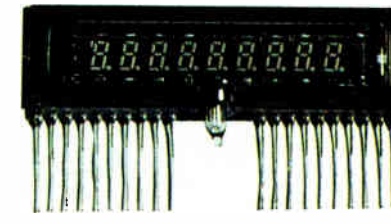
You've seen their bright, large, eye-pleasing characters in inexpensive calculators. They're called, technically, "Vacuum Fluorescent Indicator Panels" or, for short, **FIPs**. Actually, **FIPs** are modern developments of very old technology, that of the vacuum tube. In fact, they're triodes, complete with plate (anode), cathode, and grid, but with the addition of a phosphor on the segmented plate so the characters will glow. Brightly.

THE CHART TELLS THE STORY. Even though NEC is among the world's largest producers of both LEDs and gas discharge (plasma) displays, we see **FIPs** rapidly taking over for most applications—such as calculators, data & POS terminals, clocks, radios, car dashboards, microwave oven controls, instruments, CB, TV, etc. For obvious reasons, that are summarized in the chart at far right.



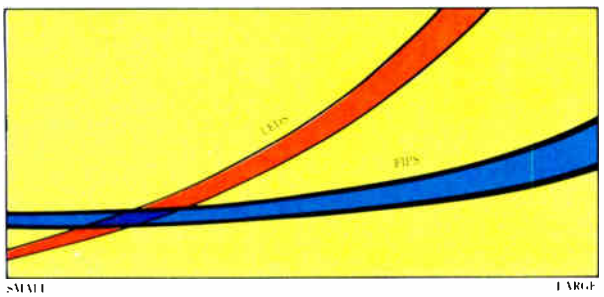
Typical Red LED

AND THERE ARE OTHER GOOD REASONS, SUCH AS RELIABILITY & LONG LIFE. The tremendous variety of uses that **FIPs** can be put to calls for very high acceptance standards. NEC has developed what may be the most rigorous QA and QC in the world. In a recent, routine test cycle, a total of 1085 **FIPs** of various models were put through a total of 15 grueling tests...with a single failure. The tests, and their standards, are described in the new **FIP** Selector Guide, available by mailing the coupon in this ad.

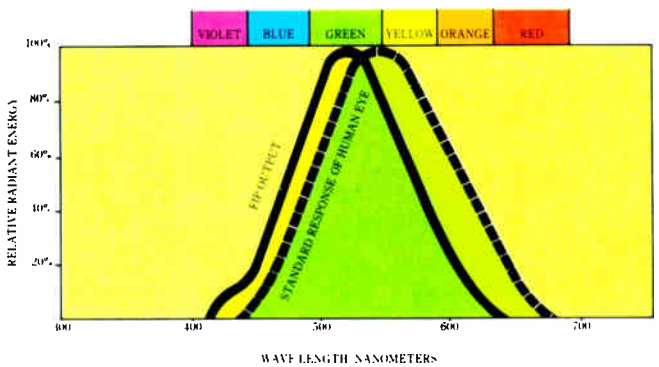


way for FIPs*.

ONE GLANCE TELLS THE COST/PERFORMANCE STORY. The larger the character size, the better the direct savings. That doesn't take into account the additional indirect savings from such things as simpler circuitry, fewer failures, and easier assembly. Check this graph, to get the idea.



THE STORY ON BRIGHTNESS AND LIGHT BANDWIDTH. FIPs' phosphors are selected to be extremely efficient converters of electrical energy to light energy, minimizing power input. In addition, the light is spectrum-wide, from red to violet, and can thus be filtered to provide any single hue desired. The light predominates in the blue-green area, which overlaps the standard curve of human eye response (see graph), so the viewer perceives the maximum of brightness for the minimum of power input. And—the gentle, soothing blue-green glow is considered to be much less fatiguing to the eye than red and orange colors.



LED/GAS DISCHARGE/FIP COMPARISON CHART

	LED	GAS DISCHARGE	FIP
VOLTAGE	~1.7-5V	~150-200V	~10-40V
POWER/CHARACTER	high	low	low
CURRENT	high	low	low
MOS IC DIRECT DRIVE	no	no	yes
THIN & FLAT	yes	yes	yes
VIEWING ANGLE	wide	wide	wide
BRIGHTNESS	moderate	moderate	high
MOUNTING EASE	good	good	good
COST/PERFORMANCE	fair	good	excellent
READABILITY	fair	fair	outstanding
COLOR CHOICE	limited, fixed	red, limited	many—filterable

33 TYPES AVAILABLE IN HIGH VOLUME—HOW TO SELECT YOURS? Easy. Send for our just-off-the-press FIP SELECTOR GUIDE. It tells everything you need to know to select exactly the **FIP** for your application. Then, mail the postpaid return card bound into the guide, and we'll send you the data sheets you require, with the comprehensive specifications. Make sense? Then we hope to hear from you soon. Mail coupon, or telephone us at (408) 738-2180, Telex 34-7475.

NEC

NEC America, Inc.

NEC America, Inc., Electron Devices Div.
3070 Lawrence Expressway
Santa Clara, CA 95051
Send me that 8-page FIP Selector guide.
My application is (or will be) _____.
☐ Call me for immediate requirement at
(_____) _____-_____, extension _____.

NAME

TITLE MAIL STOP

COMPANY

STREET

CITY STATE ZIP

*Registration Pending

Circle 71 on reader service card

IF YOU THINK FIBER OPTICS IS A THING OF THE FUTURE, IT'S TIME YOU SAW THE LIGHT.

Some people think fiber optics is still a few years away.

But then some people still haven't heard about us.

We're Galileo Electro-Optics Corporation.

And we've got the world's broadest line of optical communication cable.

It's called Galite.®

And it gives you the kind of choice in strength, propagation efficiency, thermal compatibility, chemical resistance, weight – and cost – to make all the incredible advantages of fiber optics practical for your application right now.

And just look at those advantages.

Optical fiber can handle over 10,000 times more information than copper wire, in the same amount of space.

Optical fiber can handle amounts of information copper wire can't even touch – a 30 volume Britannica, transmitted in a tenth of a second.

Optical fiber is virtually immune to electromagnetic interference, cross talk, short-circuit loading, and fire.

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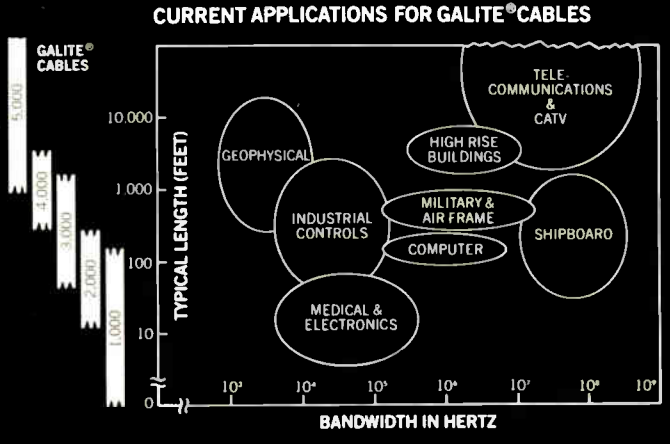

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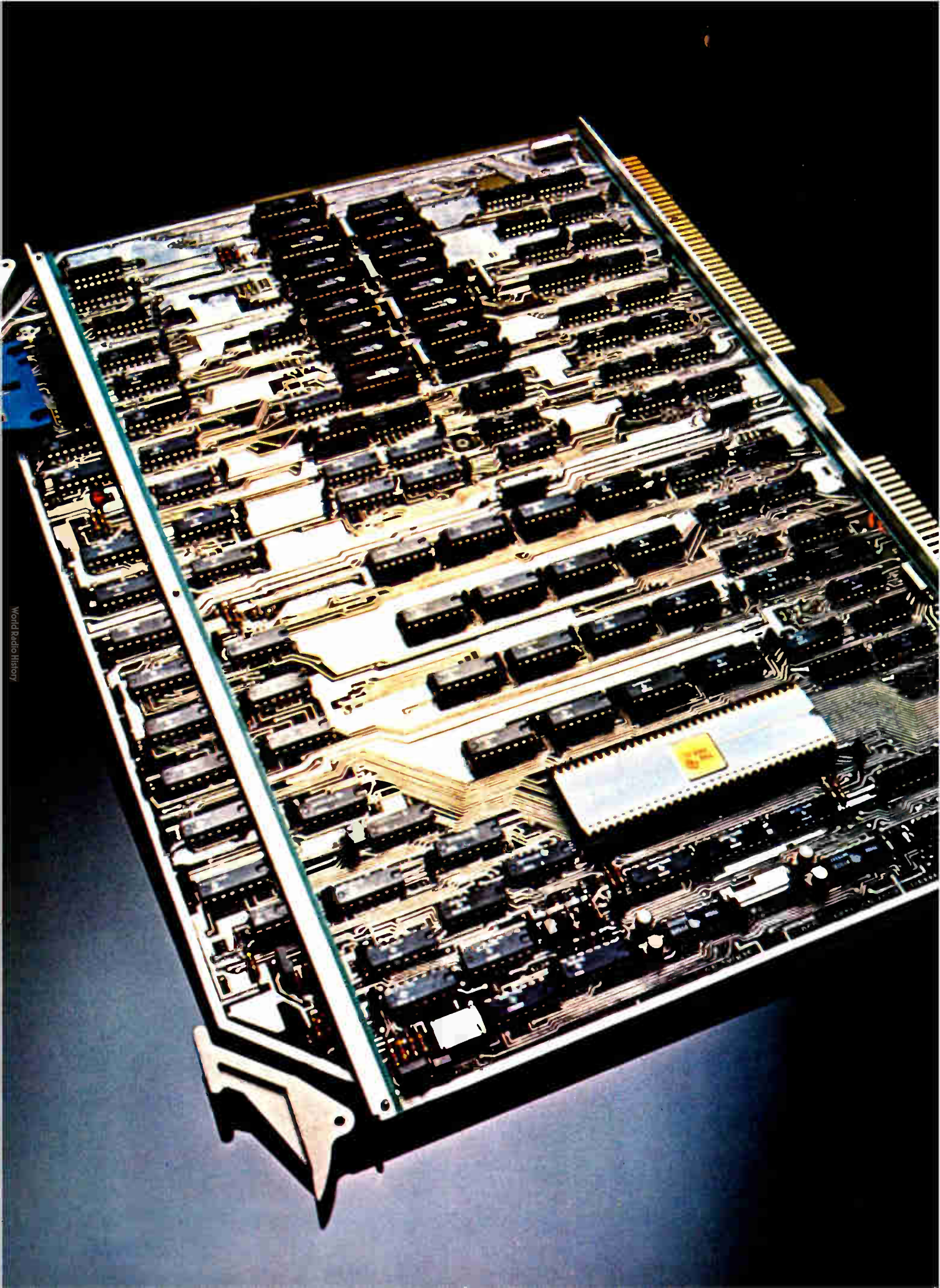

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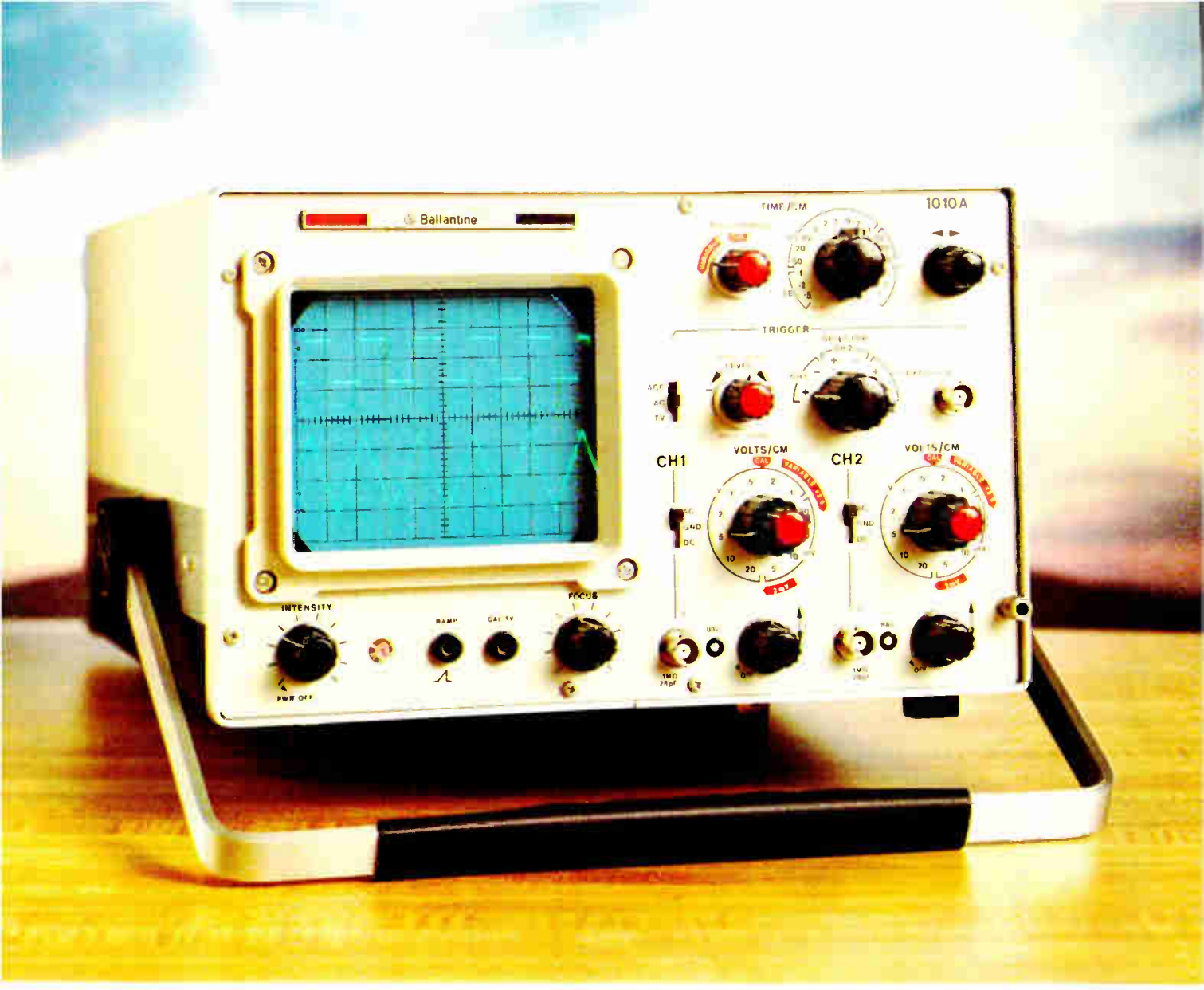

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CB chip market is technology battlefield

Six IC houses making frequency synthesizers for 40-band models, with three using bipolar and three using C-MOS processes

Bernard Cole, San Francisco bureau manager, and Lucinda Mattera, Components Editor

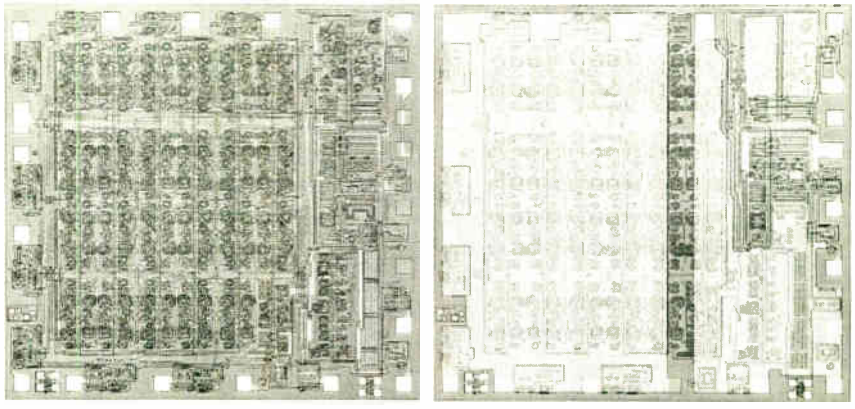
The chance to make new inroads with technology has semiconductor manufacturers jumping into the citizens' band market with impressive frequency-synthesizer chips that meet the new 40-channel allotment. But, as so often happens in integrated circuits, a battle is shaping up between vying technologies—in this case, bipolar and complementary-MOS processes.

At least a half dozen semiconductor makers are now beginning to offer samples of new monolithic synthesizers, with a split down the middle between the two technologies. Three companies going with bipolar, and three with C-MOS.

Proponents of the bipolar chips point out that they can operate directly at the upper CB frequency of about 27 megahertz, so they do not require the prescalers or external mixer circuitry that C-MOS synthesizers do. On the other hand, C-MOS chips have lower power dissipation, sometimes a hundred times less than that of the bipolar chips.

Utilizing a combination of two bipolar processes—emitter-coupled logic and integrated-injection logic—Signetics Corp. of Sunnyvale, Calif., has come up with a one-chip synthesizer that could provide more than the 40-channel requirement, says consumer products marketing manager Neal Williams. The NE575 contains the equivalent of 800 to 1,000 gates (90% I^2L, 10% ECL) on a single 100-by-110-mil die. It can operate at input frequencies of up to 40 MHz, giving a 128-channel capability. In large quantities, the price is $2.50 to $3 each—scarcely more than present-generation chips.

Using bipolar technologies avoids a drawback of existing C-MOS chips, points out Russ Hansen, consumer applications manager, in that the latter were designed when the number of channels available for CB radios was only 20 or so. To meet the expanded range, most of them have programmable counters that must operate at the top-end CB frequency of 27 MHz, which is at the very limits of C-MOS technology, he says.



Big boy. This 102-by-206-mil chip from RCA houses a phase comparator, active filter, VCO, 11-stage counter, and a 13-stage counter. It uses C-MOS and closed C-MOS logic.

The ECL circuitry of the NE575 permits operating at input frequencies of up to 40 MHz, while its I^2L circuitry minimizes the external components needed and holds power drain to around 240 milliwatts. The NE575 requires only one external crystal and no tuned circuits other than those in the external voltage-controlled oscillator.

Like Signetics, National Semiconductor Corp., Santa Clara, Calif., has opted for a combination of ECL and I^2L in its DS8900 phase-locked-loop frequency synthesizer. The 29,000-mil^2 chip contains the equivalent of 500 to 1,000 devices, says Keith Mueller, senior designer.

The use of ECL input circuitry to generate the transmit frequency directly from an off-chip VCO makes possible a 30% to 60% reduction in the number of components necessary to build a typical 40-channel CB system, he says. Previous C-MOS chips, he adds, required external mixer circuits, as well as external filters and other components to clean up the mixer-generated noise.

The 28-pin DS8900 is loaded, with an input amplifier, an ECL synchronous programmable divider, an ECL phase comparator, a high-speed charge pump, a lock detecter, a subtracter, a 40-word-by-6-bit read-only memory, an up/down decade counter, channel-select logic, and segment decoder/drivers.

Despite its complexity, the device holds power consumption to 500 mw. In large volumes, price on the unit will be about $5 each. National, which has been offering samples of the part for about two months, expects to be in volume production by the end of the second quarter.

A bipolar low-power-Schottky device in a 16-pin package, the 11C84,

is the CB-synthesizer contribution from Fairchild Semiconductor, Mountain View, Calif. It incorporates all the circuitry usually used in a digital PLL, including a programmable divide-by-N counter, a reference-frequency divider chain, and oscillator.

Low-power-Schottky technology permits Fairchild to achieve high-frequency dividers right on the chip, eliminating the need for a prescaler or down converter between the VCO output and the divide-by-N input. The only external circuitry required are the oscillator, an active integrator, and a crystal. Power dissipation is held to 550 mW.

To reduce frequency-modulation distortion in the VCO, the phase detector on the 11C84 incorporates an anti-backlash feature. "A common shortcoming of phase detectors is their inability to detect small phase-angle changes between the two frequencies under comparison," says Chuck Alford, applications manager for digital products. This causes fm distortion, which is avoided in the Fairchild chip by a technique that forces the detector to operate outside its dead zone. Like National and Signetics, Fairchild has samples available and expects to be in production by the summer.

At least two semiconductor producers are responding to the bipolar challenge with new C-MOS chips designed for 40-channel operation. Several different processes are used.

Samples of a real beauty are available from the Solid State division of RCA Corp., Somerville, N. J.: a monolithic synthesizer that even includes an on-chip VCO. The device requires a minimum of external components—merely a reference crystal, an RC network for setting the frequency range, and a tuned LC tank circuit for improving the dispersion of the synthesized frequencies.

Built with a combination of C-MOS technologies—standard C-MOS and the newer C^2L (closed C-MOS logic)—the chip is capable of generating all 40 channels at a typical power dissipation of 150 mW. Only about a year old, the firm's C^2L technology provides faster speed and greater packing density than standard C-MOS, without sacrificing low power dissipation and high noise immunity.

On a 102-by-206-mil piece of silicon, RCA is squeezing a phase comparator, an active filter, a VCO, an 11-stage mask-programmed counter for dividing down the reference frequency, and a 13-stage counter for dividing down the synthesized frequencies. This latter counter has nine electrically alterable stages and four mask-programmed ones. About half of the chip area is inactive, because the designers have isolated the VCO from the logic circuitry by a ground plane so as to decouple these two sections.

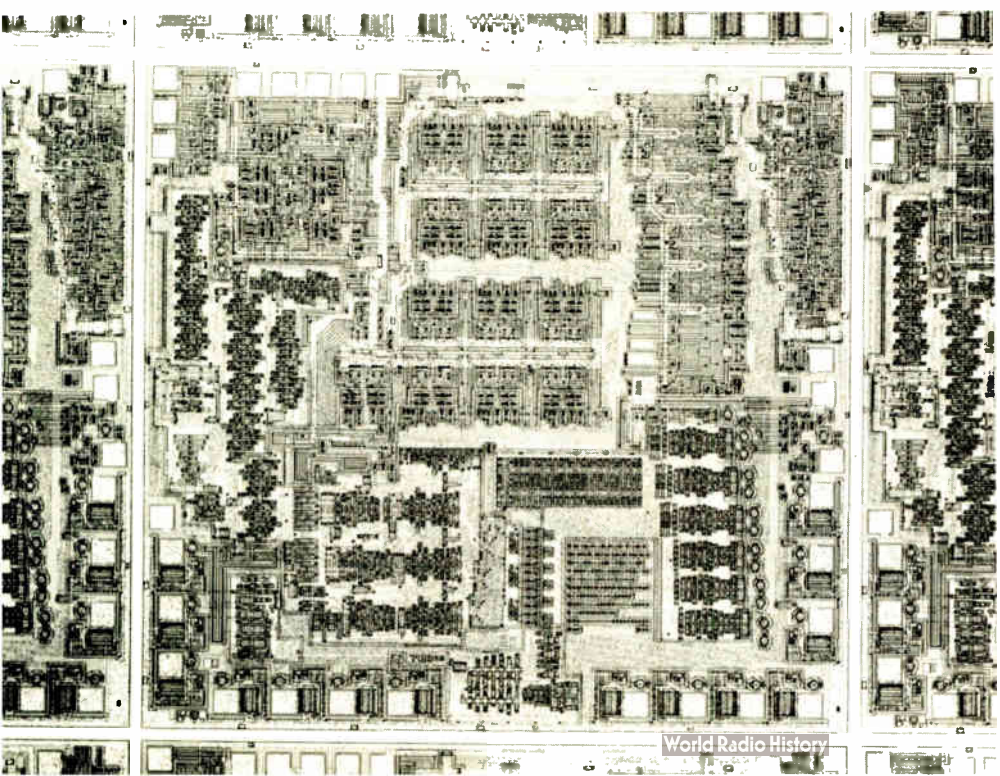
The high-speed programmable counting capability of C^2L permits the phase-comparison frequency to be set equal to the 10-kilohertz channel spacing needed for CB, says the company, thereby minimizing the magnitude and number of possible spurious frequencies. Also, the low power dissipation of C^2L tends to eliminate parasitic frequency modulation caused by coupling through transients, the firm says.

Yet another new C-MOS synthesizer chip is being made by the Solid State Products division of Hughes Aircraft Co., Newport Beach, Calif. Like the RCA device, it requires fewer external components than earlier C-MOS designs. Although the HCTRO347 still needs an off-chip VCO, it contains a mask-programmed logic array that converts the input format for channel selection, thus using fewer external parts.

The chip is capable of 45-channel operation, yet its typical power dissipation is an incredibly low 5 mW, he notes. Hughes has samples available and should be in production in six to eight weeks. Price for the 16-pin plastic dual-in-line part will be under $2.50 each in volume.

Without offering new designs, Motorola Semiconductor Products Group, Phoenix, is on the C-MOS synthesizer bandwagon. Earlier this year, the firm said it planned to market a bipolar I^2L chip, the MC3390, with capability up to 100 channels. But, says a company spokesman, the chip has been shelved indefinitely. Instead, Motorola is second-sourcing five existing C-MOS designs, part numbers MC145104, 06, 07, 09, and 12. "They are the industry standards for this year, with over 60% of the CB radios using them," notes Richard Ahrons, who is with Motorola's MOS facility in Austin, Texas. □

Combination. National's phase-locked-loop frequency synthesizer uses ECL and I^2L technologies. The 29,000-mil^2 chip contains the equivalent of 500 to 1,000 devices.



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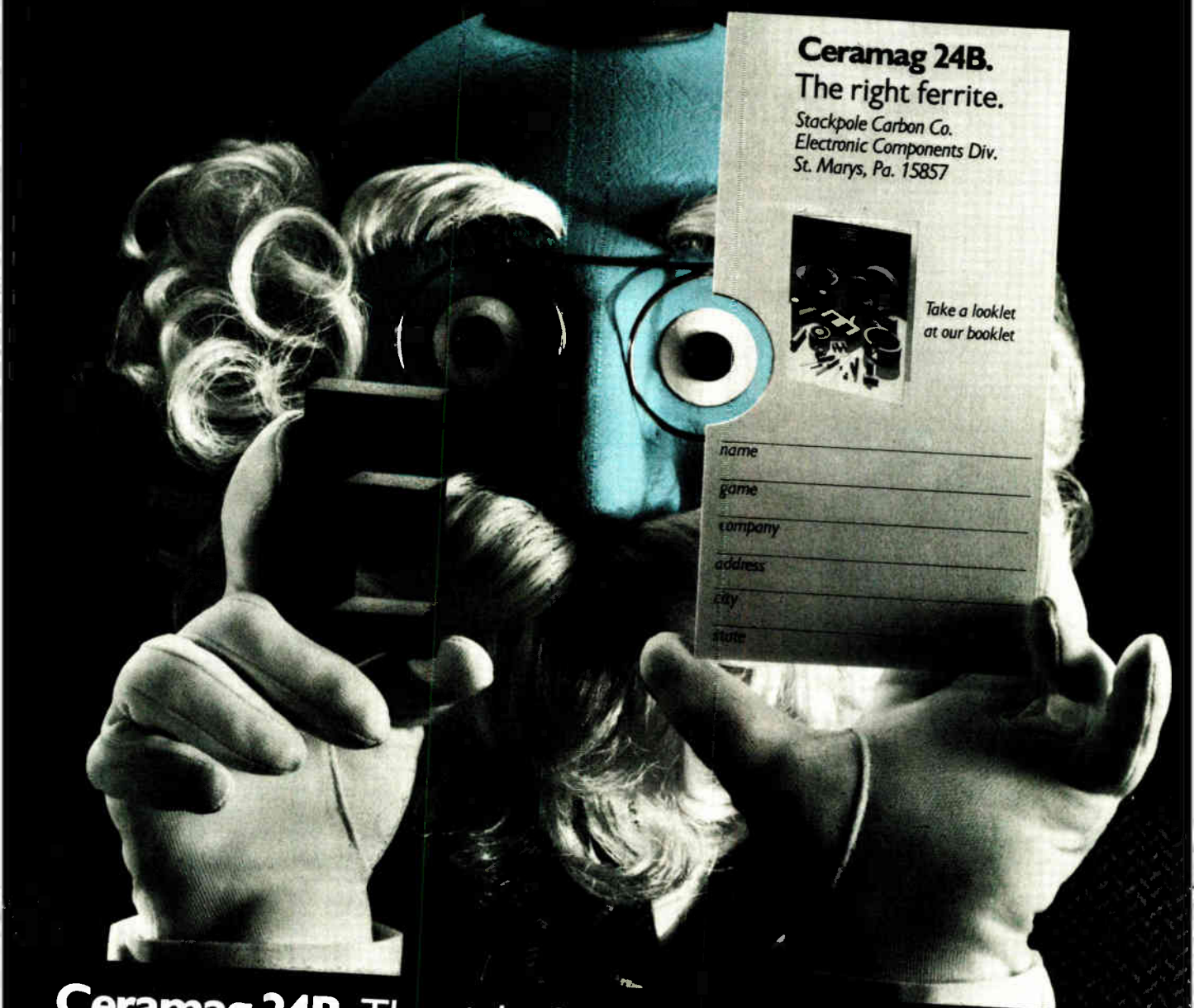

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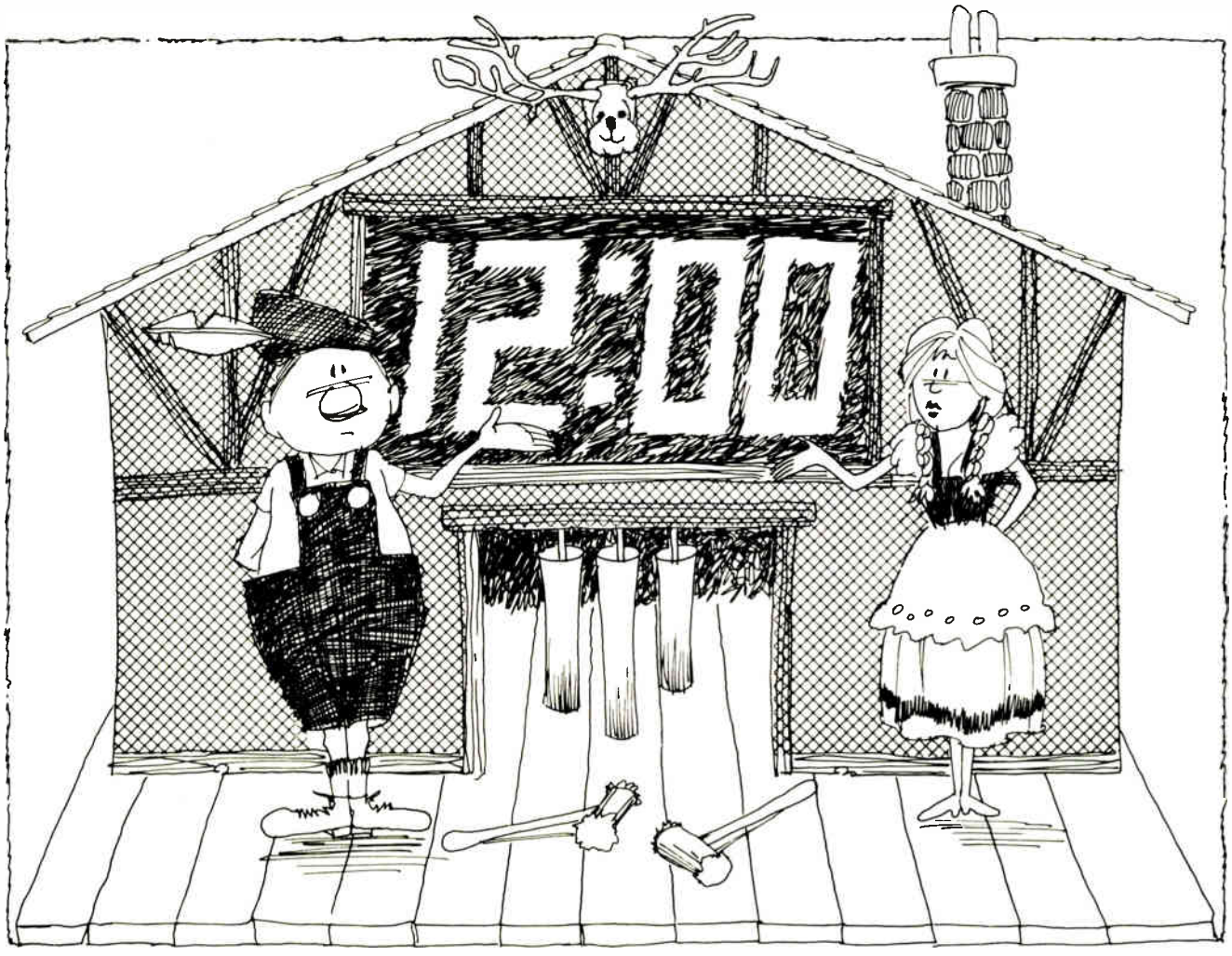

Probing the news

Swiss make up for lost time

by Laura Pilarski, McGraw-Hill World News

For Swiss watch makers, time and technology flew by as they spent years talking about getting into electronic watch production instead of doing it. But things are changing: the swing from traditional mechanical-electrical watch models to solid-state technology has accelerated to full speed this year. The Swiss are finally trying to catch up in the world race to manufacture and market crystal-clocked watches and movements.

This significant effort has been spurred in part by the American success in digitals and by the need of the Swiss to bolster overall watch sales, which have suffered from the world's economic ills, the ever-strong exchange rate of the Swiss franc, and changing tastes.

Last year, electronic movements and watch exports were close to 2.7 million units worth more than $100 million out of a total of 62.2 million watches and movements exported. The total this year is expected to more than double; next year, according to industry sources, could be another banner volume year. To prepare, the Swiss rather quietly have been putting themselves into position, both in technology and manufacturing facilities, to come up with a completely Swiss-made electronic watch, including circuitry.

Most Swiss watch companies—small and large—and all better-known brands came to the Basel watch and jewelry fair this month with at least one representative digital watch—along with quartz-analog models, which have a strong appeal in Europe.

Paul Tschudin, vice-president of Ebauches S.A., Switzerland's biggest producer of watch movements, minces no words. "We are very definitely going after a share of the world market in digitals," he says, "and there should be no [mistake] about our [ability] to compete both in technology and price." However, he hastily adds, "not at the $12.95 retail market price."

In the long-range, the Swiss see digitals growing in popularity. Mar-

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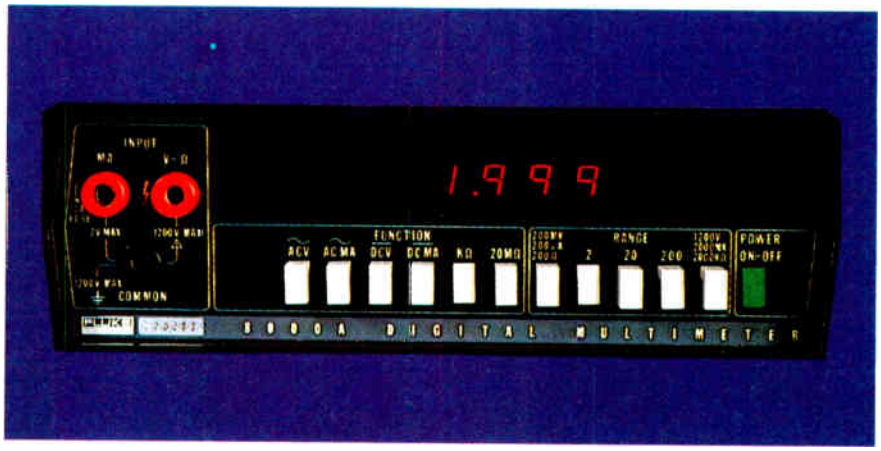

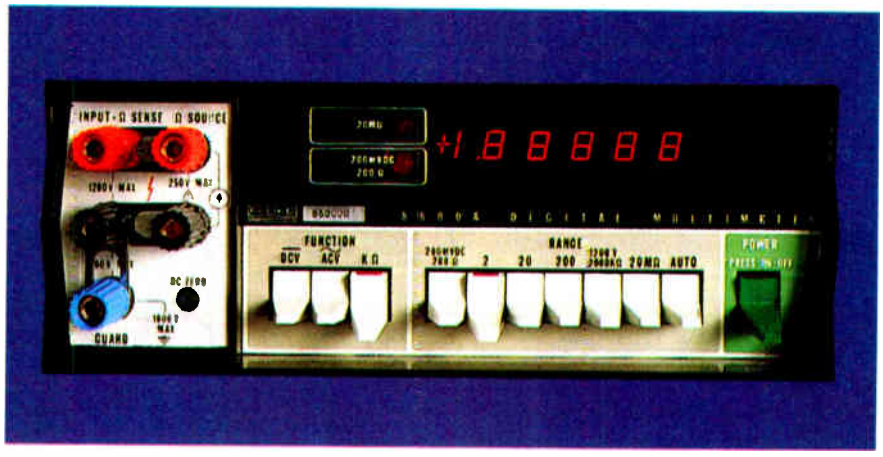

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Probing the news

ket surveys show a current 8% European penetration in sales advancing to a possible 30%–40% in the 1980s.

The Swiss favor liquid-crystal displays as less power-hungry and more practical over light-emitting diodes. They also like complementary-MOS circuitry. Earlier this year, Ebauches signed on Brown-Boveri et Cie. as its main supplier of LCDs, with the goal of producing some 5 million electronic movements in 1977, probably half of them digital. At the same time, the two Swiss firms agreed to close cooperation in research and development of possible future electro-optic systems. Brown-Boveri went into mass production of twisted-nematic LCD cells at a special plant in Lenzburg in 1975, with opening year production going roughly one third to Switzerland, one third to the U. S., and one third to Japan. Now a sizeable proportion will be going to the home watch industry, with production of eight sizes of LCD cells and about a dozen front styles.

The closest competitor to Ebauches in supplying modules to the Swiss and others (including a large order to Bulova) is Modules Electroniques S.A., at LaChaux-de-Fonds—a subsidiary of Nepro Watch, an independent, enterprising company. Its head is Paolo Spadini, a maverick among Swiss watch makers in that he is a fervent disciple of the digital watch.

Last year, the firm went on line and turned out more than 250,000 LCD modules. "We could have sold 100,000 more if I could have produced them," Spadini says. This year the production will be more than doubled.

Three ways. Spadini says that consumers and the market, too, have become confused by price erosion. He sees three directions for the digital world market:

- A technically good, multifunction gadget-type watch, with the Japanese as the leading producer.
- A low-price, technically efficient model offering minimal information and no elaborate styling, with American companies like Timex and Texas Instruments as leaders.
- A flat, more elegant dress-type watch for men and women, with the Swiss as leaders.

Together with Nepro and five other watch-involved firms, Mondaine, a Zurich firm, late last year founded the Electronic Precision Industries Cooperative in Zurich to facilitate purchases of electronic watch components at lower costs. "This gives us centralized buying power," explains company executive Ronald Berheim.

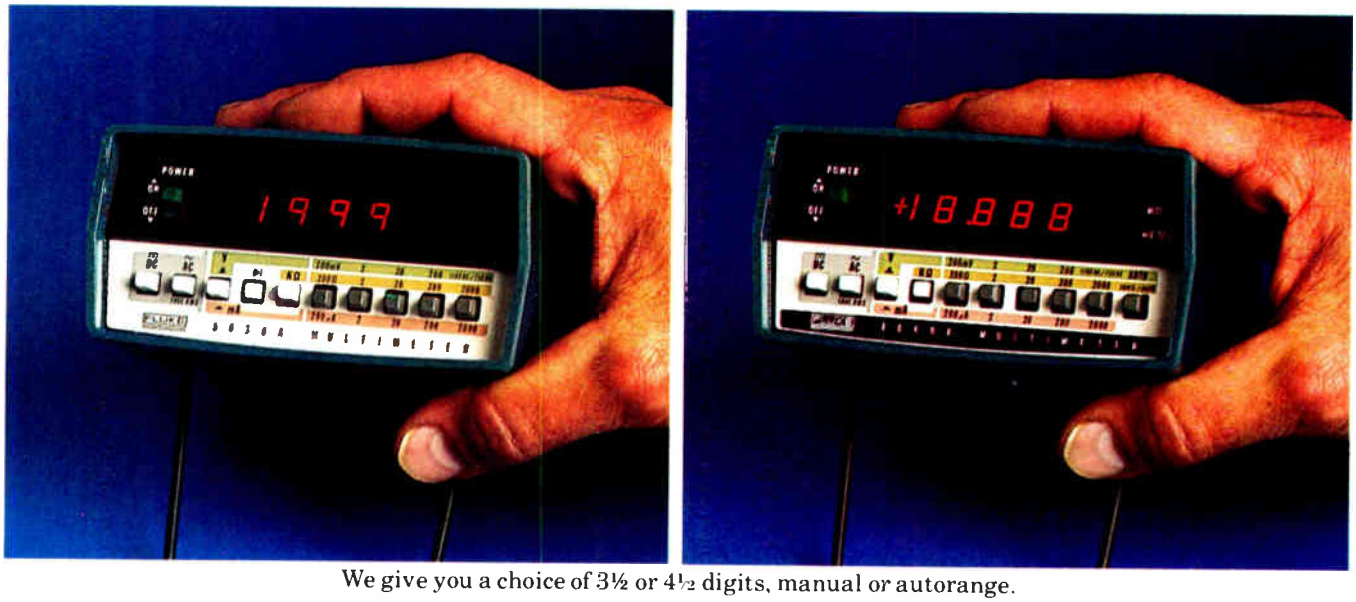
The growing importance of solid-state watches also is mirrored in stepped-up activity by the Societe Suisse pour L'Industrie Horlogere, a holding company for such prestigious brands as Omega and Tissot. SSIH Electronic S.A. was created the beginning of this year to continue and expand quartz crystal production—already among the biggest in Europe—and to make some LCD modules. At Basel, Omega introduced a quartz movement designed by SSIH that is just 0.533 cubic centimeters in volume. It measures 13 by 15.15 millimeters, and with battery is only 3.35 mm thick. And Heuer caused a stir when it said it will introduce this year an analog-digital stopwatch that is the same size as conventional ones.

Half enough. Faselec, owned by Philips of the Netherlands and watch-industry interests, says that about half of what is currently needed by Swiss watchmakers in the line of chips for digital watches comes from Switzerland. This firm makes silicon-gate C-MOS chips as well as custom devices.

For the future, Swiss technical experts see growth in functions and features of digital watches. "The flashy stage of digitals has passed and now we can get down to serious, down-to-earth considerations," says a top Swiss solid-state specialist. While the Swiss have looked at integrated injection logic, they do not see it as attractive until it can come up with the same yield at the same cost as C-MOS.

Solar cells already are being used in several watch models and microprocessing has been at least introduced, but is judged as too expensive and needing too big a chip. □

Six important questions to ask of any DMM that claims to be designed for field service.



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Commercial electronics

Wiegand effect getting practical

The 5-to-6-V pulse generated from a 3.5-cm wire can fire an SCR and switch electrical loads—no other trigger is necessary

by Gerald M. Walker, Senior Editor

The first products to exploit the Wiegand effect are already in sight [*Electronics*, April 14, p. 39]. In fact, the latest and perhaps the most dramatic application—a 3.5-centimeter wire that generates a 5-to-6-volt pulse upon encountering a magnetic field—will be demonstrated next month at the Chicago Product Engineering Show by the effect's chief patron, developer, and licenser, Echlin Manufacturing Co. of Branford, Conn.

To produce the 3.5-cm wire, John Wiegand, discoverer of the effect, worked closely with Echlin product designers. The pulse is large enough to fire a silicon controlled rectifier or switch electrical loads in industrial controls without any other trigger input. It is generated whenever the specially treated ferromagnetic wire is subjected to magnetic energy, an event that causes a sudden change in the magnetic relationship between core and shell. This change is what produces the pulse.

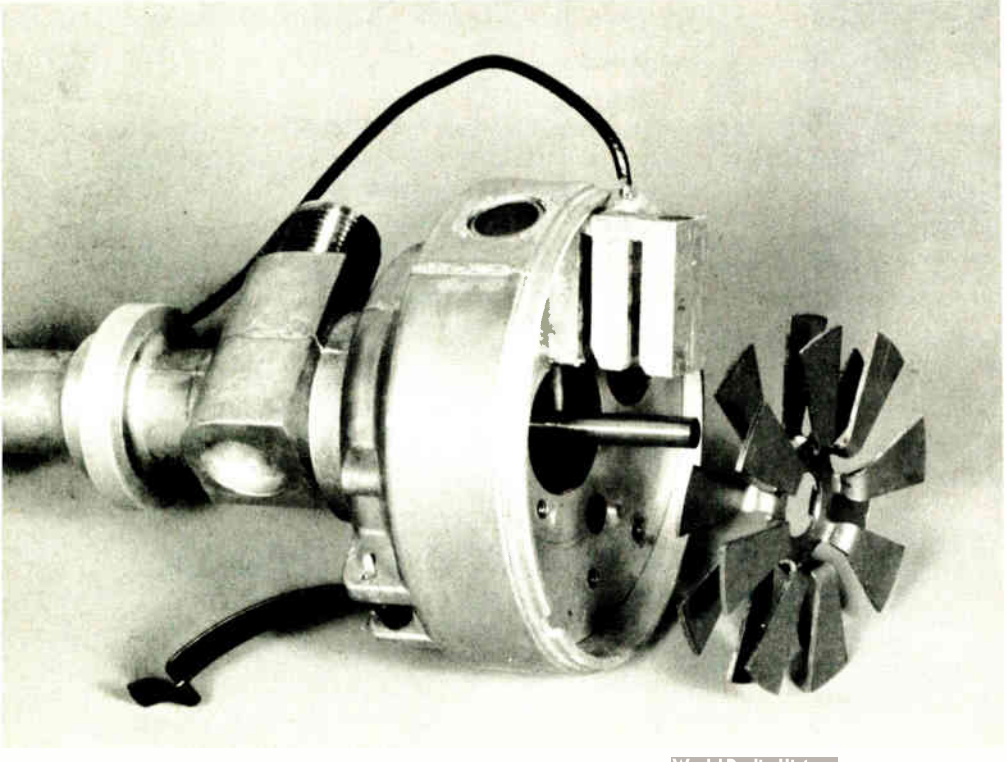
"The Wiegand effect is not a substitute for semiconductor devices—it cannot match the speed and density of a semiconductor memory, for instance," acknowledges J. David Marks, Echlin's vice president of engineering. "But it is an adjunct to semiconductor devices in many applications." He recalls that Echlin originally became interested in the effect for use in an automotive part, "but when we saw possibilities for other, more extensive products, Echlin proceeded a year ago to acquire the entire Wiegand technology."

Among the more immediate possibilities are an auto distributor, in which the wire will help time spark ignition, and plastic charge cards, where the wire would replace the standard magnetic stripe. Further off are other automotive applications, as well as industrial ones—for instance, a Wiegand-based limit switch could be designed into a machine-tool control.

Wiegand devices have other advantages, besides their ability to produce a pulse without an electrical input. They are stable in temperatures ranging from $-196^{\circ}C$ to $+300^{\circ}C$. The effect is not speed-dependent; that is, the amplitude and duration of the pulse stay constant, no matter how fast a magnetic field is applied to cause the "Wiegand jump." The special treatment of the wire—cold working ferromagnetic alloy wire by stretching and twisting it, followed by heat tempering—promises high yields and is fairly easy to automate when large quantities are required.

Going slowly. But Wiegand technology is still not completely understood, making manufacturers very cautious about jumping into product development. To remedy this problem, Echlin is both sponsoring basic research at Yale University's Department of Engineering and Applied Science and demonstrating the practical aspects of this technology by developing automotive products. (The firm is primarily an automotive parts manufacturer.) The company's original interest was in an auto distributor, which will probably be

Off and running. Wiegand effect is used in this automobile distributor, in which specially treated ferromagnetic wire will produce signals to time spark ignition.



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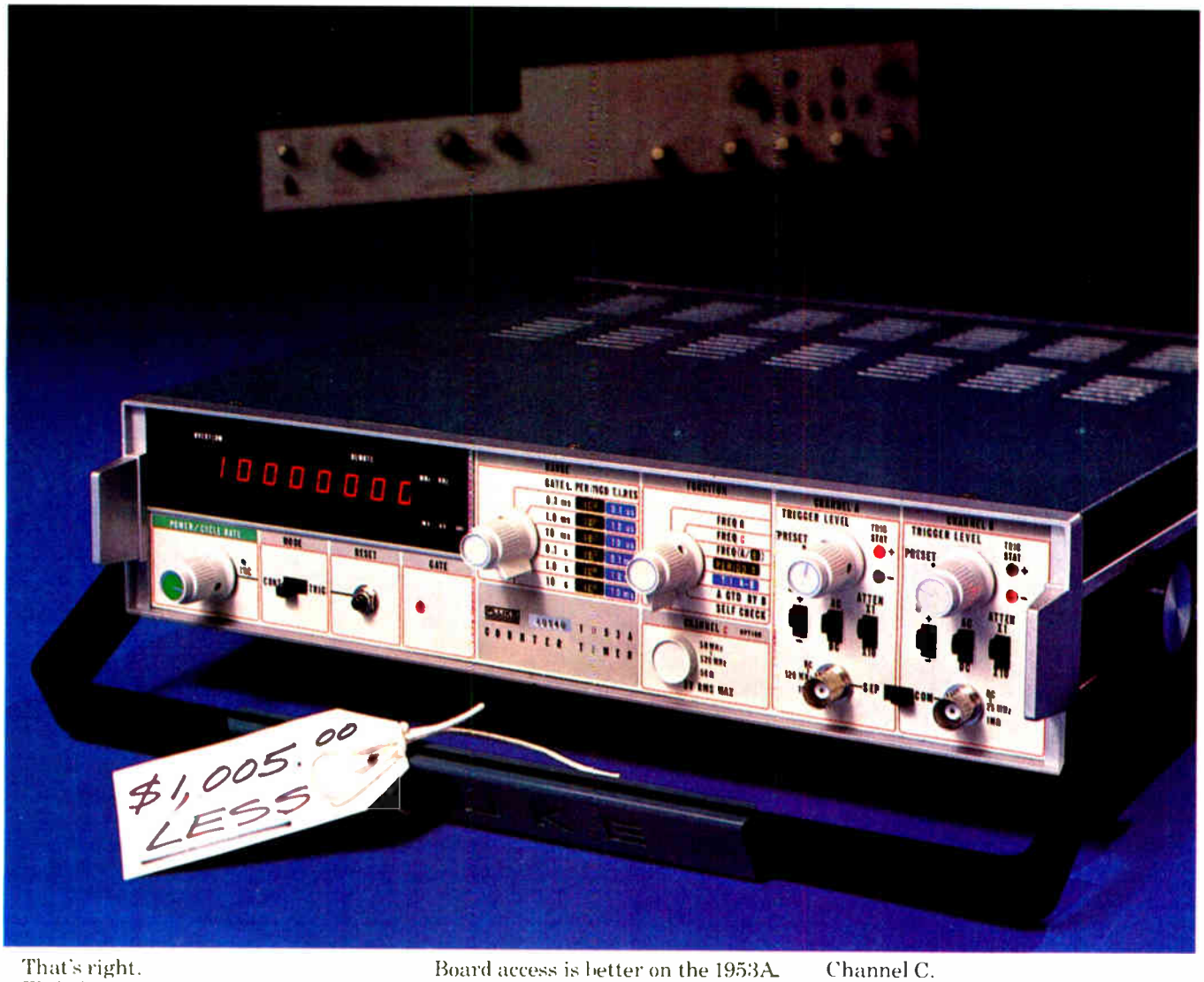

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placed on the market by the fall.

In the Wiegand-based distributor, the wire will produce signals to time spark ignition. A Wiegand module consisting of one wire wrapped in a coil is mounted between two permanent magnets of opposite poles. Eight-blade vanes (in the case of eight-cylinder cars) are mounted between the magnets and the module as interruptors so that when the vanes rotate, a Wiegand pulse passes through each air gap in time with the needs of sparkplug ignition. Precisely how the signal is handled to fire the plugs depends on the type of ignition system used.

"The Wiegand distributor signal replaces a light-emitting diode, or Hall-effect device, or variable inductor as a signal source to time the firing of the sparkplugs. It can be used with a capacitive discharge or an inductive ignition," explains Michael J. Sinko, project manager of advanced products for Echlin.

Auto work. The company is now working with the Big Three auto makers on various other applications. One is testing a product, and the other two will begin shortly. Besides the auto companies, Colt Industries and Robert Bosch GmbH of Germany have licensed Wiegand technology to develop automotive parts so that the prospects for fully established applications in this market seem more and more likely. One possibility, says Marks, would be as sensors—either for crankshaft position and revolutions in microprocessor-based fuel-management systems or for wheel speed in adaptive braking systems.

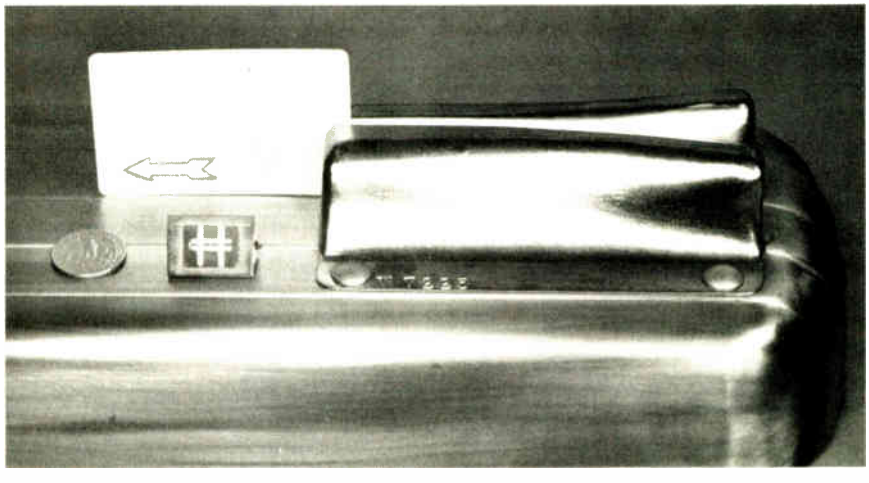
Applications for the Wiegand effect in data handling also appear promising. Echlin licensed International Business Machines Corp. this year, and trials of access card readers have started in Boston's subways and Canada's airports.

A series of wires embedded in a plastic card produce a binary-coded-decimal signal when the card is passed through a reader. The wires are more secure than a magnetic stripe, because it is impossible to destroy or alter the information in the card without destroying the card itself. Also, a lot of information can be stored at a nominal cost.

But the main attraction is the ability to gain access to this information with a read head unit that requires no electrical power. This quality makes it easy to install readers in doors, turnstiles, vending machines, and the like—places where magnetic-stripe readers would be too costly and would get too much abuse to survive for long periods.

Echlin plans also to provide complete modules designed for specific applications such as card reading, sensing, or auto parts. These modules will consist of various configurations of the basic Wiegand parts, including treated wire, coil, and magnets, that can be handled as subassemblies for systems manufactured by the licensees. □

Card player. Wires embedded in a plastic card produce a BCD signal when it is passed through a reader. The system is undergoing tests in Boston's subways and Canadian airports.



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We've prepared a special brochure which describes our REACT program more fully. This brochure also contains a discussion of custom LSI time/cost considerations in today's numbers. For your copy, circle the R.S. number, or contact REACT Marketing, at (408)247-5350.

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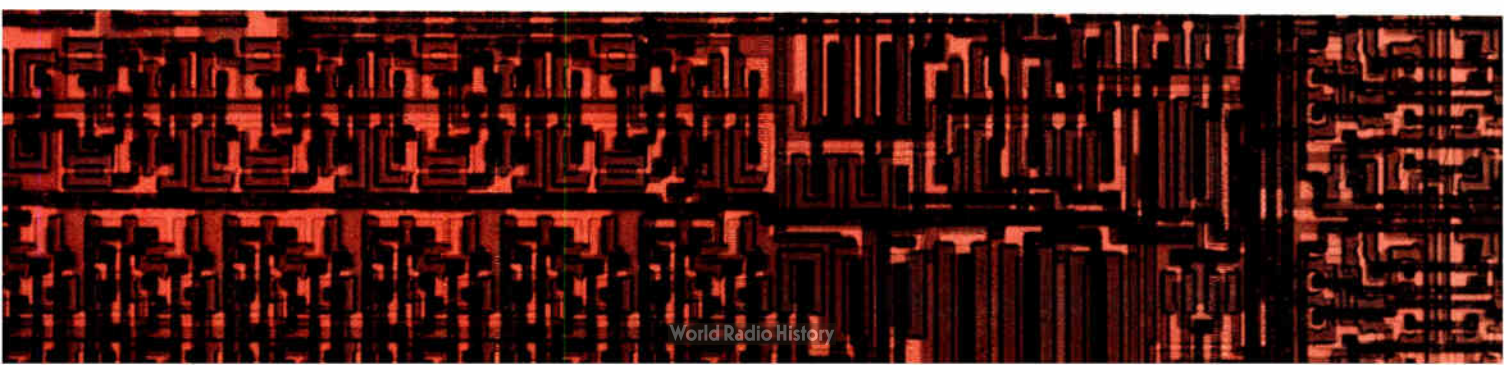

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DYNAMIC RAMS.

Consumer electronics

Court intensifies import storm

Latest decision mandating countervailing duties, plus tariff body's call for increased TV duties, send shock waves across the Pacific

by Ray Connolly, Senior Editor

Bureaucratic blood pressures went up in Washington and Tokyo earlier this month when the U. S. Customs Court in New York upheld the Zenith Radio Corp. contention that Japan's exclusion of most consumer electronics exports from its 1962 Commodity Tax Law is a bounty or grant. The ruling orders that those U. S. imports from Japan would be subject to countervailing duties equal to the unpaid taxes in Japan—anywhere from 13% to 20% of the product's value.

The three-judge court's unanimous ruling went far beyond the March recommendation of the International Trade Commission of the U. S. calling for an increase in television imports tariffs (*Electronics*, March 31, p. 74). The court upheld Zenith's demand that tariff hikes be slapped on radio receivers; combinations of radios, phonographs, and television sets; tape recorders and players, and color TV picture tubes.

The Treasury Department, which lost to Zenith and must enforce the ruling through its Customs Bureau, immediately appealed to the U. S. Court of Customs and Patents Appeals—even before Japan's formal protest had reached the White House. The ruling, if upheld on appeal, could become a precedent affecting up to two-thirds of future imports of every kind.

Reactions. Akira Haranda, Matsushita Electric Industrial Co.'s executive managing director in Tokyo, seized on that issue, warning that European countries granting the same exemptions will be subject to the same measures. The economic and political impact on overall world trade would be strong, he asserted, calling for U. S. Government appeals and other legal measures to "speedily rectify this irrational decision."

President Jimmy Carter appeared to oppose the ruling, telling the press three days after its issuance that a key feature of his anti-inflation program would be to take no protective Federal action to restrain cheaper imports. Yet he may not have that option if the court ruling holds up. As Judge Nils A. Boe points out in his concurring opinion, "If a decision of a court shall be predicated on political and economic expedience and, in so doing, shall ignore judicial precepts and the statutory mandates of the Congress, then assuredly an erosion of the basic constitutional doctrine of the separation of powers results. The judiciary should not nor cannot serve as the alter ego of the Executive or the Congress." As to Treasury's argument that countervailing duties don't square with the General Agreement on Tariffs and Trade, Judge Bernard Newman pointed out that GATT must yield to previously existing law. "Moreover," he added, "GATT could not . . . modify or rescind an existing act of Congress."

Despite President Carter's strong free-trade stance, it is evident that he is in an increasingly tighter bind from pressure from the Customs Court and the ITC and from organized labor and TV manufacturers. Also caught are importers. They may be obliged to post a special entry bond as a contingency against higher tariffs. As one of them says, this could mean "a fortune in back tariffs, if this thing is upheld in a couple of years."

Import bond doubles

The Customs Court order to assess countervailing duties on imports of Japanese television sets was a blow to strained U.S.-Japan relations. But in an unrelated matter, the Treasury Department disclosed shortly afterward that it had ordered entry bonds to cover prospective penalties on Japanese TV dumping in the U. S. to be more than doubled from 9% of value to 20%.

In March 1971, the Treasury found that Japanese set makers, except Sony Corp., were dumping their products in the U.S.; that is, selling them for less than the prices in home market. At that time, the 9% bonds were ordered to cover possible penalties pending an assessment and, for political reasons, penalties were delayed. Now the Treasury data, complete only through 1974, shows that dumping has worsened.

Most U. S. industry officials were unaware of the move, but expressed delight when apprised of it. "This is an internal Treasury ruling not subject to court appeal like the Customs Court judgment, so it is already in effect," explains one industry official in Washington. "This means Japanese set prices will have to go up on any units taken from a bonded warehouse after the increase. I don't see any way importers can avoid boosting prices to cover themselves on dumping penalties. Remember, they could go back to 1971."

One short-term certainty is that the coming international economic summit conference in London next month will produce many new trade and tariff questions for Carter's representatives. Of U. S. options, one Treasury official moans, "Don't ask now. We don't have any answers yet, but we're trying like hell to come up with some," by the May meeting.

Price impact. The labor-industry coalition called Compact—Committee to Preserve American Color TV—which fought before the ITC for import quotas on receivers, sees the court ruling as a reaffirmation of its position. Compact cochairman Allen W. Dawson, executive vice president of Corning Glass Works, calls it "a myth that the consumer will take it in the chops if import restrictions are placed" on TV sets.

The coalition's argument for price stability is based on the large set inventories overhanging the present market—more than 2 million units at the end of 1976's third quarter, a figure swollen by the fourth quarter's unprecedented volume and the undiminished flow in the first 1977 quarter. "During the first two months of this year," Dawson asserts, "imports of color TV sets increased by 30% over the same 1976 period, a year that saw a record increase of 133% to 3.3 million imported sets from 1975."

Not only will inventory accumulation hold down prices, believes Compact, but so will RCA Corp.'s recent statement "that it would not raise prices in the event of restraints on imports, "the group's statement concludes." Given this competitive environment, any significant increase in prices must be regarded as extremely unlikely."

Citing the latest court ruling, the ITC findings, and the "widespread hardship already suffered by industry workers," Dawson could not restrain a concluding needle for Carter policies: "We don't believe the President of the United States will want to sacrifice our (television) industry and its 70,000 remaining jobs to keep people working in Japan, which has 2% unemployment against the 7%-to-8% we have had here for the past several years." □

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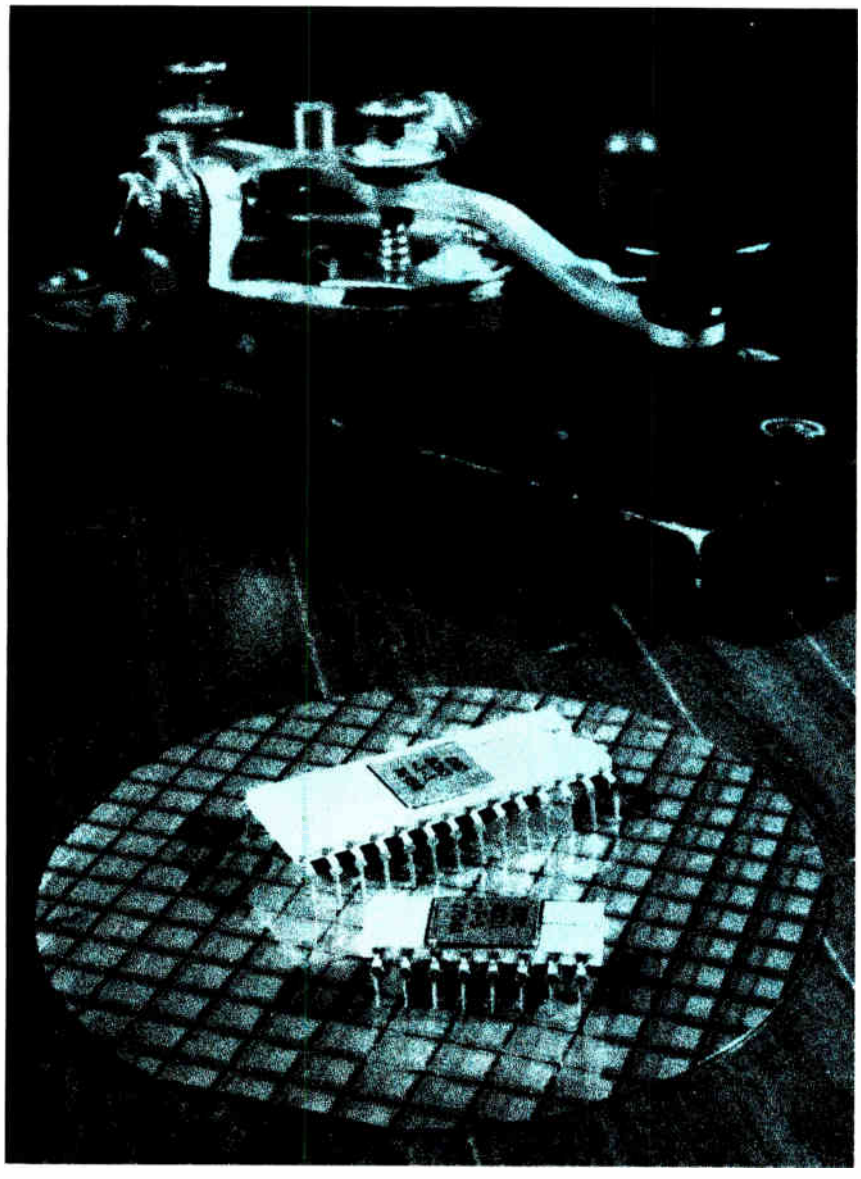


Large-scale integration is ready to answer the call of telecommunications

by Richard Gundlach, *Communications Editor*

☐ Economy, reliability, and versatility—the three big bell-ringers of large-scale integration—are reaching the point where they meet the exacting standards of the telecommunications industry. After working changes in such segments of the field as data communications, LSI is on the verge of transforming the biggest of them all: the telephone industry.

The three levels of the telephone network—the telephones themselves and related equipment, the switching elements and other central-exchange

TABLE: COMPARING SILICON PROCESSES FOR TELECOMMUNICATION APPLICATIONS

Process	C-MOS	Single-channel MOS	Bipolar
Evolution: 1970 to 1980	metal gate silicon gate mixed C-MOS/bipolar oxide-isolation C-MOS/bipolar high-density (no guard bands)	p-channel MOS silicon-gate n-channel MOS silicon-gate depletion-load double-polysilicon-gate oxide-isolation fine-geometry	linear & TTL I^2L Schottky ion-implant-resistor FET / linear oxide-isolation high-density
Key features	inexpensive LSI random logic low power wide operating-voltage range insensitive to power-supply fluctuations forgiving process for both system and process engineers easy for system designers to use without knowing process limitations	high-density digital circuits high-volume LSI manufacturing process more flexible than C-MOS in performance tradeoffs sample-and-hold capability inherent in process (active device-capacitor process) CCD fabrication process capability that allows n-channel MOS digital circuits and CCDs on the same chip	best current-drive capability for a given area low output impedance well-controlled voltage levels wide operating-voltage range low = voltage operation linear amplifier circuits (active device-resistor process) high = speed performance I^2L for high-density, low-power, low-voltage digital circuits I^2L for mixed digital and analog circuits on same chip withstands voltage and current overloads and reversals
Major applications	all standard logic requirements in PBXs, switches, terminal equipment, channel banks and other transmission equipment cost-reducing existing TTL designs codecs and custom line circuits line-powered telephone circuits	memory and memory products microprocessor applications in switching systems and terminals, including interface and input/output devices CCD filters and analog-signal-processing circuits for voice in PCM and FDM channel banks and line circuits CCD imagers for readers, facsimile, and the like	all circuits connected to either end of the telephone line op amps for active filters and similar applications codecs and tone generators voltage regulation and protection circuits high-speed performance devices for central processing units transmission equipment, such as PCM repeaters

Source: Bell Northern Research

equipment, and the transmission lines, terrestrial microwave radio relay and satellite links—are accelerating their use of distributed intelligence. Microprocessors, semiconductor memories, and specially tailored LSI chips are beginning to cut hardware and assembly costs, to shrink equipment sizes, and to provide a host of new features at all three levels of the network.

Telephone companies and semiconductor makers are providing LSI chips made with the metal-oxide-semiconductor, complementary-MOS, and bipolar silicon processes. Although none of these processes is best for everything, a low-power, low-voltage technology is needed. However, right now each of these processes suits some particular applications, says Neil Berglund, manager of silicon technology for Bell Northern Research, Ottawa, Canada.

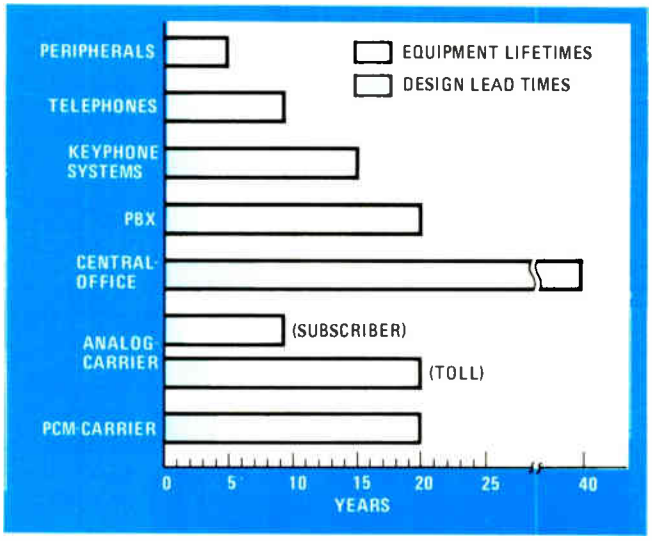
Three processes

As outlined in the table, Berglund looks to C-MOS, which is an inexpensive approach to LSI random logic, to fill standard logic requirements in private branch exchanges, switches, terminal equipment, and channel banks and other transmission equipment, as well as for line circuits and coder/decoders (codecs). Custom-designed C-MOS circuits are cost-effective replacements for transistor-transistor-logic circuits in use today, he says.

MOS leads to CCDs

He looks to n- and p-channel MOS circuits for memories and memory products and for microprocessor applications in switching systems and terminals, including interface devices. Since the process lends itself to fabrication of charge-coupled devices, it can provide n-channel MOS digital circuits and CCDs on the same chip. So it will find use in CCD filters and analog signal-processing circuits in pulse-code-modulation and frequency-division-multiplexing equipment.

Bipolar technology is attractive because it combines high density, low power, and low voltage with the ability to mix digital and analog functions on the same chip. Berglund sees the process being used in all LSI chips that connect to either end of a telephone line, such as codecs and tone generators, in transmission equipment such as



1. Time frame. It can take a long time to get LSI circuits designed into telecommunications equipment, but the reward could be worth the delay for semiconductor companies willing to chance it. Once designed, such equipment is likely to be produced for many years.

PCM repeaters, and in high-speed devices for central processing units.

As the telephone companies continue their slow conversion to digital networks, LSI chips will be used to transmit voice in digital form more cheaply and efficiently. A preview of the future can be found in some new subscriber switching systems (keyphones, which have a row of buttons for such functions as intercoms and choice of outside lines, and PBXs). They are using digital multiplexing exclusively to provide full features to each telephone in the system, but with only two or four thin wires (instead of the thick cable housing more than 50 wires) connecting the main console to the equipment cabinet that interfaces the system with the telephone network.

In these new PBX and keyphone systems, the LSI codecs for voice encoding and decoding are either in each individual phone or in a unit serving a dozen or so phones under microprocessor control. Each microprocessor shares control functions with a larger CPU and memory, all tied to a common data bus.

Telecommunications companies also are interested in built-in self-diagnosis, for which microprocessors are well suited. LSI circuits will help assure the reliable service demanded by data-communications users and will minimize the down time of just about every telecommunications system. The telephone company's new generation of large switching systems is starting to employ microprocessors for fault analysis on a routine basis.

Expanding marketplace

Just as important as microprocessors are the LSI chips tailored to perform existing functions in the telephone network. They also are providing new features in the telephones themselves, such as automatic repertory dialing and pushbutton dialing. Most of these specially designed chips are intended by the semiconductor makers as relatively standard devices, usable in all telephone systems. The firms are also working on custom LSI circuits with some of the equipment manufacturers, and these chips may become available to all comers.

The telecommunications markets for LSI circuits are begining to explode. The Stanford Research Institute, Palo Alto, Calif., puts worldwide LSI telecommunications sales at more than $1 billion in 1985, up from $25 million in 1975.

Three factors spur growth

Strong growth, widening use, and new customers are ahead, says Harry Newton, a New York City telecommunications consultant. He says American Telephone and Telegraph is expanding its purchases from outside suppliers from the present levels of $900 million a year for equipment and several hundred million dollars for electronic parts.

Also, the Government's General Services administration is allocating more of its $400 million annual telecommunications expenditures for cost-saving and innovative solutions to problems. Newton says the third factor is the rapid and extensive upgrading of telecommunications networks by the oil-rich Middle Eastern countries and Nigeria.

Equipment suppliers eyeing the emerging markets realize that their products must be upgraded. Their designers have realized that only LSI technology will provide them with the economic tradeoffs necessary to replace older equipment, while also allowing them to offer added features without extra cost.

Many equipment manufacturers, looking for a competitive edge, are designing with LSI circuits that the semi houses have yet to put into production, says Jim Solomon, manager of research and development for industrial linear integrated circuits at National Semiconductor Corp., Santa Clara, Calif. Cloaked in veils of secrecy, major equipment makers such as Bell's Western Electric, International Telephone and Telegraph, General Dynamics' Stromberg-Carlson Corp., GTE Automatic Electric, United Telecommunication's North Electric Co., and many smaller suppliers, are working with selected semiconductor companies to develop custom chips (see "Getting together," p. 96).

However, suppliers and semiconductor makers alike wonder how fast the pace-setting Bell System will design more LSI into its equipment. On the other hand, Bell and other major phone companies wonder if semiconductor makers are willing to pay the entrance fee: the time required to get their chips designed into telephone equipment. For those willing to wait several years or so, the payoff could be handsome. Telephone equipment lifetimes range anywhere from five to 40 years and so would represent a large continuing market for those LSI chips that are designed into the gear.(Fig. 1).

Telephone companies traditionally have been slow to replace installed equipment that represented large capital investments, so long as it essentially met existing demands. However, that policy is changing. With the press of competition and the need for cost-effective solutions for a more responsive network, coupled with customer demand for greater performance and economy, acceptance of LSI-implemented equipment should be

Getting together . . . sort of

Since telephone companies want the benefits of large-scale integration and since the semiconductor manufacturers have the LSI expertise, cooperation between the two industries would seem natural. But such cooperation is the exception rather than the rule—particularly in contrast to the joint development efforts of telephone-equipment makers and semi houses.

The capacity to produce custom chips exists in the major North American telephone companies—AT&T's Bell Telephone Laboratories Inc., Bell Canada's Bell Northern Research, General Telephone and Electronics Corp.'s GTE Labs, and International Telephone and Telegraph's various research labs—and overseas. In general, the labs want to work with semiconductor makers but will not help to put them in the telecommunications business. "As long as they are acting and looking like competitors, we must treat them as such," says one telephone-company spokesman.

Most major telephone companies claim they do not want to be chip producers, but each is developing in-house chips, along with the masks necessary to produce them. They also want the in-house expertise to be able to evaluate the various process technologies and to provide backup in some of the areas where the semiconductor houses are supplying chips.

There is some cooperation, exemplified by the joint effort of Texas Instruments Inc. and Le Centre National d'Etudes des Telecommunications, which spawns most of the equipment for the French nationally-owned telephone company. Texas Instruments is developing several LSI circuits for the time bases, codecs and transcoders in the second-generation pulse-code-modulation transmission equipment that CNET is developing.

However, the semiconductor manufacturers are finding it almost impossible to squeeze information about the intricacies of the telephone network from the operating companies. They have pretty much turned to the equipment suppliers in hopes of working together to develop LSI chips that can become standard, volume-production devices.

The equipment makers see a competitive edge in working with the semiconductor houses. They expect the next generation of equipment to cost less, while including the host of extra features that large-scale integration makes possible.

Many of the equipment makers lean towards custom chips if cost can be kept down, and semicustom chips, especially where the initial quantities are low. Since the initial engineering of semicustom chips is usually handled by the customer, not the semiconductor firm, costs are held to a minimum. But for such relatively standard circuits as pulse-dialer and tone-dialer chips, suppliers expect to use the devices offered to all comers by the semiconductor industry.

The tailored chips will come from the cooperation between equipment makers and chip manufacturers like Exar, Signetics, Fairchild Semiconductor, and Hughes Microelectronics Products division. The equipment manufacturers find the approach appealing, because it results in economical custom chips without a commitment to large-volume purchases from the cooperating semiconductor manufacturer.

Typical of the approach is Exar's operation. The firm has several LSI device arrays without the final mask pattern. The engineer at the equipment maker designs the desired circuit and then prepares a layout simply by interconnecting appropriate device terminals on oversize drawings of the array supplied by the chip maker.

After reviewing the circuit layout and schematic, Exar generates a custom interconnection pattern—a metal mask—that is applied to prefabricated wafers. The customized wafers are scribed into individual IC chips, packaged, and delivered to the customer.

The Exar process usually takes one to two months and costs about $2,000 for 50 IC prototypes. LSI prototypes will cost more—up to $10,000.

much faster in coming than past experience suggests. "There's no new system in production at Western Electric or under development at the labs that doesn't use ICs," says Robert C. Fletcher, executive director of the IC Development division at Bell Telephone Laboratories Inc., Murray Hill, N.J.

Another indication of Bell's position came recently from the top, when company chairman John D. deButts told a group of investment analysts "The fact is that we are in the process of building a new nationwide network—an all-electronic network characterized by solid-state devices and stored program control." He pointed to Bell Laboratories' recently developed microprocessor [*Electronics*, Feb. 17, p. 83] as playing a leading role in the new network.

The enthusiasm of the telephone companies and equipment suppliers for LSI is genuine, but there are some reservations. For example, a low-cost LSI codec for individual telephones certainly will come, but right now the semiconductor firms are talking about a price tag around $10. That is what the present codec shared between numerous lines costs on a per-line basis, says John McDonald, vice president of research and engineering at TRW's Vidar division.

"We will evaluate the new LSI products thoroughly before designing them into our equipment," says McDonald, who has not been overly impressed with semiconductor reliability. "Failure of a 15¢ semiconductor part could end up costing us several hundreds of dollars," he says.

Toeing the mark

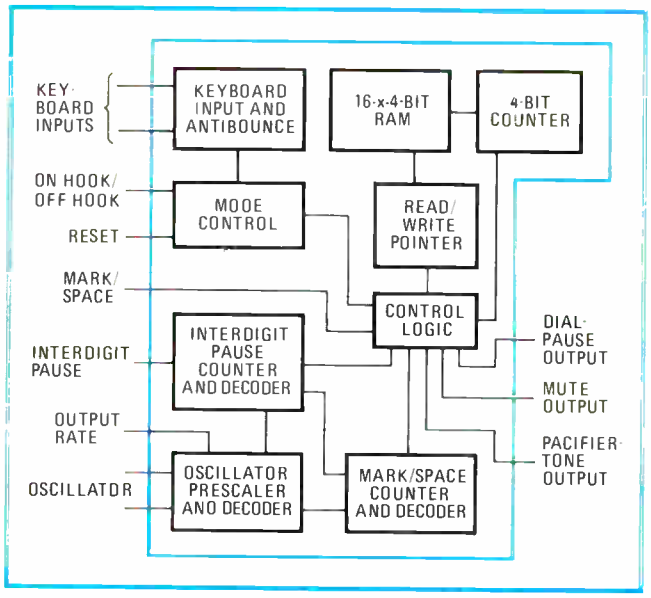
Telephone-company reliability requirements are in the neighborhood of one hour total system breakdown every 30 years. So some of the operating companies are hesitant about LSI because they do not know the cost of inspecting these circuits to make sure they meet the reliability standards. "Just to develop an efficient program to test all functions of LSI circuits would be costly," says Sture Edsman, assistant production director at L M Ericsson, Stockholm, Sweden. He feels that the phone companies would have to perform extensive dynamic testing at high temperatures—and that is a very costly proposition.

LSI aims at network functions

In spite of the reservations sometimes expressed by telephone-company officials, semiconductor firms are charging ahead with the development of LSI chips for telecommunications applications. Over a dozen semi houses are working on various types of chips, some of which are already designed into equipment. Most of the devices, however, are not yet in production, although equipment designers already are interested in them.

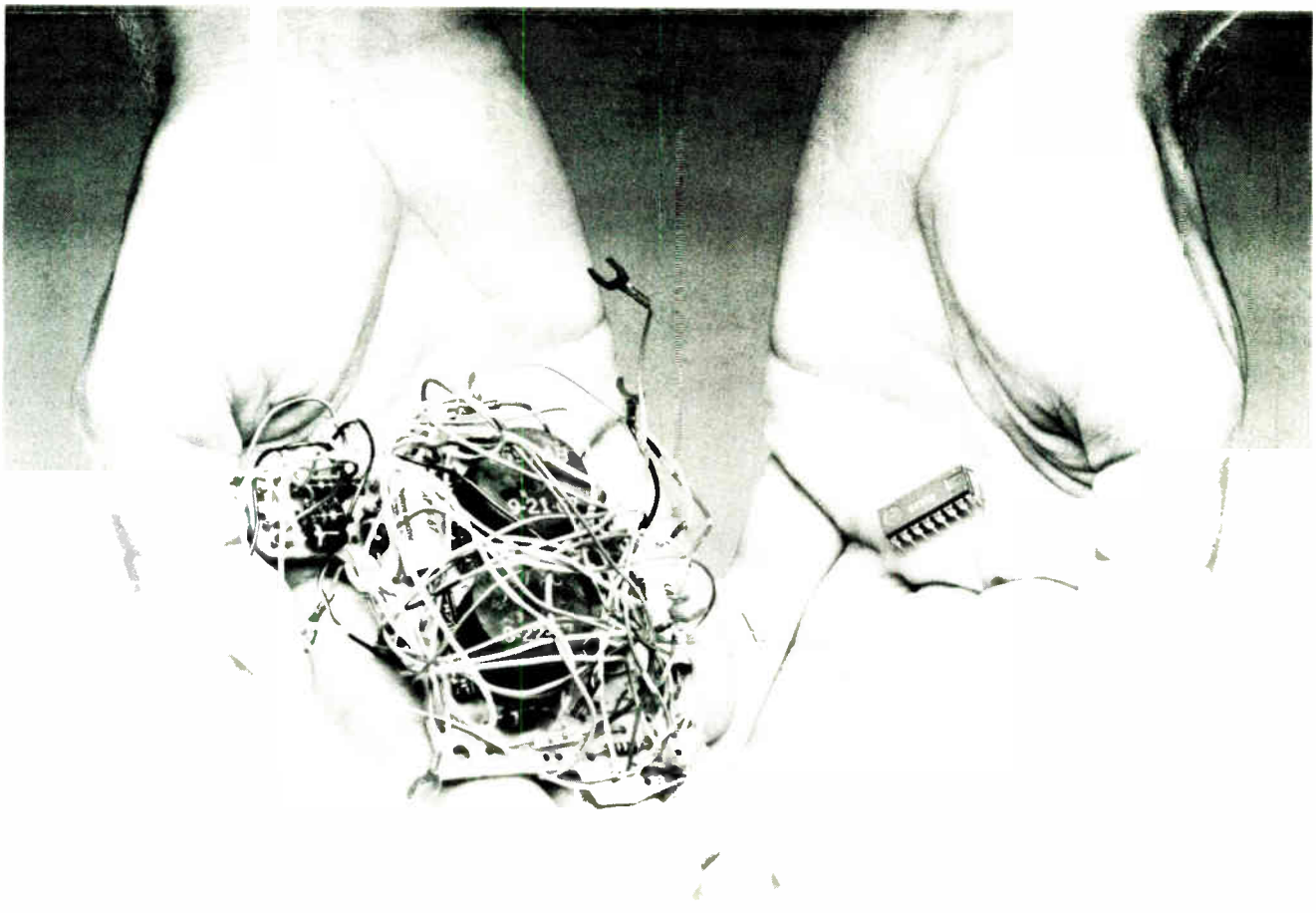
Microprocessors will have their place in telecommunications, filling all kinds of control functions. Semiconductor makers also see a number of opportunities for specially developed LSI chips:

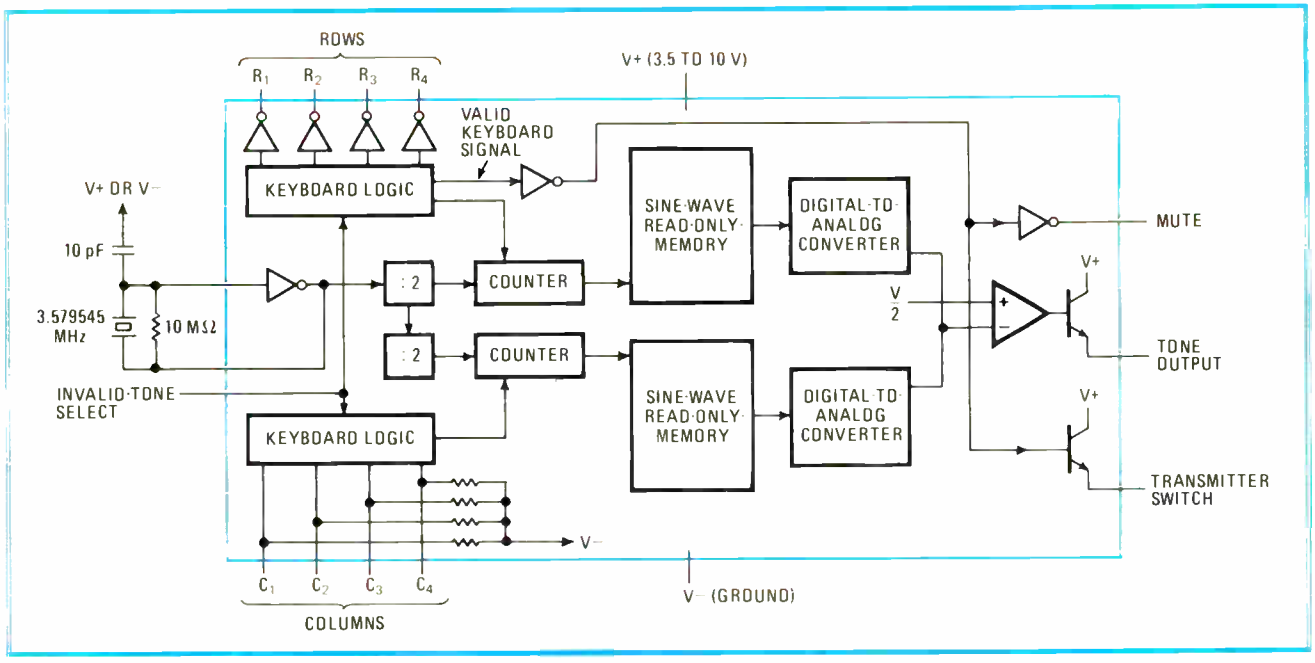
- Pulse-dialer chips that convert push-button information into dialing pulses for phone lines not equipped to handle tone signaling.
- Repertory-dialer chips that store frequently called phone numbers, then automatically dial on push-button command.
- Tone-dialer chips to generate the dual-tone multifrequency signals that are replacing dialing pulses throughout the telephone network.
- Tone-detector chips that detect valid tone signals in central offices and in customers' equipment.
- Repeater chips that reshape, retime, and boost the pulse-code-modulated signals on digital telephone lines.
- Coder/decoder chips that convert voice to digital form



2. Push button in, pulse out. AMI's S2560 keypulser converts pushbutton data into rotary dial pulses for use on phone lines not equipped to handle tone signaling. The chip requires no multiphase clocking, has 16-digit capability, and provides feedback.

3. The hands have it. A single tone-dialer chip eliminates a handful of discrete components and wire, as well as the time to assemble and tune. The LSI circuit (AMI's S2559 is shown) functions properly even at the low telephone-line voltages.





4. Generating tones. Mostek's tone-dialer, the MK5085, is typical of these chips that generate tone pairs for dual-tone multifrequency telephone dialing. The chip, powered directly from the telephone line, works with present telephone keyboard assemblies.

and back in PCM and delta-modulation systems.

- Frequency-synthesizer chips that generate carrier frequencies to transmit hundreds of telephone signals simultaneously in frequency-division-multiplexed trunks, microwave links, and the like.
- Analog compandor chips to improve the signal-to-noise ratio on telephone lines or trunks.
- Modulator/demodulator chips that frequency-multiplex several conversations onto a single telephone line.
- Programmable interface chips for data-communications applications.

There are chips in varying stages of development for each of these functions, from several companies.

From push button to dialing pulse

The first LSI chip to find its way inside the telephone is the pulse dialer, also known as the key pulser. Stored in memory are the dial pulses equivalent to the push-button inputs. These signals are pulsed out to the rotary-dial telephone exchange when the user punches in the number he is calling.

A typical pulse dialer chip from American Microsystems Inc., Santa Clara, Calif. is shown in Fig. 2. National, Motorola, and General Instrument Corp. have similar chips on the market, and Mostek will have one available soon. In Germany, ITT's Standard Electrik-Lorenz AG has developed a custom LSI circuit for its Quickstep button-to-dial pulse telephone.

Adding extra memory to these chips can provide an automatic redial feature. The memory stores the last number dialed, and the caller need only punch a single button to redial. If he or she has a Touch-a-matic phone from AT&T or an Instafone from Great Britain's Pye TMC Ltd., it is possible to store many frequently called numbers. The Instafone will work anywhere in the world and is one of two automatic-signalling button-to-dial-pulse sets that Pye is building around its custom MOS LSI circuit [*Electronics*, March 31, p. 55]. The other is the 47-number Multicall telephone for businesses. The British Post Office is planning customer trials of 1,500 Instafones, to be priced at under $150 each, and 2,000 Multicall units, to be priced at under $400.

Simplifying the pushbutton operation

In the long run, all telephone exchanges will handle the dual-tone multifrequency signals from push-button phones, so the extremely complex Touch-Tone assembly is another good candidate for LSI replacement. Extensive cost-reduction work has still left a discrete package that requires considerable assembly and tuning time. For example, the two large coils each have four windings that must be burned in and tuned by hand. All the components must be assembled on a board and interconnected with the keyboard assembly.

Replacing this circuit with an LSI chip (Fig. 3) is no easy task. To eliminate the LC oscillator, the sinusoidal frequencies must be synthesized digitally to an accuracy within 1.25%, and the resulting total harmonic distortion must be less than the telephone companies' worst-case specification of 10%. The signal level must remain constant over the 3.5-to-13.5-volt range that can exist at the telephone.

The chips developed assure proper functioning even on long subscriber loops when the voltage drops to 3 V or so. Moreover, they will work with an inexpensive calculator keyboard by performing many of the switching functions in logic rather than by metallic contacts.

One of the first tone-dialer chips came from Mostek Corp., Carrollton, Texas. The single chip (Fig. 4) provides tone generation and all the necessary keyboard logic. Bipolar and MOS transistors, all formed by the C-MOS process, implement high-speed digital circuits, an operational amplifier, and two complete digital-to-analog converters. Ion-implanted resistor-ladder net-

works are used to avoid costly trimming procedures in production.

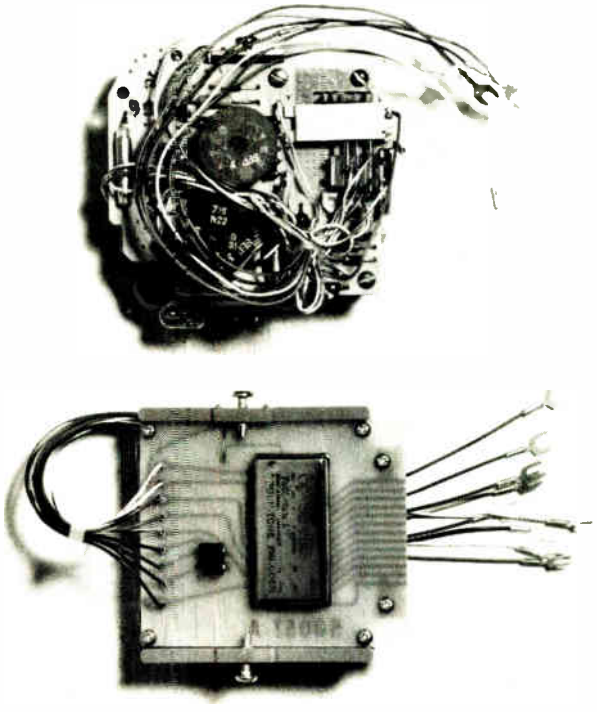
The chip has an inexpensive off-chip 3.58-megahertz crystal (the same as in color-television sets) for reference, which is divided down to obtain the audio frequencies. On the chip, the op amp performs current-to-voltage conversion and sums the two sine waves to produce the tone pairs representing each number on the keyboard. The low-distortion digitally synthesized sine waves need no external filtering.

A low-impedance bipolar buffer/amplifier is capable of driving telephone lines. An external silicon diode bridge avoids damage to the IC when the voltage polarity from the central office reverses—a common occurrence in the telephone network.

Mostek estimates its MK5085/6 costs half of its electromechanical equivalent. System economy stems from integration of all system functions on a single LSI chip, thus requiring few external components. Both tone dialers work with conventional telephone keyboards; the 5086 lends itself to machine-addressed inputs from automatic dialers and microprocessors.

Other tone dialers available include the AY-3-9400/10 from General Instrument, the S2559 from AMI, the ICM 7206 from Intersil, the MC14410 from Motorola Semiconductor, the MM5395 from National, and a chip from Texas Instruments.

A unit that replaces the entire Touch-Tone assembly comes from Telenetics, Newport Beach, Calif. (Fig. 5). Its keyboard assembly combines a p-channel MOS chip for digital timing and tone generation with hybrid thick-film circuitry for the analog interface in a 32-pin dual in-line package. The diode bridge for reverse-polarity protection is off chip. The unit, the model 7603, can handle inputs from keyboards, from hardwired program sequences that turn it into an automatic dialer, and from random-access memories, read-only memories, and programmable ROMs associated with repertory dialers and similar setups.



5. Tone signalling. Telenetic's tone dialer, (the 7603, mounted on the firm's keyboard assembly) generates DTMF signals from several input formats: a standard keyboard, a semiconductor memory, or hardwired 4- or 8-digit numbers sent on command.

Other chips detect tones

As well as generating dual-tone multifrequencies, telephone networks must be able to detect them. And DTMF receivers in central offices, PBXs, and keyphones, as well as in mobile radio systems and computer signaling and control systems, are good candidates for LSI tone-detector chips. Receivers using discrete components cost from $250 to $500 and are constructed on pc boards that include several analog filters, automatic-gain-control circuitry, and tone detectors.

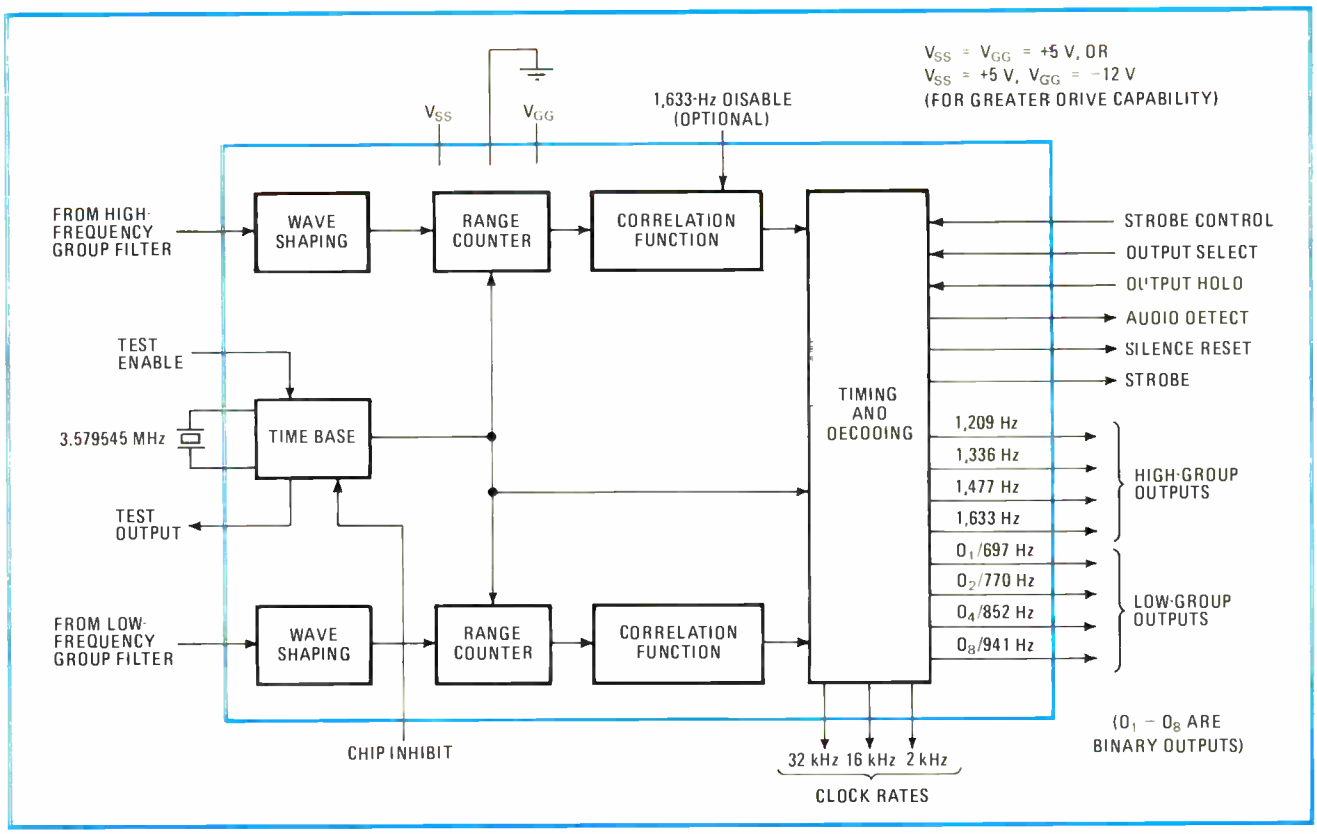
The detector must recognize the tone pairs representing each punched-in number within a certain bandwidth, while tolerating dial-tone noise and input-amplitude variation or amplitude differential between the two tones. Then it produces a 2-of-7-, 2-of-8-, or binary-coded data output indicating the presence of a valid tone. It also must comply with such telephone-company specifications as meeting the timing restrictions inherent in the process of generating DTMFs.

One of the first tone-detector chips on the market that eliminated many of the required components was the CRC 8030 from Collins Radio's Commercial Telecommunications division, Newport Beach, Calif. Implemented with a p-channel MOS ion-implanted process, the chip is hermetically sealed into a 28-pin ceramic DIP. It accepts filtered and shaped DTMF signals and converts them to binary- or 2-of-8-coded data. A complete DTMF receiver requires a filter/limiter along with the tone-detector chips.

As is typical of such circuits, the 8030 includes time-base generation, wave shaping, range counters with correlation circuitry, and output timing and decoding functions (Fig. 6). The characteristics of the necessary front-end filter must be geared to the performance of the system. For high-quality central-office detectors, a highly selective filter is needed; for the low-noise environment of subscriber equipment, less stringent filtering is acceptable.

Among the other semiconductor makers with tone-detector chips is Mostek, which is readying the C-MOS MK5102N that requires only a single supply ranging from 4.5 to 10 v. Some of General Instrument's AY-5-9800 series meet the filtering requirement with on-chip op amps coupled with external resistors and capacitors (Fig. 7). All versions have on-chip registers allowing designers to program the number of cycles of the incoming waveform that must be analyzed to determine if a valid signal tone has been received.

Significant savings in power consumption, as well as greatly improved reliability and performance, is the



6. Detecting tones. Collins CRC 8030 DTMF detector includes time-base, wave shaping and correlation circuitry, as well as output timing and decoding functions to convert high and low group-filtered frequencies into binary data or 2-of-8 coded data.

boast of the PCM repeater chip. Pulse-code-modulation repeaters are used every few thousand feet in telephone lines to reshape and retime voice-frequency signals transmitted digitally. The regenerated pulse drives the next section of the line.

A monolithic repeater chip from Exar Integrated Systems Inc., Sunnyvale, Calif., replaces about 90% of the electronic components and circuitry in a discrete repeater and operates over a temperature range of −40°C to 85°C. Two chips are required for bidirectional operation.

The initial chip, the XR240, does the basic job very well, says Alan Grebene, vice president of engineering at Exar. But most of the equipment suppliers asked for modifications they felt were necessary to meet Bell specifications. So Exar developed the XR277, which incorporates the various modifications, as well as drawing less power—12 milliamperes at 6 v instead of 13.5 mA at 8 v. The reduced power is important to designers of repeater equipment because Bell has been pushing for low-power repeaters to cut demand on the central-office power supply. A new version on the drawing board will operate with lower s/n ratios at the repeater input, thus allowing greater space between the repeaters while assuring the same bit-error rate at the output.

Codecs are coming

The key to a fully digital phone network is the coder/decoder that converts analog voice to digital code and at the other end reconverts the coded bit stream back into voice signals. Using upwards of 200 discrete components handwired onto a couple of relatively large pc boards, codecs are expensive.

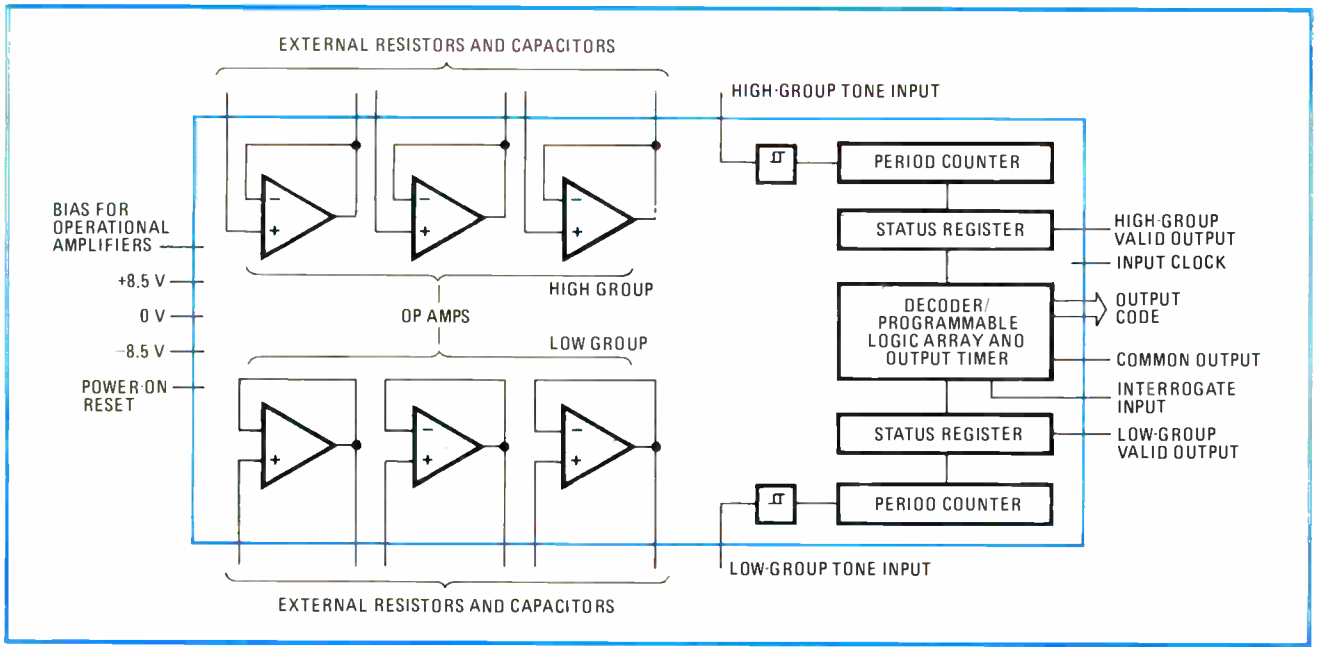
To cut costs, phone companies have shared a single high-speed analog-to-digital and d-a converter among many telephone lines. But the cost is still high. Equipment designers would replace the single expensive codec if LSI codec chips were cheap enough to use on every telephone line with multiplexing of the resulting digital bit streams. The analog multiplexers could then be replaced with simpler, cheaper digital chips that are much less bothered by crosstalk.

Either a logarithmically companded PCM or a form of delta modulation can generate the digital codes used in telephone systems. The log-PCM circuits perform instantaneous companding in a time-invariant nonlinear process, while adaptive-delta-modulation circuits perform syllabic companding, a kind of automatic gain control that essentially is a time-varying linear signal processing.

The 32-kilobit-per-second sampling rate of ADM would seem to make it more attractive for voice digitizing than the 64-kb/s rate of PCM. But all over the world, PCM is firmly entrenched in telephone networks—and it is better for data signals.

However, ADM's efficiency, economical implementation, and lower idle-channel noise make it attractive in other applications such as military communications systems, mobile telephones, and some satellite channels.

A few companies, among them Motorola, Harris Semiconductor, Melbourne, Fla. and Consumer Microcircuits of America, Galesburg, Ill., have monolithic



7. Tone receiver. Adding external resistors and capacitors to those models with on-chip op-amps in General Instrument's AY-5-9800 series of multifrequency tone receiver devices provides active filters to separate low-group and high-group tones.

versions of ADM codecs. But at least a dozen other semiconductor manufacturers have PCM codecs that are in varying stages of readiness.

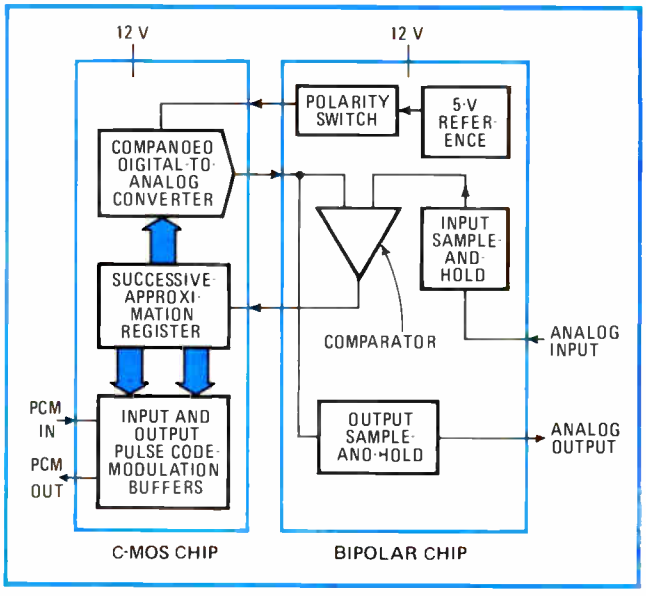
Precision Monolithics Inc., Santa Clara, Calif., the first company with a monolithic companded d-a converter on the market, is adding the circuitry such as sample-and-hold and control circuits necessary to turn its Comdac into a full-blown codec. Other semiconductor firms, such as National, Siliconix, Signetics, Intel, AMI, Exar, Motorola, Fairchild, Raytheon, General Instrument, AMD, and Telenetics have LSI codecs in various stages of development. Of the several telephone companies working on codecs, Bell Northern Research has the most sophisticated device of all under test in its laboratories. It is a one-chip codec that includes charge-coupled filters.

Different designs

Instead of two on-chip converters, National's two-chip codec shares a single d-a converter between code and decode functions (Fig. 8). Since the a-d conversion always takes longer, it is continuous until d-a conversion is necessary. Then an interrupt takes place, and the a-d information is stored in memory until the d-a conversion is quickly accomplished.

The codec contains all the elements for converting one channel of voice input to standard 8-bit PCM and back to voice. It has a companded d-a converter and a successive-approximation register that makes it possible for the converter to perform the a-d encode function.

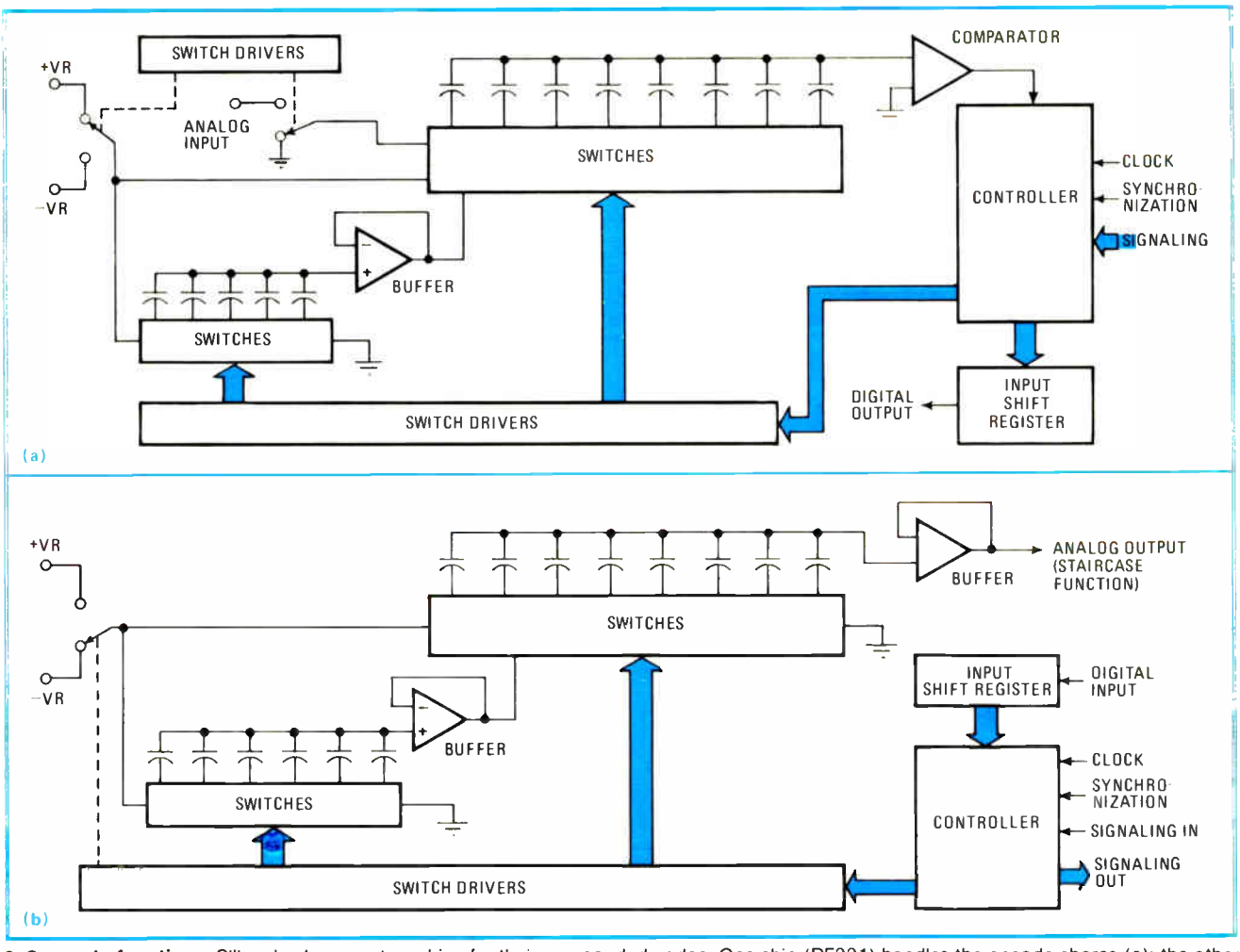
The National codec will directly generate a companding code that meets either the μ255 standard used in the U. S., Canada, Japan, and some South American countries, or the A-law standard used in the rest of the world. The μ255 standard calls for compressing the input signal according to a piecewise linear approximation of a logarithmic relationship where μ is the companding coefficient in the log equation used. The similar A-law standard uses a slightly different companding coefficient.



8. Shared. National's two-chip PCM companded codec—a 24-pin C-MOS DIP, and an 18-pin bipolar DIP—shares a d-a converter between encode and decode functions. A successive-approximation register is used with the d-a converter to perform the a-d encode.

Of the two National chips, the MM48100 is C-MOS, and the LM2700 is bipolar. The C-MOS chip has high-speed input and output buffers that allow the PCM words to be transmitted or received as a burst at any rate from 64 to 2,048 kb/s.

The bipolar analog chip has input and output sample-and-hold circuits, a precision 5-V reference, a polarity switch that converts the reference voltage to +5 V or −5 V depending on the most significant bit, a comparator, and an autozero function that eliminates drift. The zero



9. Separate functions. Siliconix also uses two chips for their companded codec. One chip (DF331) handles the encode chores (a); the other chip (DF332) does the decoding (b). Each works independently and can function at either North American or European sampling rates.

point of the d-a transfer can be shifted by temperature-induced drift, and eventually increased noise will result.

Other than power-supply-decoupling parts, the National codec requires only four external components. The sample-and-hold-circuit has two 100-picofarad and a 0.1-microfarad capacitors and a 1-megohm resistor in the autozero filter. The codec can operate in a range of ±8 v to ±12 v with a typical dissipation of 150 milliwatts at 8 v.

Other codecs

A two-chip C-MOS codec that requires no external components except for input and output filters is available from Siliconix Inc., Santa Clara, Calif. The DF331 encoder (Fig. 9a) and the DF332 decoder (Fig. 9b) work independently of one another and can function at the North American 8-kilohertz sampling rate or the European 16-kHz rate.

A single-chip codec from Signetics Corp., Sunnyvale, Calif., is implemented with integrated injection logic. The breadboard version (Fig. 10) of the ST100 uses several ICs on a pc board and has already been checked out by major telecommunications-equipment makers. Samples of the 24-pin DIP version using I^2L technology will be available later this year, with pricing of $6 each in 100,000-piece quantities expected.

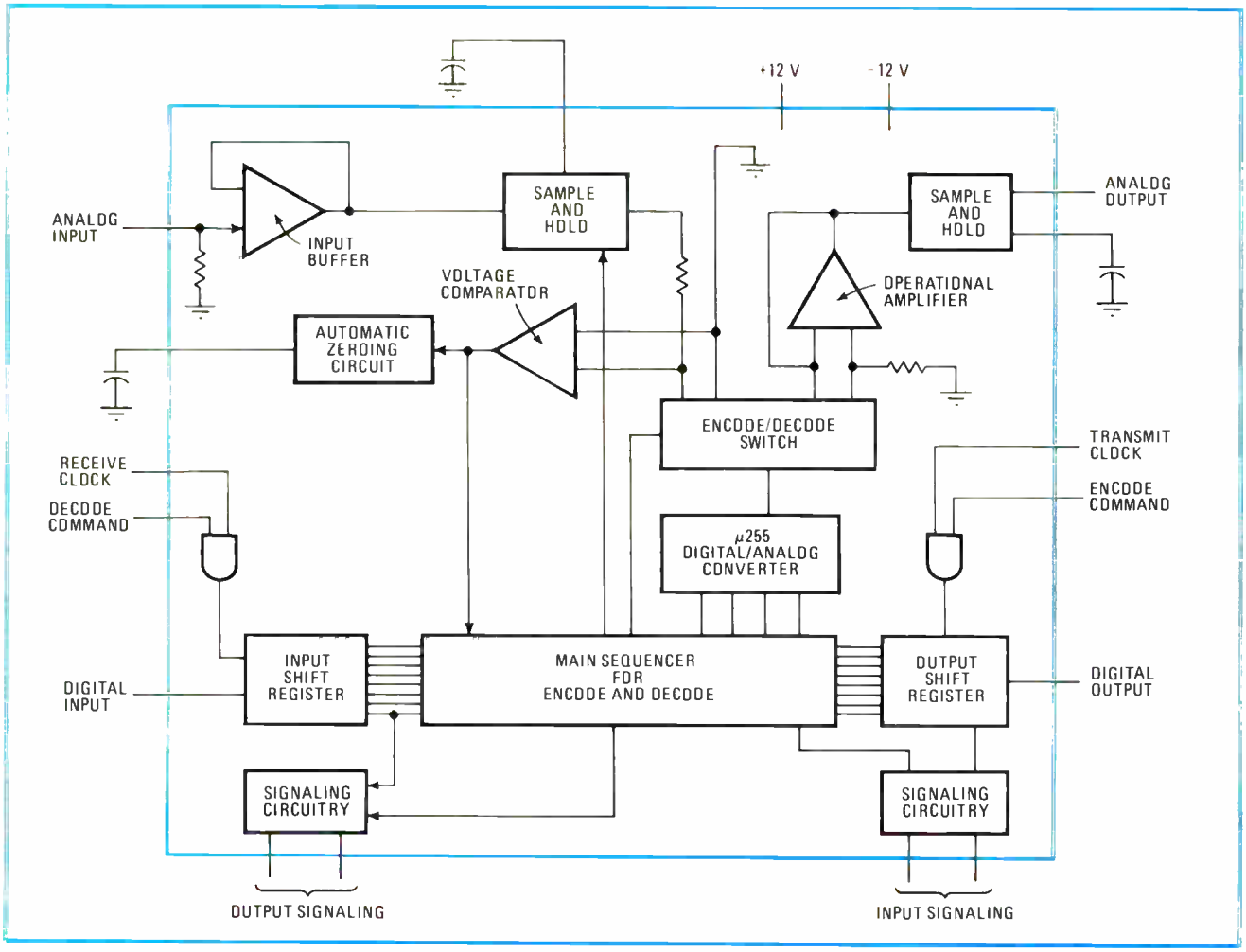
A similar single-chip C-MOS codec for both μ255 and A-law companded 8-bit PCM systems is due from Motorola Inc.'s Semiconductor Products Group, Phoenix, Ariz. Scheduled for samples late this year, the chip will accommodate one full-duplex channel (Fig. 11). With a simple C-MOS transmission gate selector it will service two full-duplex channels, and it may be configured to decode four channels simultaneously.

The chip houses three op amps, a μ255 or A-law current-steered d-a converter, input and output sample-and-hold circuits that require two nonprecision external capacitors, and all the digital interfacing needed for the various standard PCM frame formats.

The 24-pin device uses the successive-approximation technique in the a-d conversion and will time-share the d-a converter for decoding serial digital words. It also has autozeroing.

A codec using charge-redistribution techniques with MOS capacitive voltage dividers to implement both d-a and a-d conversion and companding is coming from AMI. The firm's designers may even make the code pin programmable for either μ255 or A-law companding.

Industry sources expect Intel Corp., Santa Clara, Calif., soon to introduce an n-channel MOS single-chip



10. Single-chip sharing. Signetic's single-chip companded codec, the ST100, timeshares a digital-to-analog converter between code and decode functions. The I²L chip can operate at clock rates as high as 2 MHz and is capable of asynchronous operation on transmit and receive.

codec with some on-chip filtering. Also on the chip is circuitry allocating time slots or receiving control inputs from a microprocessor when the codec is shared among many telephone lines.

Low-cost filtering, such as an on-chip filter, is essential to the success of LSI codecs, because telephone companies say they need a $2 codec plus filter to make it economically feasible to install a unit in each telephone. Right now semiconductor makers are considering pricing codec chips without filters at something under $10 in large quantities, and some active filters cost about $7 in large quantities.

Two filters

Codecs require two filters. A low-pass filter on the analog output gets rid of high-frequency noise and may smooth the reconstructed voice signals with minimal distortion. At the digital input, an aliasing filter removes any spurious high-frequency signals that might get translated down to the lower voice frequencies, thus causing intermodulation problems.

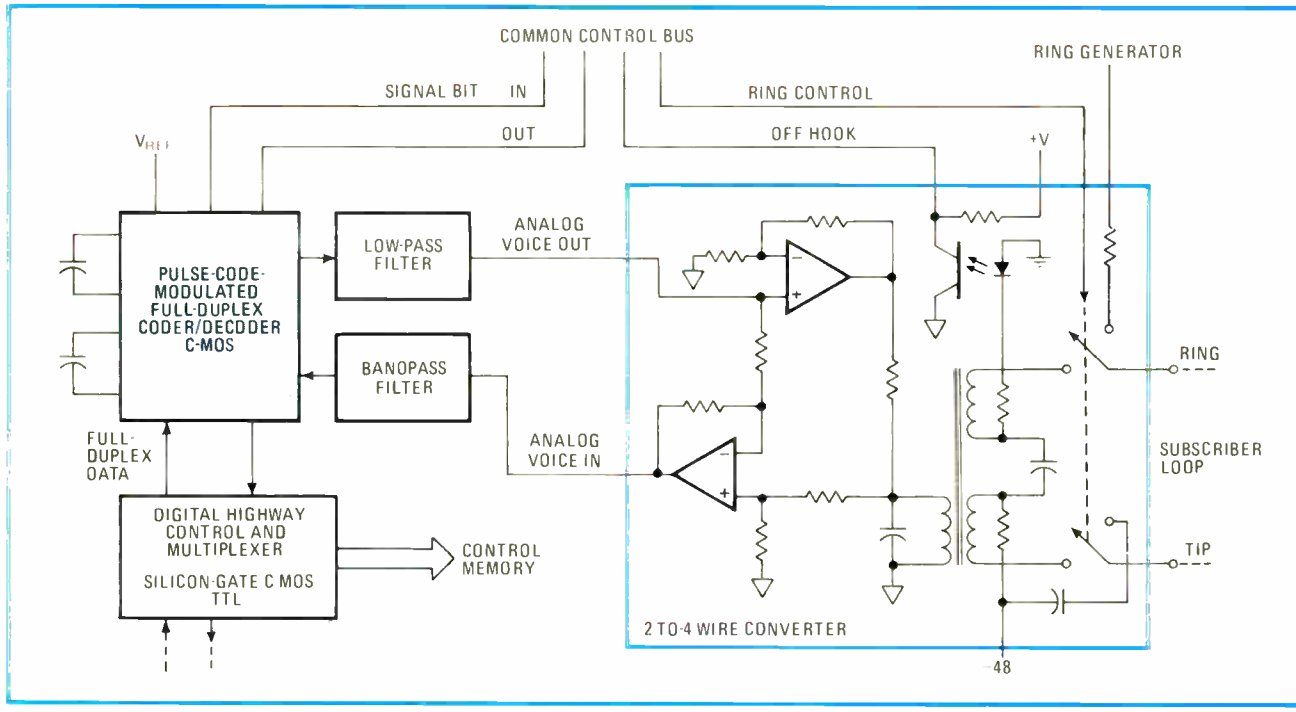
Active filters—op amps plus resistors and capacitors—are one solution, if large-volume production is possible. The many requirements for different center frequencies, bandwidths, and the like have worked against standardization, but in the telephone industry these parameters are fixed. So the semiconductor firms are taking a new interest in active filters—National and GI, among others, have models on the market.

Signetics is developing an active filter using I²L technology and ion implantation to maintain the tight tolerances required to eliminate costly trimming of on-chip monolithic resistors. Small capacitors outboard of the chip will still be needed.

Another possibility is the hybrid approach that Bell Labs is investigating. The device under development uses monolithic op amps, chip capacitors, and thin-film laser-trimmed resistors.

However, some industry observers think a technology breakthrough is necessary to crack the filter price barrier. Perhaps closest to this goal is Bell Northern Research with its single-chip codec companding incorporating charge-coupled devices for the necessary filters. A BNR spokesman predicts that these one-chip devices will be commonplace in competitive digital-switching systems by the early 1980s.

The costly filters in the transmission part of the phone network are another target for semi houses. In frequency-division-multiplexing equipment, frequency-synthesizer chips are generating the transmission



11. Per-channel codec loop. Motorola's C-MOS codec will accommodate one channel of full-duplex operation. With a simple C-MOS transmission gate selector, it will handle two full-duplex channels. It may also be configured to decode 4 channels simultaneously.

frequencies accurately enough so that filter banks are not necessary.

The Signetics 8X08 80-MHz chip is a typical example. It can generate as many as 1,999 frequency channels from a single crystal-controlled oscillator. It combines emitter-coupled logic and low-power Schottky TTL on the same substrate to implement counters, phase detector, reference oscillator, and programmable divider chain.

An LSI chip geared for analog telephone applications is the monolithic compandor. The analog equivalent of the codec, it expands and compresses voice signals to improve the s/n ratio. Exar's XR2216 and Signetics' 570 for trunks and 571 for single lines are typical compandor chips.

Also for analog systems is the modulator/demodulator chip that functions as a transmitter and receiver. A modem is essentially an a-m carrier system for frequency-multiplexing several conversations onto a single telephone line.

National has developed a two-chip FDM modem, the LM1823/6 that translates several voice frequencies simultaneously to some frequency between 20 kHz and several hundred kilohertz. Translation back to voice takes place at the other end of the transmission line.

In spite of the long-term trend toward digital phone systems, there probably is a good market for compandor and modem chips in existing analog equipment, which accounts for better than 80% of today's telephone network. Recent legislation encourages more one-party lines in rural communities, and these analog chips will help make them possible at least cost.

Just as in voice transmission, LSI is beginning to provide designers of data-communications equipment with powerful new chips. The chips will bring similar advantages, but the emphasis is on programmability.

The density of LSI shrinks the size, power, and cost of existing hardware, while programmable operation permits the same part to be used as a standard component throughout the system. Adaptability is another important benefit of programmability. Changes in baud rates, character lengths, error checking, and protocols can be accommodated through software configuration. Redesign time and cost are reduced significantly, and product life is improved.

Focus on data communications

Typical of the new LSI chips tailored for data-communications equipment are two programmable serial-communication circuits from Signetics. The 2651 PCI is a programmable communications interface; the 2652 MPCC is a multiprotocol communications controller.

The 2651 PCI combines the functions of a universal synchronous asynchronous receiver/transmitter with those of a baud-gate generator in a 28-pin DIP. The MOS chip is fully compatible with TTL, does not require a system clock, and operates from a single 5-V supply. A straightforward addressing scheme makes it compatible with most 8-bit microprocessors.

The chip greatly reduces hardware requirements and software overhead in modems, particularly for character- or byte-controlled protocols such as Digital Equipment Corp.'s DDCMP and IBM's Bisync. Its self-test capabilities can pinpoint failures in the processor-communications interface, in the modem, or in the communications channel—either locally or remotely.

The 2652 MPCC can receive, format, and transmit serial digital data in bit-oriented protocols such as IBM's SDLC (synchronous data-link control). Its ability to manage these protocols minimizes software-control requirements and program-development time. In a 40-

pin DIP, it can replace as many as two pc boards full of components.

The chip operates at speeds as high as 500 kb/s from a single 5-V power supply and is fully compatible with TTL circuits. Both receiver and transmitter sections are double-buffered and operate in half- or full-duplex modes. The 2652 can interface with an 8- or 16-bit data bus, which makes it compatible with minicomputer and microcomputer systems.

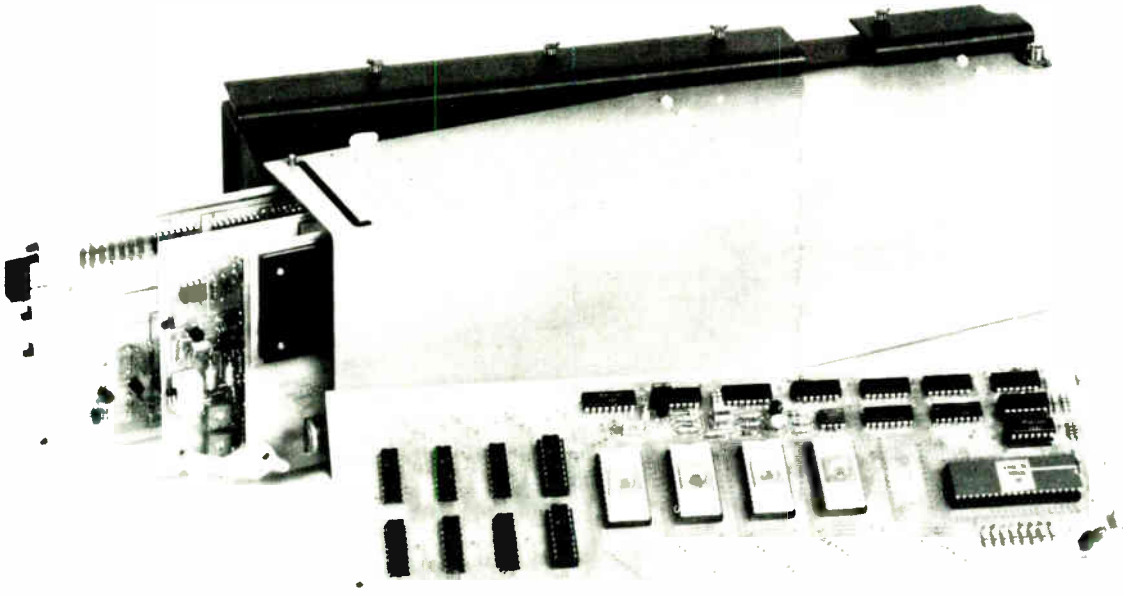
System designers put LSI to work

Equipment designers have already seized upon LSI circuits as the solution to many of their problems. As well as those chips already described that are in production, engineers are using semiconductor memory for storage needs in central-exchange offices and PBXs.

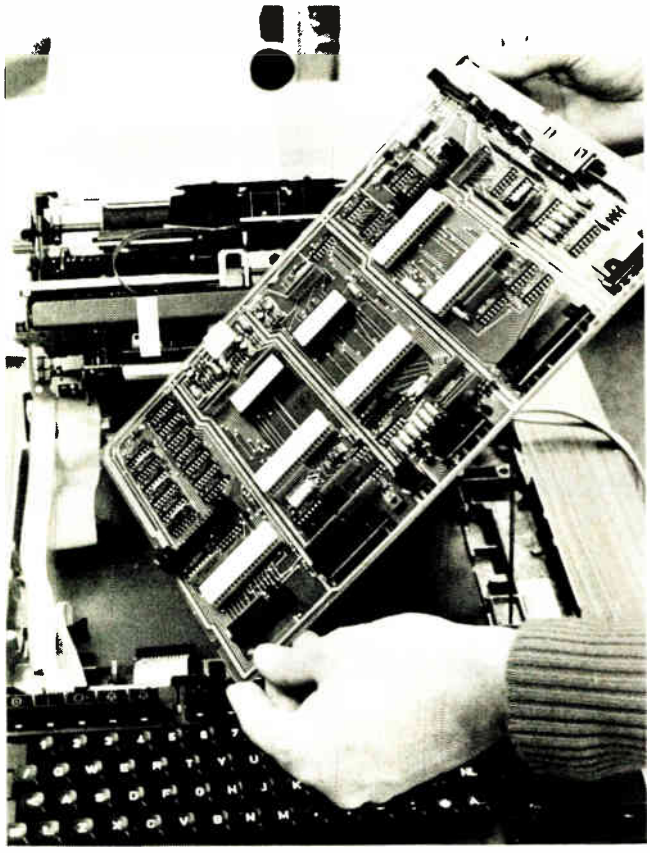
Microprocessors, custom logic, and timing chips are enhancing performance without adding much cost and are permitting updating and customizing of installed equipment through software changes. They are serving in sophisticated digital switching systems that route calls and data throughout the telephone network, and in PBXs and keyphone systems. In intelligent data terminals, they are being used for code conversion, transmission-error detection and correction, and data formatting. In telephone central offices, they are upgrading equipment to provide faster more versatile service.

An early example of LSI use was the CBX, an all-electronic computer-controlled PBX that Rolm Corp., Santa Clara, Calif., introduced in 1975. In addition to

13. User's choice. The custom LSI digital timing chip in the hand forms the heart of two Collins Radio single-frequency signaling units: the "piggy-back" version (lower left) that plugs directly into a Collins channel multiplex modem, and the stand-alone version directly behind. Above the stand-alone version is its Collins predecessor that updated the Western Electric signaling module (top).



12. Flexible dialer. The four printed-circuit cards of the speed-tone dialer can be programmed to provide other functions as well. The controller card in front houses a 6800 microprocessor, four PROMs, and two C-MOS RAMs with additional sockets on board for six more.



14. LSI shrinks size. Siemens' Teleprinter, model 1000, is built around seven MOS circuits. Custom-designed chips are used because standard, commercially available circuits would require considerably more peripheral components.

using much semiconductor memory for software implementation of formerly hard-wired functions, the system has an LSI-implemented module for self-testing, changing extension numbers and similar functions through remote software programming. CBX uses a shared-codec approach, but Rolm's designers envision per-channel LSI codecs with on-chip filtering in the long run.

One LSI chip in the module is the Collins CRC 8030 tone detector in the DTMF receiver board. Rolm's product plans feature microprocessor use in some desk telephones for special call routing and the like, in trunk interfaces for critical timing functions, and to lighten the load of the central processing units, thus permitting use of less powerful gear there.

The microprocessors on which Rolm has settled are Intel's 8080 and 8085. However, the designers are concerned because there is no licensed second source for these devices. "Others have copied the chip, but, like RAMS, microprocessor chips have pattern dependencies, and each manufacturer's chip is likely to be different," says James Kasson, engineering manager of Rolm's telecommunications division.

Microprocessors control the 580 digital switching system from Wescom Inc., Downers Grove, Ill., providing a single software package that meets the varied requirements of most telephone companies. Six 8080s in a distributed-processing configuration control the system. Each processor has its own memory unit, which means the setup is inexpensive to interface, simple to program, and easy to maintain.

The Vidar division of TRW in Palo Alto, Calif., also takes advantage of low-cost LSI circuits in its new integrated digital switching system to distribute the processing load among various system elements instead of having a single large controller handle it all. The system, IMA2, was designed to meet telephone-company transmission and switching needs in rural exchanges. As well as integrating the standard functions, it provides automatic message accounting.

Let the software do it

The distributed processing permitted Vidar to use 8080 microprocessors and LSI memory. Digital words representing all the tones needed in a telephone office (dial, ring-back, and the like) are stored in a nonvolatile ROM and are converted to audio tones in a d-a converter upon command. The controlling unit is an 8080 with its programs and data stored in a 4,096-bit RAM and with a magnetic-tape cartridge for program backup. The switching function also uses LSI memory.

The high reliability demands of telephone systems means that faults must be detected quickly and redundant devices switched in without human intervention. The standard approach is to use two large computers with their outputs compared to determine a fault. Since 30% to 40% of the system software must be set aside just for self-test routines, each controller must have sufficient capacity for that as well as for the switching.

Vidar's new switching system uses a primary and secondary controller setup, with two microprocessors and comparator circuitry in both the primary and secondary systems. The two processors in each controller run in parallel. The outputs are compared, and any difference results in control being switched to the other system. Eliminated is the need to test for the faulty processor in the primary system. Since the processors need not perform self-diagnosis, they can be simpler devices than is necessary in the standard approach. Vidar's approach was made possible by low-cost microprocessors, LSI circuits, and some innovative software programming.

Other equipment manufacturers are taking advantage of the microprocessor's ability to handle program changes easily through software, even after the design is finalized. For example, Mitel Corp., Ottawa, Canada, uses Motorola 6800 microprocessors and LSI circuitry through several orders of system complexity.

The simplest kinds of these microprocessor-based products are used on a single line; for example, the CM8300 speed-tone dialer in Fig. 12 can be programmed not only to speed-dial numbers on a 2-digit command but to store as many as 90 16-digit telephone numbers for quick automatic dialing. With a slight modification, the 8300 will allow computers to automatically call one another when data transfer is required. Terry Matthews, the firm's executive vice president, says that simply adding more LSI chips to one of the four common pc cards can provide an updated or entirely new dialer without excessive redesign time or high cost.

Often the microprocessor's power is not necessary, and equipment designers are using other LSI circuits to take

over some of the functions of existing equipment they are updating. Typical of this approach is the recently developed in-band signalling board that snaps onto an existing section of a modem on a pc board (Fig. 13) from Rockwell International's Collins Radio Group, Dallas. It uses a custom LSI circuit manufactured by the firm's Newport Beach, Calif., facility. The circuit provides the timing control for transmitting and receiving and digitally reshapes incoming pulses.

With such a relatively low-cost retrofit, phone companies can pick up the advantages of in-band signalling, which eliminates two of the six wires required for each telephone line going to a central office. The reshaping of incoming pulses also means that marginal trunk performance may be improved.

A custom chip, developed with Exar, appears in a direction-detector subassembly from Lorain Products Corp., Lorain, Ohio. The firm puts the subassembly in its voice-frequency switched-gain PCM repeater module for two-wire telephone lines. From the existing hybrid subassembly, designers developed a discrete version, then a two-chip semicustom version, and finally the custom version. Frederick J. Kiko, the firm's manager of transmission research and development, says the full-custom subassembly needs no resistor array or field-effect-transistor switches, as did the semi-custom model. Moreover, it costs only an eighth of the hybrid version.

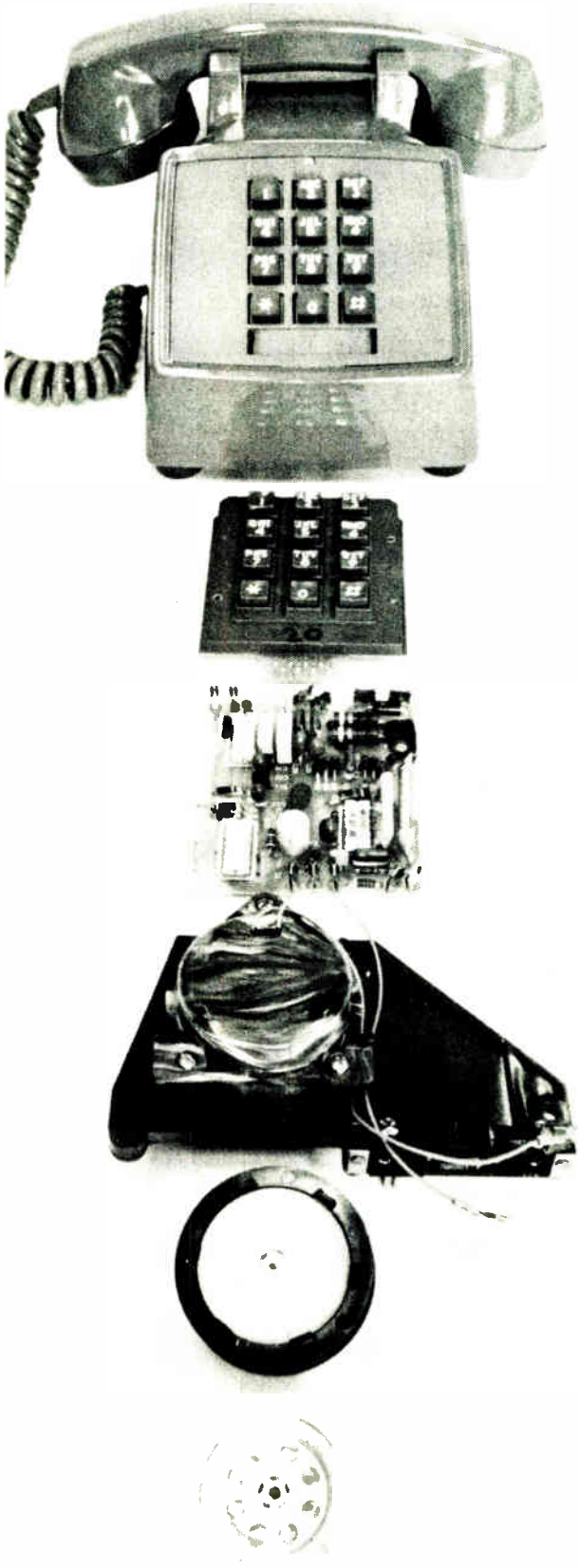
In Europe, LSI is helping teletypewriter designers shrink size by two thirds. It considerably reduces the number of moving parts, which improves reliability and cuts noise levels to less than one quarter the level of conventional electromechanical teletypewriters.

The new machines are coming from Siemens AG and Standard Electrik-Lorenz, both in Germany, and from Philips Gloeilampenfabrieken in the Netherlands. The Siemens Teleprinter 1000 is built around seven custom MOS circuits (Fig. 14). Hans Helmrich, a director of Siemens' communications division, says that these LSI circuits have made possible functions that would be expensive and space-consuming if implemented by conventional techniques. A further advantage is a considerable reduction in assembly costs, he says.

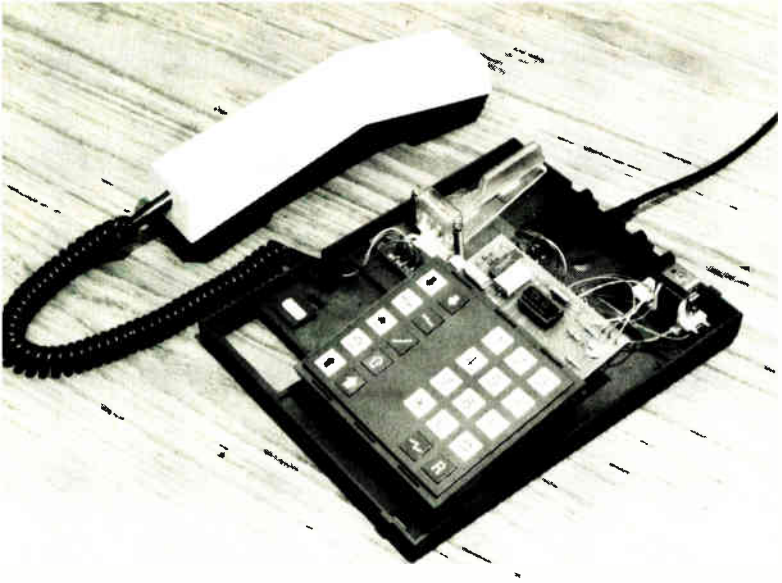
The Philips teletypewriters can serve as programmed all-purpose communication terminals for telex and telegraph use and for data communications. Like the Siemens machine, the microprocessor-controlled terminal is smaller and quieter and has fewer moving parts.

Transforming the telephone

The most apparent revolution that LSI will bring to the telephone system will be the changes in what the telephone will look and what it can do. Several telephone companies, both in the U. S. and abroad, are working on LSI replacements for the electromechanical innards of the standard telephone. The aim is to include everything: the 2-to-4-wire hybrid transformer, the bell ringer, the carbon microphone, the receiver, and the dialpad



15. Electronic telephone. This set, undergoing trials in Canada, consists of (top to bottom) a conventional chassis, a calculator-type keyboard, a 3-chip solid-state circuit pack (to be replaced with a single I^2L LSI circuit), a tone ringer, a transmitter, and a receiver.



16. New generation. The key telephone, above, is part of GTE's new ATEA-8000 electronic business telephone system that incorporates several LSI chips designed in Belgium using computer-aided design tools worked out by GTE Labs, Waltham, Mass.

keyboard assembly. In Great Britain, ITT's Standard Telecommunications Laboratories is developing an LSI chip using standard buried-collector linear technology for a fully electronic operation in a standard chassis. But in Canada, BNR has 200 telephones already in field trial that have three-chip packages (Fig. 15). The phones combine a calculator-type keyboard with the three ICs. Under development is a single I²L chip that will replace all three chips.

The real advantage of LSI for phone innards is the extra features it will permit in new models and retrofitted standard units. Of course, the chips' small size signals an eventual wholesale redesign of the telephones.

Still, there is no general agreement on a time-table for the all-electronic telephone. Some observers predict it will appear in the telephone network within several years. At the other extreme, some think it will never go into widespread use. The telephone is the common denominator in any telecommunications system, and changing even a screw is a momentous event, says Mitel's Terry Matthews. This fact of life, coupled with the telephone's harsh operating environment, will hinder acceptance of electronic phones.

However, telephone manufacturers around the world are offering phones with calculator-type keyboards and tone-dialer and repertory-dialer chips. Besides Pye's Instaphone and Multicall and Bell's Touch-a-matic and new keyphones, there are ITT's Quickstep, the Digitone from Bell Canada's Northern Telecom Ltd., and GTE's new generation of electronic business-telephone systems, the ATEA-8000 (Fig. 16). An AT&T spokesman predicts that by the early 1980s, LSI circuits will appear widely in the company's PBX and keyphone systems—which currently are less than 1% electronic models.

Various equipment makers are marketing telephones with similar features directly to the consumer. Since LSI makes such features as repertory dialing an economic reality, more and more products are showing up. While the market is small, it could grow in light of recent rulings by the Federal Communications Commission that make it easier to plug such equipment directly into the telephone network. The big question that remains is whether consumers will be willing to pay for the conveniences the new equipment offers.

What's ahead

The trend toward microprocessing techniques in all phases of telecommunications is already under way, and with the increasing availability of LSI chips aimed at communications chores, rapid acceleration is a certainty. The list of LSI applications will grow to cover everything from pocket phones to satellites. As more digital exchanges go into place, emphasis will be put on using low-cost codecs and filters for individual phones, thus completing the last link in a fully digital network.

Telephones seem destined for other changes, as well. "LSI is showing that you might bring the computer into a man's home with a TV-telephone-modem-computer combination," says John Shields, an ITT-Europe vice president. "LSI chips are making it possible for telecommunications to interact in new ways with the consumer."

It is not difficult to imagine the sophisticated telephone of the future with a DTMF receiver and control circuitry enabling the user to dial his or her home number and use more tone signals to get the phone to go off-hook electrically and to execute various commands. A phone call could turn lights on or off, regulate the thermostat, or start the oven.

With the telephone and a low-cost LSI-implemented intelligent terminal, a user could gain access to a computer in a library or other central location and receive information via the telephone line. In like manner, a salesman with a portable tone generator could quickly send information to a central computer. With a small visual receiving device, the salesman could acquire information instantaneously from the computer via tone signalling over telephone lines. Today, small portable cathode-ray-tube terminals with built-in modems serve this function, but for simple data transfer, the tone-receiver chip could cut costs drastically.

Utilities could automatically read gas and electric meters via the telephone network. Other service companies could obtain similar data. For example, American Subscription Television of Los Angeles will be sending scrambled TV programming over Channel 22 and then automatically bill subscribers for programs viewed by tying the leased home TV decoder to a central computer via the telephone network. Standard Microsystems Inc., Hauppauge, N.Y., is already building the LSI chips needed under a contract with Clarion Corp., a major Japanese manufacturer of electronic equipment.

A final area of telecommunications that will rely on LSI circuits and microprocessors is the rapidly developing field of teleprocessing—data communications, Picturephones, and the like. The output of almost all data-processing equipment requires additional processing before transmission over the phone network. Moreover, the need to protect communicated data is creating a new family of LSI encryption/decryption chips. □

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Circle 109 on reader service card 109

Sample-and-hold and op amp form special differentiator

by John Nolte
University of Colorado Medical Center, Denver, Colo.

A sample-and-hold module and an operational amplifier can form a differentiator circuit that is especially useful at very low frequencies. In both accuracy and noise immunity it leaves conventional differentiators far behind, even when they are built with highest-quality components, i.e. low-drift, high-input-impedance amplifiers and high-value, low-leakage capacitors.

High-frequency noise, which can upset the operation of the common RC differentiator, is no problem with this "digital" circuit because its gain is independent of the noise frequency. In addition, its frequency of operation is set simply by adjustment of the sampling frequency. The circuit is therefore capable of a wide frequency response, quite unlike its analog counterpart, in which the components selected to reduce high-frequency noise also narrow the frequency response.

In essence, this circuit solves the equation for the slope of a line. The equation may be expressed as:

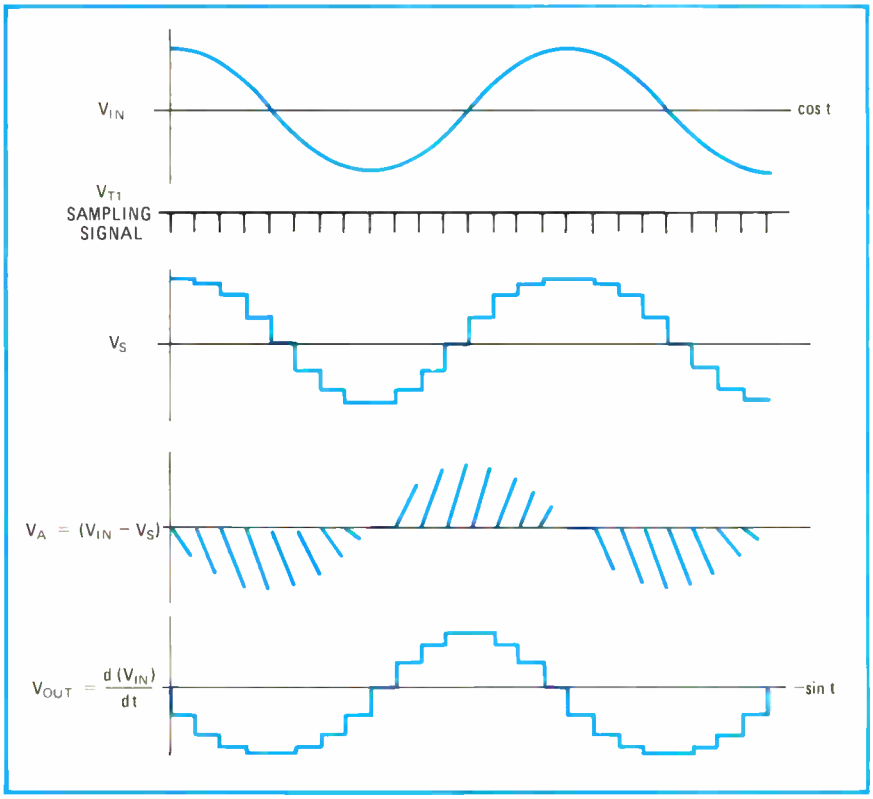
$$E_f = (d(e)/dt)dt$$

where E_f is the final output voltage at the time immediately before the next sample, and d(e)/dt is the change in input voltage between sampling intervals, or the derivative of the input signal with respect to time. The output waveforms in Fig. 1 indeed confirm this equation. How is the output generated?

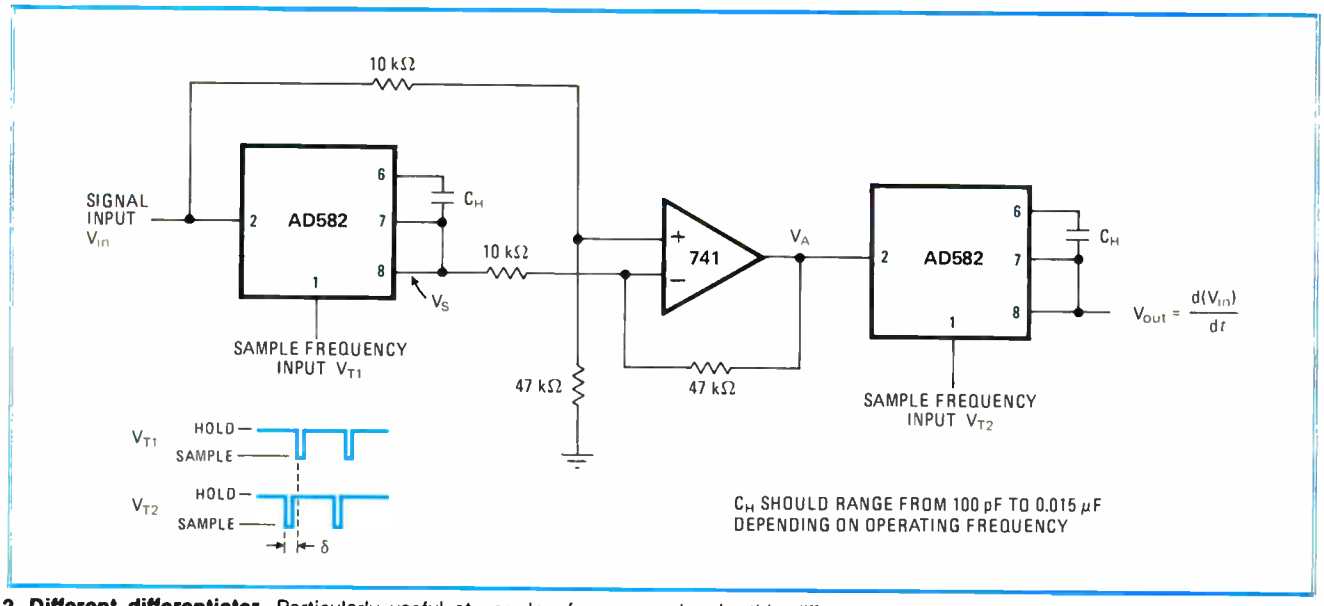
As shown in Fig. 2, the input signal V_{in} at pin 2 is sampled at a frequency introduced at pin 1 of the AD582 sample-and-hold device. The output of this device charges capacitor C_H with the instantaneous V_{in} potential at the sampling instant; therefore the output signal V_s is a staircase approximation to V_{in}, for a small sampling time with many samples taken per input frequency. (For clarity's sake the waveforms in Fig. 1 show a disproportionately low sampling frequency.) The difference between V_s and the original input frequency V_{in} is amplified by the 741 operational amplifier.

During each sampling period, the difference between these two signals is zero, making the output of the 741 (V_A) also zero. However, during each hold period, the output of the op amp rises to a value proportional to the change in input voltage with time. This proportionality is more or less linear, because of the small change in V_{in} versus V_s during a single sample period.

The output of the 741 is therefore a sawtooth waveform with an envelope (formed by the sawtooth peaks) approximating the derivative of V_{in}. To yield a true staircase approximation of the derivative, a second sample-and-hold device can be used to sample the peaks



1. Sample waveforms. Input signal V_{in} (shown here as cos *t*) is sampled at rate V_{T1}, and sample-and-hold output V_S is a sawtooth with an envelope that is the derivative of V_{in}, or −sin *t*. Final sample-and-hold produces staircase of derivative, V_{out}.



2. Different differentiator. Particularly useful at very-low-frequency signals, this differentiator uses a sample-and-hold and a difference amplifier to obtain the slope of the waveform. Second sample-and-hold recovers peaks of differentiated waveform. Negative pulse train (duty cycle approximately 1%) for sampling signals can be generated by a 555 timer circuit.

of the sawtooth, thus removing the unwanted components generated by the first sampling module.

For reasonable accuracy in differentiating a signal, the sampling frequency should be at least a few times, but preferably on the order of 100 times, greater than the input frequency. Decreasing the sampling frequency will lower the input frequency that produces a full-scale or maximized-value output. □

FET pair and op amp linearize voltage-controlled resistor

by Thomas L. Clarke
Atlantic Oceanographic and Meteorological Laboratory, Miami, Fla.

A matched field-effect transistor pair can be combined with an operational amplifier and a few resistors to form a circuit in which one FET's drain-to-source resistance (R_{ds}) bears a precisely linear relationship to a control voltage (V_c). Though a single FET can serve as a voltage-controlled resistor, the relationship of R_{ds} to the gate-to-source voltage (V_{gs}) is nonlinear.

The basic idea in this circuit is to control V_{gs} through a feedback loop that senses if the amount of current flowing through the FET, and hence its R_{ds}, is of the proper value. As shown in Fig. 1, this is accomplished by deriving a signal from half of the FET and applying it to a "summing" node at the inverting port of an op amp.

The output of the op amp is connected to the gate of the FET, thus forming a closed loop. The resulting change in V_c causes a proportional change in R_{ds} because the op amp is a linear device, and because input voltages are compared to a fixed voltage (V_{ref}) at the noninverting terminal. Depending on the configuration, R_{ds} can be made proportional to V_c or its reciprocal.

In the circuit to be seen at the left of Fig. 1, R_{ds} varies in proportion to the reciprocal of the control voltage, as is indicated by the following equation:

$$R_{ds} = |V_{ref}|R_c/(|V_d|-|V_{ref}|)$$

where V_{ref} is assumed to be between 0 and V_c. A voltage divider may be used to derive V_{ref}. Moving V_{ref} to the drain of the FET, as in the circuit to the right, the following equation holds:

$$R_{ds} = |V_{ref}|R_c/|V_d|$$

where V_{ref} should be a well-regulated source, since it may have to supply considerable current. These equations are based on the facts that V_c draws current from the negative input of the op amp through R_c and that this voltage drop results in current flow into the terminal by the FET. The application of Kirchhoff's law then yields the above relationships.

As shown in the circuit at the left of Fig. 2, R_{ds} may also vary in direct proportion to the control voltage. Therefore, the relationship becomes:

$$R_{ds} = R_d|V_d|/(V-|V_d|)$$

where V_c is greater than $-V_p$ but less than 0 v. This circuit, while not as linear as those of Fig. 1, can be improved significantly by replacing R_c with a current source, I, as shown at the right of Fig. 2. The relationship then simply becomes:

$$R_{ds} = |V_d|/I$$

The circuits are built with Siliconix 285 dual FET chips and LM324 op amps. Use of high-speed op amps such as the LM318 would permit more rapid variations of resis-

Varian resolves magnetron interface puzzles.

Radar system designers no longer need to be puzzled about matching magnetrons and modulator/power supplies, because Varian magnetrons are now available in completely interfaced Ritter transmitter packages.

Ritter, a recent acquisition of Varian, Beverly Division, has had extensive experience in airborne pulsed and CW transmitter systems, developing an expertise in high-density, high-efficiency and high-reliability packaged power sources. Ritter has shipped in excess of 2,000 subsystems annually, utilizing various types of prime power systems in the 3 kilowatt to 2 megawatt ranges.

The Ritter operation of Varian now offers the best combination of magnetron expertise plus excellence in modulator design and fabrication. All the system designer must supply are input conditions to the modulator and what he wants out of the transmitter. The Ritter operation of Varian does the rest, including design, engineering and manufacturing—all with Varian's usual high standards of quality, reliability and performance.

To solve your magnetron interface puzzle, call Varian, Beverly Division, Salem Road, Beverly, Massachusetts 01915. Telephone (617) 922-6000. Or call any of the more than 30 Varian Electron Device Group Sales Offices throughout the world.

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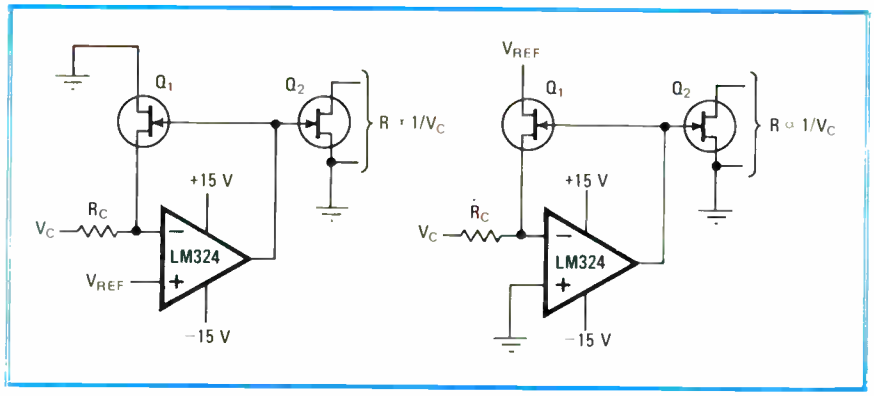
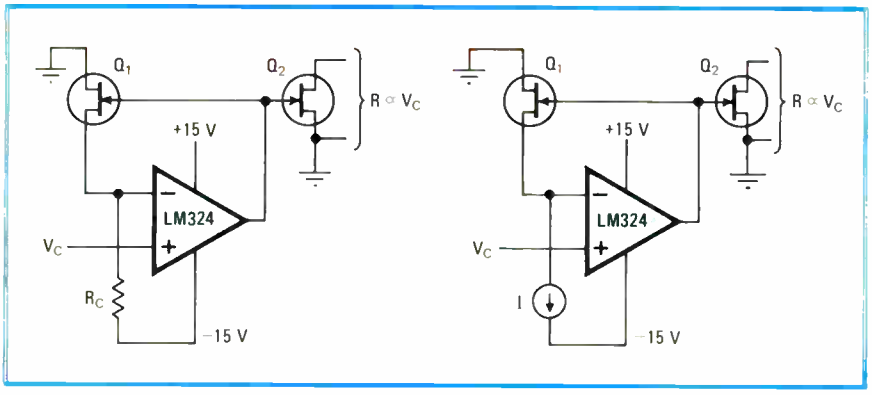
Circle 112 on reader service card





1. Voltage-controlled resistance. Unused half of FET Q_2 can function as voltage-controlled resistor in external circuits. R_{ds} is inversely proportional to control voltage in both circuits. V_c values are negative for n-channel FETs, positive for p-channel FETs.

2. Direct proportional control. R_{ds} varies linearly with V_c in both circuits. If V_c exceeds V_{ref} or breakdown voltages of FET in either figure, a resistor should be inserted between output of operational amplifier and gate of FET to prevent burnout.

tance. No stability problems are encountered because the FET introduces negligible phase shift in bandpass frequencies of the op amp. Optimal results are obtained, of course, with FETs formed on a common substrate, and if desired, p-channel devices may be used for positive control voltages. □

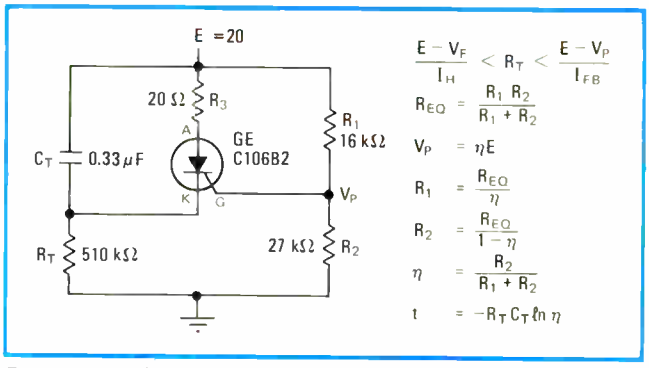
SCRs make serviceable relaxation oscillators

by Larry P. Kahhan
Princo Instruments Inc., Southampton, Pa.

Few designers realize that a silicon controlled rectifier can be used as a relaxation oscillator, just like its sister thyristor, the programmable unijunction transistor. The circuit arrangement is much akin to the PUT oscillator, as shown in the figure.

When power is applied, capacitor C_T charges, and the voltage across resistor R_T decreases exponentially. When the voltage across R_T, which is the cathode voltage of the SCR, drops to 0.6 volt less than the gate voltage, the SCR turns on. This turn-on produces current flow through C_T and a voltage spike across R_3.

Since the large value of R_T prohibits there being sufficient current to maintain conduction, the SCR immediately turns off, and C_T begins its charge cycle again. The period of oscillation is approximately given by $t = -R_T C_T (\ln \eta)$, where η is the fraction of the supply voltage that is applied to the gate, or $R_2/(R_1 + R_2)$. The high-impedance (500-kilohm) sawtooth-waveform output is available at the SCR's cathode, and a pulse waveform appears at its anode. The output impedance at this point is less than 20 ohms. If a high-current pulse is desired, a pulse transformer might replace R_3.

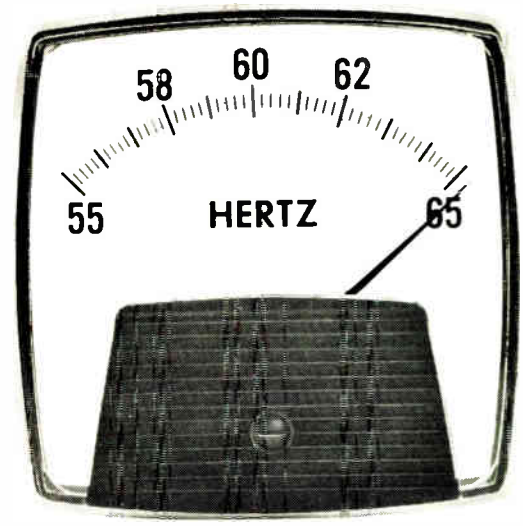


Programmability. An SCR oscillator retains the features of a unijunction-transistor circuit, including programmability of the firing point. Values shown yield an oscillation frequency of about 15 Hz. Gate-to-cathode voltage drop is neglected in the equations.

Design equations in the figure outline the criteria for oscillation. Values for SCR on-voltage, holding and forward blocking currents may be obtained from the data sheets. □

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.

How to pick the right frequency meter for your product.



Two distinctly different kinds of panel meters exist for the purpose of measuring frequency — indicator type and vibrating-reed type. It's important to know these and other differences enumerated here if you want to pick the frequency meter that's right for *your* product every time.

Pointer and large numerals in analog-type GE frequency meters are clear and easy-to-read... match BIG LOOK® and HORIZON LINE® styling of other GE panel meters.

1 Decide whether price, or accuracy plus appearance, is your prime consideration.

Manufacturers who buy strictly on price prefer vibrating-reed type meters. They cost from 20 to 30 percent less than analog readout types. But analog readout meters permit faster, more accurate readings of frequency without guesswork.

2 Determine what frequency range you want to measure.

Nearly all frequency measurements can be made utilizing these standard five ranges: 45-55 Hertz, 45-65 Hertz, 55-65 Hertz, 50-70 Hertz and 380-420 Hertz.

3 Determine the right voltage rating, and the right panel meter case size, too.

GE frequency meters come in all standard ratings in 3½ and 4½-inch sizes.

By far, the most common ratings are 120-volt, 208-volt and 240-volt. Case sizes in nearly all instances are either 3½ inches or 4½ inches.

4 Find out whether the frequency meter needs accessory equipment.

Analog-type frequency meters, for example, must operate in conjunction with a solid-state circuit board and transducer. If the meter you pick needs a "black box" to go with it, that will of course add extra design and component cost considerations to your product.

GE's compact design includes both the circuit board and the transducer as integral parts.

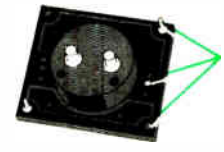
5 Make sure your meter will work in dirty environments.

There's no way you can control where your customer will use your product. As with all panel meters, frequency-type meters should be protectively enclosed in a good, tight case.

Gasketed cover on BIG LOOK® design helps keep dust and moisture out. Most distorted wave forms no problem for newest GE models.

6 Will the meter you pick be easy to replace later?

Make sure both the frequency meter and the mounting requirement you have specified for your panel are flexible enough to permit easy replacement.



GE solves your mounting problems by ultrasonically placing studs to match your panel cutouts... for new or replacement meters.

7 And don't forget the manufacturer's reputation.

Make sure he stands behind his products... and that all his panel meters meet ANSI C39.1 specifications.

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For a free guide entitled, "Pick the Right Panel Meter" (GEA-10340) and our complete Catalog (GEP-307), write to General Electric Co., Section 592-68, Schenectady, N.Y. 12345.

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GENERAL ELECTRIC

16-k RAM eases memory design for mainframes & microcomputers

by Derrell Coker, *Mostek Corp., Carrollton, Texas*

☐ The 16,384-bit dynamic random-access memory is now in volume production. Already 100,000 devices have been designed into prototype memory systems, and an estimated 3 million to 5 million devices will be installed in mainframe memories this year.

Its attraction for mainframe designers is, of course, low cost—a quarter the cost per bit of 4,096-bit parts with the same level of performance. But a less obvious asset—ease of use—guarantees its popularity outside the mainframe area, particularly in the small peripheral and microprocessor-based systems that traditionally use static, not dynamic, RAMs.

Many aspects of this ease of use are common to all 16-k dynamic designs:

- They are packaged in the same 16-pin dual in-line package as many 4-k devices, so that upgrading a board of 4-k RAMs to a 16-k board requires only one address-line change.
- All inputs and outputs are at 5-volt levels required by transistor-transistor logic, so that there is no need for the high-level clocks required by some 4-k RAMs. Moreover, inputs are low-capacitance, and three-state outputs make for maximum flexibility in driving external TTL circuits.
- The existence of latches for all data inputs and address signals relaxes requirements for input timing.
- Timing of all column- and row-address signals is very simple, requiring no overlapping cycles.
- Power supplies are completely standard, at +12 v and ±5 v, plus or minus a freewheeling 10%.

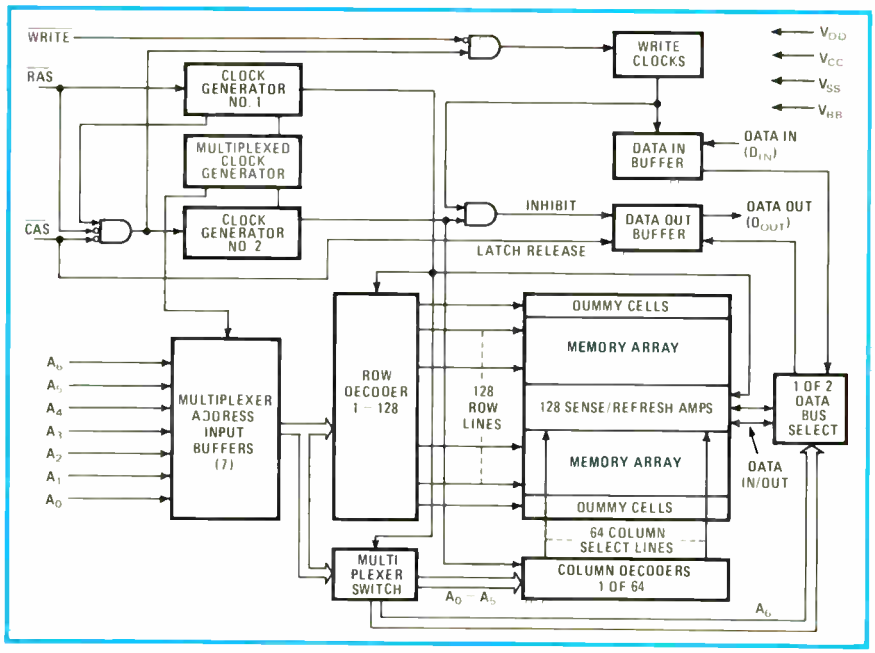
But newer 16-k dynamic RAMs, such as the Mostek Corp. MK 4116, have even subtler properties—ones that simplify the job of designing them into small systems. Though organized internally as two 8,192-bit subarrays (Fig. 1), the MK 4116 looks to the user like a balanced 128-column-by-128-row memory because its 128 sense amplifiers are located between the two subarrays and multiplexed internally by on-chip clocks.

Moreover, the same amplifiers that do the sensing also do the refreshing. They are driven by the same internal address clocks and perform the refresh action automatically during the 2-millisecond refresh period.

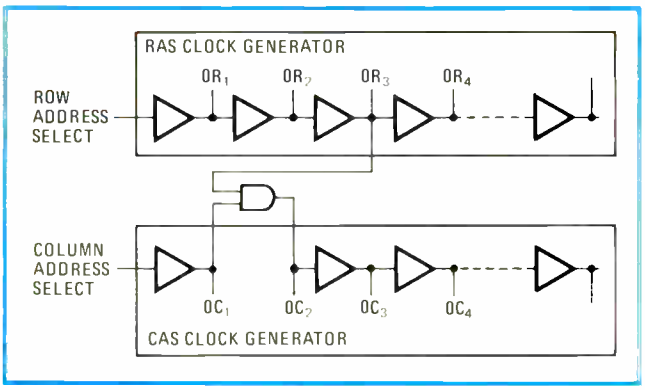
No worst-case access time

The chip's layout also results in minimum access times, because it minimizes delays in the control circuitry. The control circuitry surrounding the array is run by a network of clock generators, which in turn are activated by the externally applied row- and column-address-select signals. Consequently, the delay in the control circuitry is due exclusively to the small (and constant) clock delays that are internal to the circuitry itself and not by clock-sequencing delays, which can be considerable and varied, depending as they do on the cycle's data-address requirements. This characteristic has another benefit. It makes testing the MK 4116 RAM chip easier, since now there is no reason to search for a test sequence or for a data pattern that is worst-case for access time.

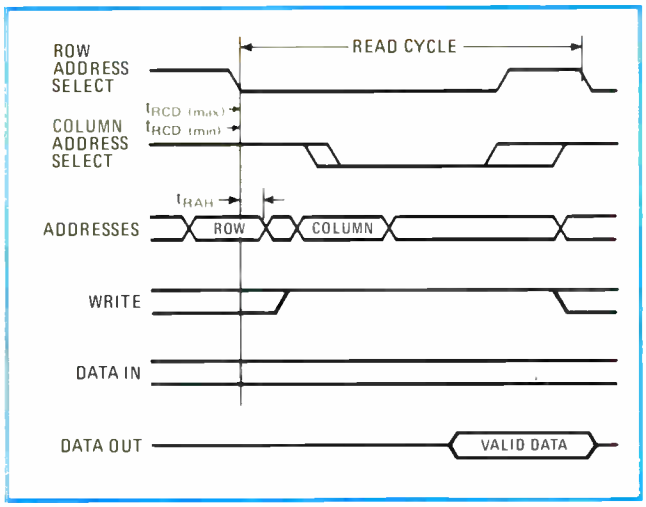
Finally, note that the address input buffers are multiplexed between row and column addresses, while the row and column decoders are independent circuits. This layout keeps the input capacitance at these terminals very low compared to the high-capacitance inputs common in some multiplexed 4-k RAMs, where each



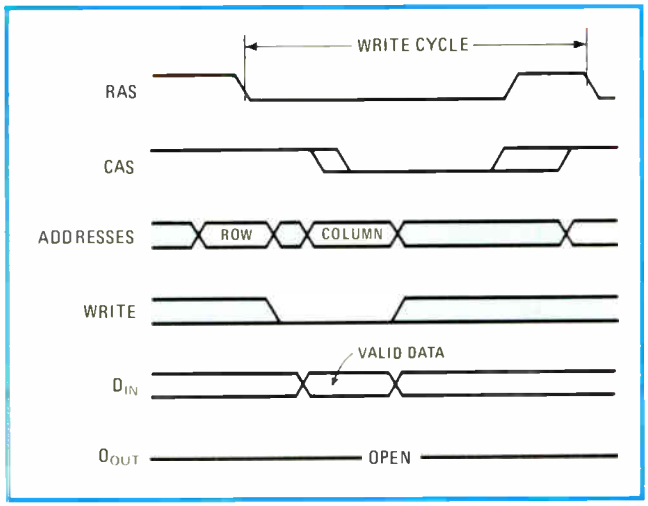
1. Organization. The MK 4116 is organized internally as two 8,192-bit subarrays separated by 128 sense amplifiers. To the user it seems to operate as a balanced 128-column-by-128-row memory.



2. Gated CAS. Timing on the chip is made simple with a "gated-CAS" design. Row-address-select (RAS) and column-address-select (CAS) signals are controlled by different delayed internal clocks, but the two clock chains are linked logically so that the address multiplex operation is removed from the data access timing sequence.



3. Mistake-free. To prevent errors in reading data, the start of the data chain is inhibited until the occurrence of a delayed signal triggered from the RAS chain. CAS is externally activated as soon as the row-address-hold time t_{RAH} is over.



4. Data ready. In the MK 4116 memory, data is valid within the specified access period and remains valid until the CAS line becomes inactive. If CAS goes low early in the write cycle, the data-output line remains in the high-impedance state throughout the entire cycle.

address pin is connected to two input buffer circuits.

Although the multiplexed-address 16-k RAM requires two strobe signals (row- and column-address-select) for control purposes, the timing requirements of these clocks are much more flexible than in the original 4-k multiplexed RAM introduced in 1973. That design made no allowance for the time required to perform the address multiplexing, so that a worst-case multiplexing time delay (which is system-dependent) had to be added to the specified access time. Also, the fact that the internal RAS and CAS clock generators in the original 4-k part functioned totally independently of one another imposed several unwelcome restrictions on the precharge and refresh operations.

The 16-k design overcomes these timing inconveniences with a feature called "gated CAS." Here, each of the control signals, RAS or CAS, triggers a sequence of events that as before is controlled by different delayed internal clocks (Fig. 2). In this case, however, the two clock chains are linked logically so as to keep the address multiplexing operation outside of the critical timing path for data access. Indeed, the data sequence is inhibited until the occurrence of a delayed signal derived from the RAS clock chain. Thus, the gated-CAS feature allows the CAS clock to be externally activated as soon as the requirement for the row-address hold time (t_{RAH}) has been satisfied (Fig. 3) and the address inputs have been changed from row- to column-address information.

The gated-CAS scheme also avoids potential reading errors during the address cycle by establishing two timing endpoints called minimum and maximum row column delay ($t_{RCD(min)}$ and $t_{RCD(max)}$). No data storage or reading errors will result if CAS is applied to the device after $t_{RCD(max)}$. In this case, however, access time will be determined exclusively by the access time from CAS (called t_{CAC}) rather than from RAS and will be lengthened by the amount that t_{RCD} exceeds the $t_{RCD(max)}$ limit.

Timing is further simplified since now recharging of all internal circuitry is initiated by RAS going to the inactive state and not (as in 4-k dynamic designs) by the appearance of CAS. This removes several timing restrictions from the trailing edge of CAS, allowing for simpler, RAS-only refresh operations, as well as improved operation of the data output.

As for reading and writing in these 16-k RAMs, data out is valid in a read cycle within the RAM's specified access time and will remain valid until the column-address strobe becomes inactive. However, if CAS goes low early in the write cycle (Fig. 4), the data-output line will remain in the high-impedance (open-circuit) state throughout the entire cycle.

This type of output operation results in a unique system capability. If write operations are indeed handled early in the write mode, then the data-input pin, D_{IN}, can be connected directly to the data-output pin, D_{OUT}, for a common input/output data bus. Full control of the data-output is achieved during a read cycle because data out will remain valid from the time t_{CAC} until CAS goes back to its high-level (precharge) state, a time determined exclusively by the system designer. Thus, data can remain valid right up until a new memory cycle begins, with no penalty in cycle time. This makes the RAS/CAS

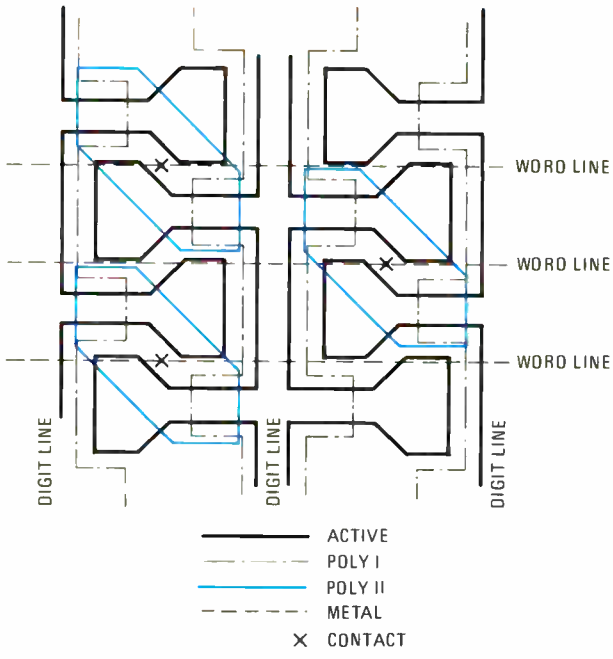
How structure affects performance

Most 16,382-bit dynamic random-access-memory chips are fabricated with a two-level n-channel polysilicon-gate process. Two levels of polysilicon greatly enhance circuit density over single-level designs without unduly increasing circuit complexity. They also (like the one-level process) allow independent adjustment of gate- and field-oxide thresholds by ion implantation, which maximizes performance, density, and reliability.

The storage cell is a conventional one-transistor dynamic design. Being metal, the row-select (word) lines do not suffer from the long propagation delays that occur with polysilicon word lines.

Data passes into and out of the cell through diffused column (digital) lines. The first level of polysilicon acts as the top plate of a storage capacitor, allowing charge to be stored in the depleted region beneath it. Metal word lines contact the second polysilicon level, which forms the gate of the transfer device, isolating the storage cell from the digit line. This makes the cell relatively insensitive to variations in the doping level of both first and second polysilicon levels.

In sum, the cell's performance is influenced primarily by junction depth, oxide thickness, and mask geometry—all parameters that can be carefully controlled.



clock timing relationship very flexible. Moreover, since D_{OUT} is not latched, CAS and/or RAS can be decoded and used for chip selection. This property leads to still more flexibility of access, because now, when both RAS and CAS are decoded, a two-dimensional (X,Y) chip-select array is realized.

Two problems plagued the metal-oxide-semiconductor dynamic RAMs of an earlier generation: poor noise immunity and poor sensitivity to input signals. Both often precluded the unbuffered use of these memories with high-performance logic families, such as Schottky TTL and emitter-coupled logic.

Noise margins

A special input buffer stage in the MK 4116 solves both problems (Fig. 5). This stage allows the chip to accept directly, with wide operating margins, all bipolar level signals. A logic 1 can be detected down to 2.2 v and a 0 up to 0.8 v.

The circuit is actually a simple differential amplifier, which compares the incoming TTL level to an on-chip reference level of 1.5 v. In operation, a positive common-mode voltage is capacitively coupled (through C_2 and C_3) to the gates of transistors Q_3 and Q_4 in order to guarantee the operation of the latch command and the MOS-level flip-flop circuitry. This voltage boost assures that the buffer latches properly, even though both the input and reference voltages may be less than the device threshold voltage.

The insertion of Q_1 and C_1 in the V_{IN} input path increases the amount of negative undershoot on V_{IN} that can be tolerated between the time that the address-hold time goes low and the time that the latching action takes place. Consequently, the chip requires the shortest possible address-hold times and allows the inputs to function independently of device thresholds and other process parameters.

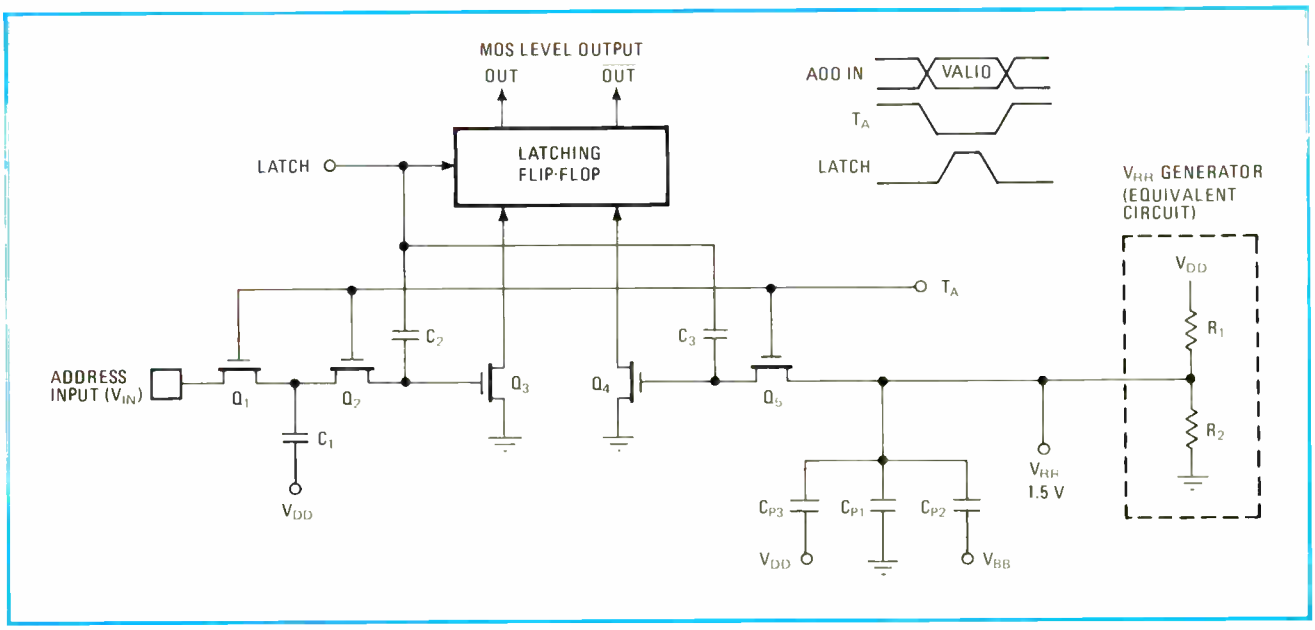
Another design feature absent from other 16-k RAMs is the use of dynamic sense amplifiers. Compared with static sense amplifiers, they reduce the active power dissipation of the chip by 25% (Fig. 6), largely because they have no need for the power-hungry digit pull-up transistors needed for static sense amplifiers.

Moreover, dynamic sense amplifiers render the MK 4116 chip less susceptible to burnout than 16-k designs using static amplifiers. The dynamic devices are selected by the same address strobes used for column and row address; they are not powered by the main system clocks, as are static sense amps. With static designs, since maximum current is drawn during these clock operations, the chip can inadvertently be burned out in the event the clock input becomes shorted to ground during system malfunction. Blowout is prevented with dynamic designs, where the power drawn by the amplifier is a function of address strobe frequency rather than clock duty cycle.

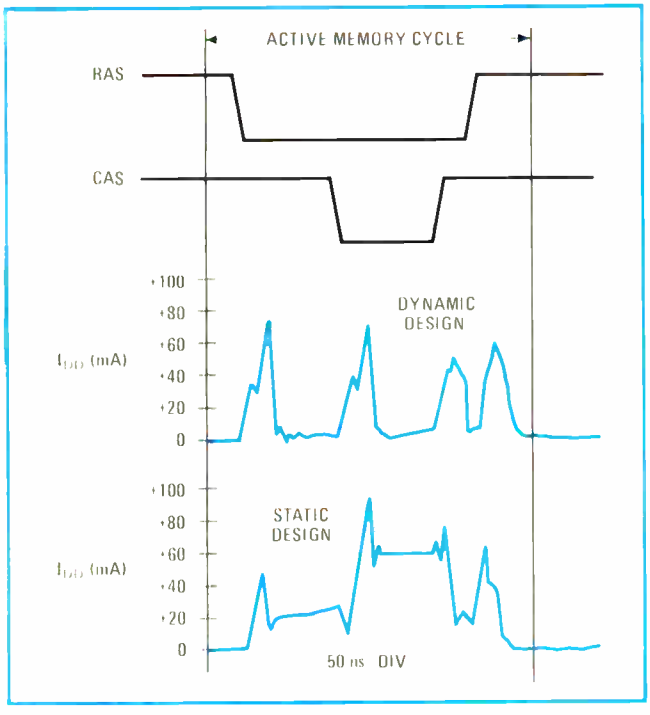
Not only does the dynamic-current characteristic of the MK 4116 prevent inadvertent burnout, it also allows the device manufacturer to specify the operating power as a function of frequency, rather than as a fixed condition. This gives the system designer a worst-case power specification, guaranteed by the manufacturer, which applies to real-use conditions.

Use in microprocessor systems

The amount of read/write memory associated with microprocessor-based systems is ever-increasing, and with their accent on ease of use, the 16-k dynamic RAMs should be strong contenders for applications in these systems. The block diagram for a typical microproces-



5. Input buffer. This input buffer stage is a simple differential amplifier. Its function is to compare the incoming TTL levels to an on-chip 1.5-volt reference level. It is capable of detecting a logic 1 above 2.2 V and a logic 0 down as low as 0.8 V.



6. Dynamic is better. Dynamic sense amplifiers require much less power than static designs, which are powered by the main system clocks and depend on power-consuming pull-up transistors.

sor-controlled 16-k-RAM memory system (Fig. 7) shows the elements of such a system. Including interface logic, timing generator, decode logic, multiplex circuitry, refresh logic, and buffers, the entire system can be implemented with the addition of approximately 12 to 20 standard TTL devices. That means that a full 64-k-by-8-bit system (the most memory that microprocessors in general can address) will fit on one double-sided printed-circuit board less than 50 square inches in area.

The functions of most microprocessor-based memory systems are reasonably simple and straightforward when compared to those of some minicomputers and large mainframes. Most microprocessors have independent memory-address signals and request read or write information on command. Thus, refresh of dynamic RAMs is easily handled during the portion of an instruction cycle that does not require a memory access.

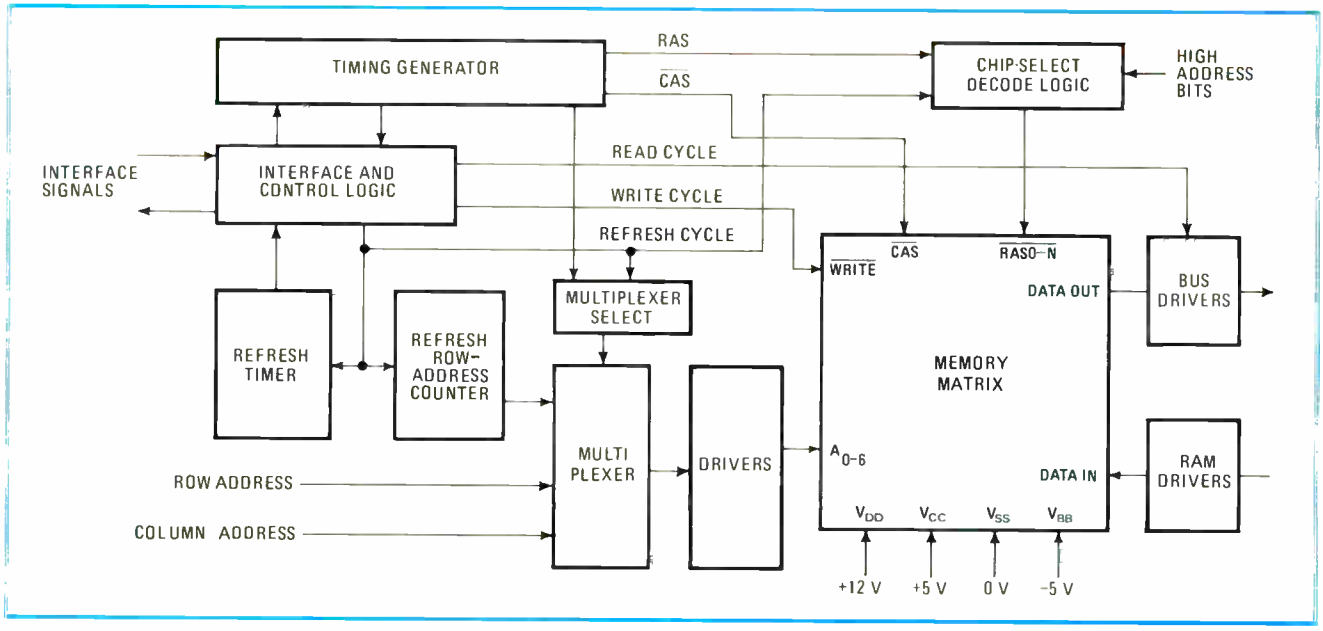
Since most microprocessor systems do not require specialized memory operations, such as read-modify-write cycles, timing considerations for the RAM can also be kept very simple. In fact, interface convenience is more important than device operating modes. Here, because there is no output latch on the 16-k RAM, it is possible to interface the memory directly with the I/O bus of most microprocessors by using the device in its common-I/O-data-bus mode. For convenience, the data-input pin of the 16-k RAM can be directly connected to the data-output pin on the system's pc board.

Minicomputer/multiprocessor applications

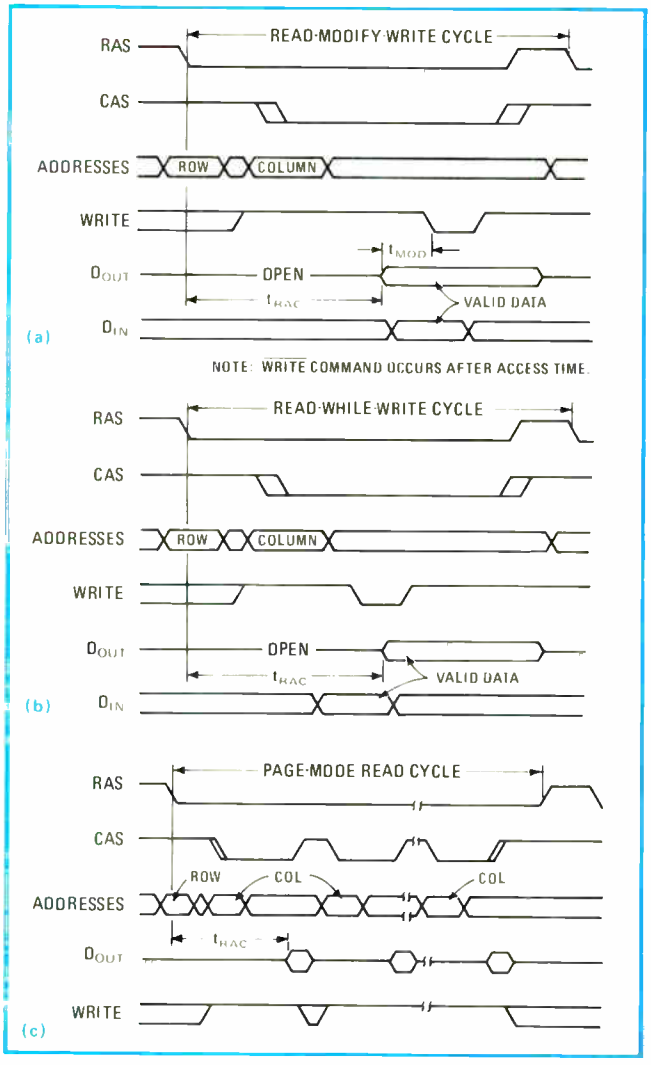
A logical progression beyond the simple microprocessor systems is in multiprocessor and minicomputer applications. Usually in these larger, more diverse data-processing applications, memory-content integrity and reliability become critical. Often special error-detection and -correction schemes are employed to ensure maximum system reliability.

In these types of applications, the 16-k RAM will have much more of an impact than any previous semiconductor memory product. In systems like these, read-modify-write cycles and concepts like page-mode operation and read-while-write memory begin to affect system design (Fig. 8).

The read-while-write memory operation of the 16-k RAM (Fig. 8a) simply implies that both a read operation and a write operation can occur at the same memory address almost simultaneously. This is done by strobing both the row and column address into the device and



7. Microprocessor systems. The components of a 16-k RAM system for a microprocessor-based application RAM system can be implemented with no more than 20 TTL packages and can fit on one 50-in.^{2} printed-circuit board.



8. Mainframe performance. The MK 4116 features such system concepts as read-while-write, read-modify-write, and page mode.

then waiting a sufficient time after the column-address strobe is activated before the write command is given. The MK 4116 has been designed and characterized so that a read operation can begin at a particular address and, even before data is taken from the memory, a write operation can begin at the same address and within the same memory cycle. The result is that data stored at a particular cell location will appear at the output of the device within the specified access time and data at the input pin will have been written into the same selected cell location within the same period.

The read-modify-write-cycle is different from a read-while-write operation (Fig. 8b) in that data is read from the selected cell, then modified, and finally written back in its modified form into the selected location. Such a read-modify-write cycle is usually used in conjunction with error-detection and/or error-correction schemes, whereas the read-while-write operation is used for high-speed shift-register or buffer applications. The same MK 4116 device can perform the read-while-write operations in significantly less time than the conventional read-modify-write.

Another type of operation that is a standard feature with the MK 4116 is page mode (Fig. 8c). Page mode allows successive memory operations to occur at multiple column locations of the same row address with increased speed and without an increase in operating power. For speed comparison, a 16-k RAM with an access time of 150 ns would have a page access of 100 ns. This represents a 30% increase in data throughput speed with page-mode operation.

To lend even more flexibility to the page mode of operation, the column-address strobe can be decoded and used as a page-cycle-select signal. This allows the page boundary to be extended beyond the 128-column locations within a single 16-k RAM. Moreover, there is no limitation to the types of operations that can be performed. □

Digital multiplexers reduce chip count in logic design

by James E. Siebert
Michigan State University, East Lansing, Mich.

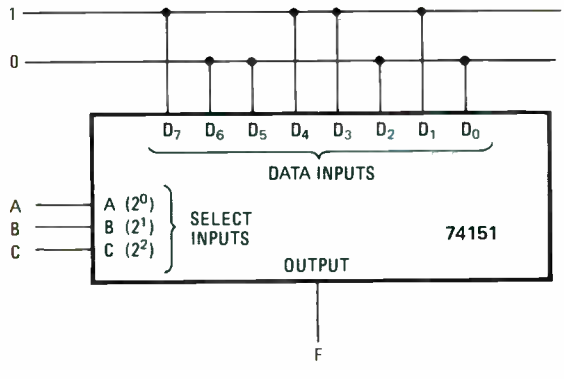
When attempting circuit optimization, logic designers traditionally use algorithms directed at minimizing gate count, but not chip count. However, if digital multiplexers are used to implement the logic functions in a circuit containing less than six input variables, chip count may often be minimized. This can usually be done without tradeoffs in cost, speed, or propagation delay.

Multiplexers in the transistor-transistor-logic family are available in quad two-input, dual four-input, or single eight- and 16-input devices. A two-variable logic block of up to four functions can be generated by a quad two-input device, with the constraint that one variable is common to each function. A three-variable function can normally be realized by using a single eight-input multiplexer, and a four-variable function can be implemented with a single 16-input multiplexer.

The primary design tool is the truth table of the particular function desired. For example, a function of three variables such as $F = AB + A\bar{C} + \bar{A}\bar{B}C$ may be implemented with a 74151 eight-input multiplexer. Using its truth table, the desired function is implemented as shown in Fig. 1. The multiplexer-select lines serve as the inputs for variables A, B and C. Data inputs on the multiplexer corresponding to the select addresses are tied high or low to provide the proper output. Implementing the same function using gates requires two three-input NANDs, two two-input NANDs, and inverters to derive the complement of the input variables for a total of 1⅓ packages.

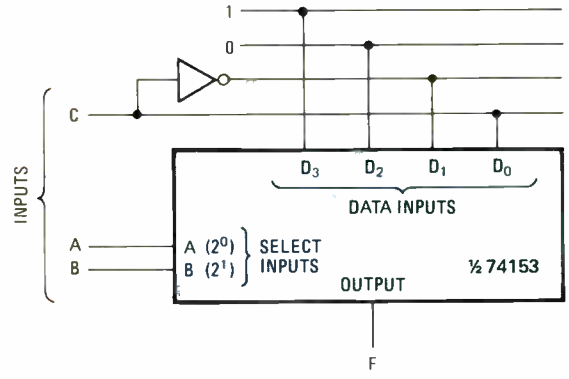
By providing one variable at the data input, a lower-order multiplexer may be used to realize the function. That is, a three-variable function can be implemented with only a four-input multiplexer, where an eight-input device was previously required. As shown in Fig. 2, partitioning the function table can aid in minimizing

SELECT ADDRESS			OUTPUT
C	B	A	F
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	0
1	1	0	0
1	1	1	1

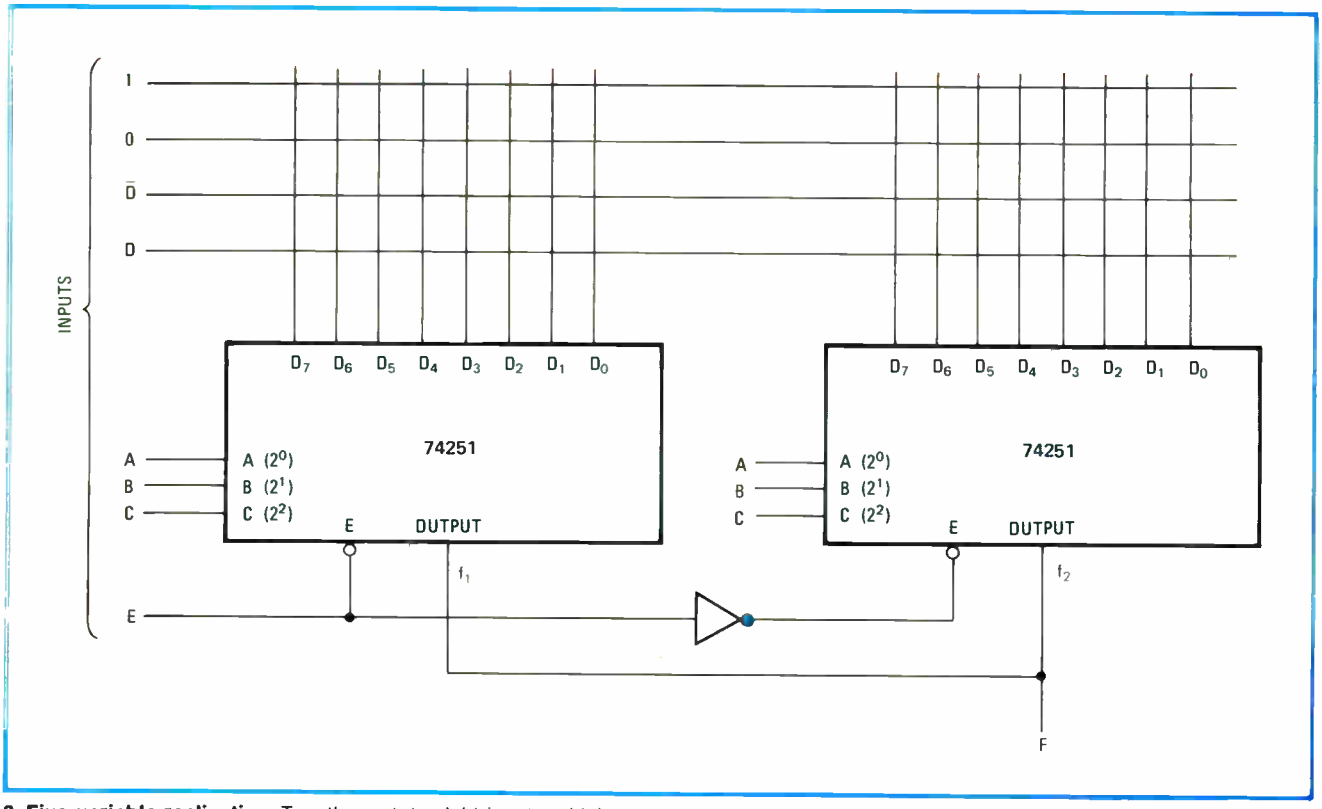


1. One-chip solution. This circuit implements the logic function $F = AB + A\bar{C} + \bar{A}\bar{B}C$. Variables A, B, C steer select inputs, and data inputs are connected HIGH or LOW depending on the multiplexer function. Discrete-gate implementation requires 1⅔ packages.

INPUTS			OUTPUT
SELECT ADDRESS			
B	A	C	F
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	1
1	1	1	1



2. Increased-efficiency circuit. Reduction of an 8-input multiplexer to a 4-input multiplexer is possible if one variable is introduced at data inputs (other variables form the select addresses). Truth table is partitioned for variable C, and design proceeds as explained in text.



3. Five-variable realization. Two three-state eight-input multiplexers can generate any five-input function. Variable E is partitioned, and two four-input problems are solved when implementing function. This can also be accomplished by any 16-input multiplexer.

design time. The single partitioned variable is made available to the data inputs; the other variables form the select addresses. By comparing the function output and the partitioned variable for each select address, multiplexer data-input connections can be readily determined. This method is also useful when implementing a four-variable function with an eight-input multiplexer. However, an eight-input multiplexer usually cannot be used for five-variable functions.

With one 24-pin package, a five-input function may be realized either by the above method or by an alternative one. The first method is needed to generate a five-variable function with a 16-input multiplexer; four variables form the select address, and the partitioned variable serves the inputs. An alternative approach is to use the three-state output available on some multiplexers. In this case, two 16-pin packages are needed, as shown in Fig. 3. The variable D is made available at the data inputs, but E is partitioned for ease in design in the truth table. There are two four-input problems to be solved, and each may be resolved by the method previously described. Variable E actually selects one of the two multiplexer functions.

Minimizing more than a five-variable combinational function is an unwieldy problem. This design approach does not result in a low package count or propagation delay. A six-variable function requires five packages. Generation of a seven-variable function requires nine multiplexers, and an eight-variable function requires 17 multiplexers. □

Calculator notes

Coil-winding program saves rf design time

by Andrew M. Hudor
Department of Physics, University of Arizona, Tucson, Ariz.

Designs for rf circuitry, especially in the low vhf region of the spectrum, often require air-core inductors that are most easily wound by hand. When given the diameters of the wire coil form to be used and the value of inductance desired, this HP-25 program calculates the number of close-wound turns that the inductor will require.

The program uses an algorithm based on a derivation of the single-layer, air-core-inductor equation:

$$L = \frac{r^2 n^2}{9r + 10l}$$

where L is the inductance in microhenries, r is the radius of the coil in inches, l is the coil length in inches, and n is the number of turns. Since this program was designed for close-wound coils, l is effectively replaced by $d(n+1)$, where d is the wire diameter in inches.

The equation above and the replacement of l allows a new equation to be expressed as a function of n, which is found by the HP-25. The new equation is:

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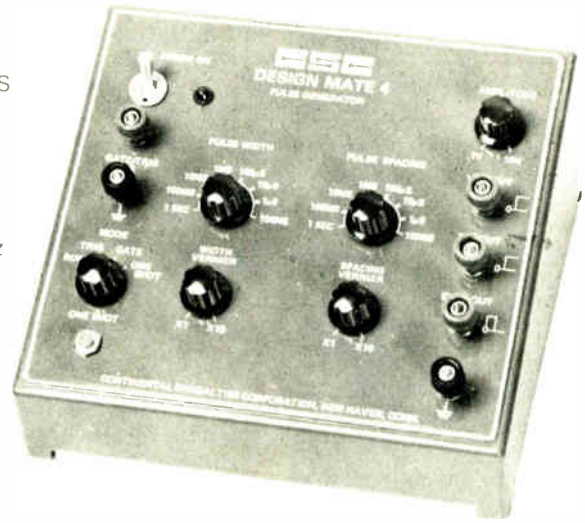

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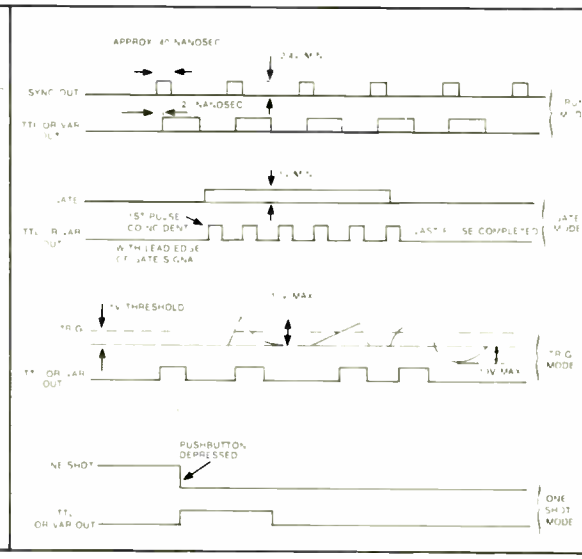
Frequency Range:	0.5 Hz to 5 MHz
Pulse Width and Spacing Controls:	100 nanosec to 1 sec in 7 overlapping decade ranges. A single-turn vernier control provides continuous adjustment between ranges
Duty Cycle:	10 -to 1 Range adjustable over entire pulse width/spacing range. 100 nanosec ON, 1 sec OFF to 1 sec ON and 100 nanosec OFF
Operating Modes:	
RUN	0.5 Hz to 5 MHz as per width/spacing and amplitude control settings
TRIG	DC to approx. 10 MHz
Input requirements	Sine waves 2 VP-P pulses 1 V peak. 40 nanosec wide maximum input 10 V. (Input Impedance Approx 10KΩ DC coupled
GATE	Synchronous gating. Leading edge of gate signal turns generator ON. Last pulse is completed even if gate ends during pulse
Input requirements	Same as TRIG Mode

ONE-SHOT	Pushbutton for single pulse. Output pulse occurs each time push-button is pressed
OUTPUTS:	
VAR OUT	
Amplitude	0.1-10 V positive
Rise fall time	Less than 30 nanosec
Impedance	400Ω max
TTL OUT	
Fan-out	40 TTL Loads
Sink	160 milliamps – 0.8 V max
Rise fall time	Less than 20 nanosec
SYNC OUT	
Pulse width	Approx. 40 nanosec. Other sync pulse spec's same as TTL out
Pulse lead time	Sync pulse leads outputs by approx. 20 nanosec
POWER	117 VAC ± 10% 50-60 Hz, 5 watts (220 VAC 50-60 Hz also available at slightly higher cost)
SIZE (WxLxHi)	7.5 x 6.5 x 3.25
WEIGHT	191 x 165 x 83 mm. 2 lbs (0.91 Kg)



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$$n = \frac{10dL \pm [100d^2L^2 + 4r^2L(9r + 10d)]^{1/2}}{2r^2}$$

and it is solved by the HP-25 for given dimensions.

For instance, you might want to find the number of turns needed for a 0.32-microhenry inductor to be used in a 50-megahertz pi-matching network. The result is that 11.08 turns of AWG 18 enameled wire (d = 0.0403 inch) will be needed round a 0.25-in.-diameter form. □

Engineer's notebook is a regular feature in *Electronics*. We invite readers to submit original design shortcuts, calculation aids, measurement and test techniques, and other ideas for saving engineering time or cost. We'll pay $50 for each item published.

HP-25 COIL-WINDING PROGRAM

LOCATION	CODES	KEYS
01	24 03	RCL 3
02 – 03	01 41	1 −
04 – 05	24 02 61	RCL 2 ×
06	24 03	RCL 3
07 – 08 09	24 00 61 51	RCL 0 × +
10 – 11	24 01 61	RCL 1 ×
12 – 13 14	24 02 15 02 61	RCL 2 g x^2 ×
15 – 16	04 61	4 ×
17 – 18	24 01 15 02	RCL 1 g x^2
19 – 21	24 00 15 02 61	RCL 0 g x^2 ×
22 – 23	24 03 15 02	RCL 3 g x^2
24 – 25	61 51	× +
26 – 27	14 02 23 06	f $\sqrt{x}$ STO 6
28 – 30	24 00 24 01 61	RCL 0 RCL 1 ×
31 – 32	24 03 61	RCL 3 ×
33 – 34	24 06 14 41	RCL 6 f $x < y$
35 – 36	13 44 51	GTO 44 +
37 – 38	24 02 15 02	RCL 2 g x^2
39 – 41	02 61 71	2 × ÷
42	23 07	STO 7
43	74	R S
44 – 45	41 13 37	− GTO 37

INSTRUCTIONS

- Key in program
- Store wire diameter:
  [d], STO 0 (inches)
- Store inductance value:
  [L], STO 1 (microhenries)
- Store coil radius:
  [r], STO 2 (inches)
- Store constant:
  10, STO 3
- Press R/S
- Value of n is displayed, stored in register R_7

REGISTERS	
R_0	d
R_1	L
R_2	r
R_3	10
R_4	free
R_5	free
R_6	free
R_7	n

Engineer's newsletter

555 turns 60 Hz into 60 clean square waves

You can use a 555 timer to isolate a system like a digital clock from line noise and transients as well as produce a clean square wave at line frequency, says Wistar Macomson of Boston, Mass. To lock the 555 into synchronism with the 60-hertz line frequency, you **select the RC network for oscillation at or near 60 Hz.** Then all you have to do is connect the timer as an astable multivibrator in accordance with the manufacturer's literature, except that you don't ground the control-voltage input, pin 5 — you just leave it unconnected. A low-ripple power supply is unnecessary, adds Macomson, and a battery backup will also keep the 555 running, although then it may drift off 60 Hz.

Take care to write SR-52 cards right

If you've experienced difficulty getting your TI SR-52 programmable calculator to accept programs you've recorded on the magnetic cards, it's probably because you're inconsistent in the way you insert the cards. Stavro Prodromou, Texas Instruments' calculator applications manager, says that the cards must be read at the same speed as they are written. The data recorded depends on the speed of the card moving past the read/write head, and if the card started sluggishly during recording, it would have to be read the same way or an error condition would be indicated. **The proper technique, says Prodromou, is to allow the motor to rev up to full speed before recording.** Insert the card just enough to start the drive motor, but not far enough for it to grab. Then, inserting it a little further will cause it to be pulled in and recording will take place uniformly.

Incidentally, adds Prodromou, although a flashing display indicates an erroneous read, try checking the keycodes by putting the machine into the learn mode. Sometimes a read error may only be incurred in a few steps, and these can easily be written over.

Have you thought about the changes in the ASCII standard?

You still have a month if you want to comment on **a new ANSI standard that will add 25 control functions to the present ANSI ASCII standard computer character set.** The new control functions, for such applications as interactive cathode-ray-tube and printer terminals, line printers, and microfilm printers, lie in the area of editing functions, formatting, and status-setting and interrogation functions, and others. The public comment period ends May 28, and copies of the proposed standard can be obtained from R. M. Brown, Computer and Business Equipment Manufacturers' Association, 1828 L Street, N.W., Washington, D. C. 20036. Price of the 100-page BSR X3.64 is $3.

Where to find out about analog switches and programmed logic

Manufacturers' handbooks usually are pretty good bargains for up-to-date design information. Among the most recent crop are at least two worthy of attention: Siliconix has "Analog Switches and Their Applications," a 352-page book selling for $4, while Pro-Log Corp. has "The Designer's Guide to Programmed Logic," featuring the 8080 microprocessor, a 150-pager for $5. Addresses are Siliconix Inc., Marketing Services Department, 2201 Laurelwood Rd., Santa Clara, Calif. 95054 (and the company will include a 20-page design catalog on its new DG-300 complementary-MOS analog switches), and Pro-Log Corp., 2411 Garden Rd., Monterey, Calif. 93940. **Stephen E. Scrupski**

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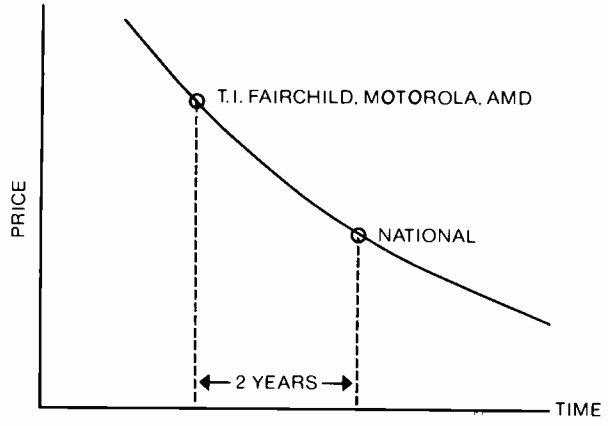

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Slew Rate	13 V/us	12 V/us
Noise (f=1 KHz)	22 nV/$\sqrt{Hz}$	47 nV/$\sqrt{Hz}$
V_{os} (drift)	8 uV/°C	10 uV/°C
Price (100 & up)	$.50	$.52

*Per T.I. Publication #63133 CSS 177

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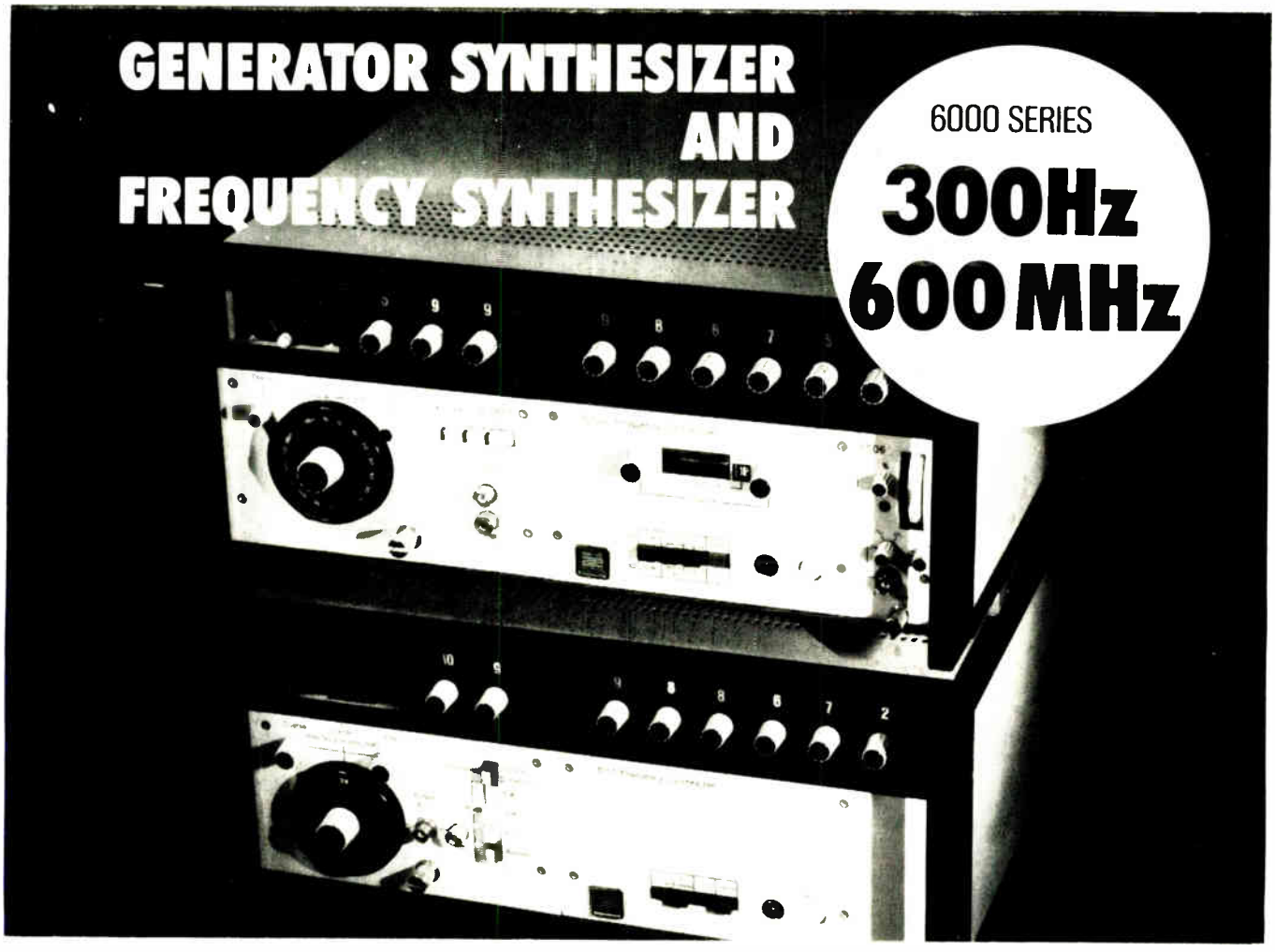

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PRODUCT UPDATE

All classes of electronic counters reap performance benefits from custom-designed LSI chips

by Stephen E. Scrupski, Instrumentation Editor

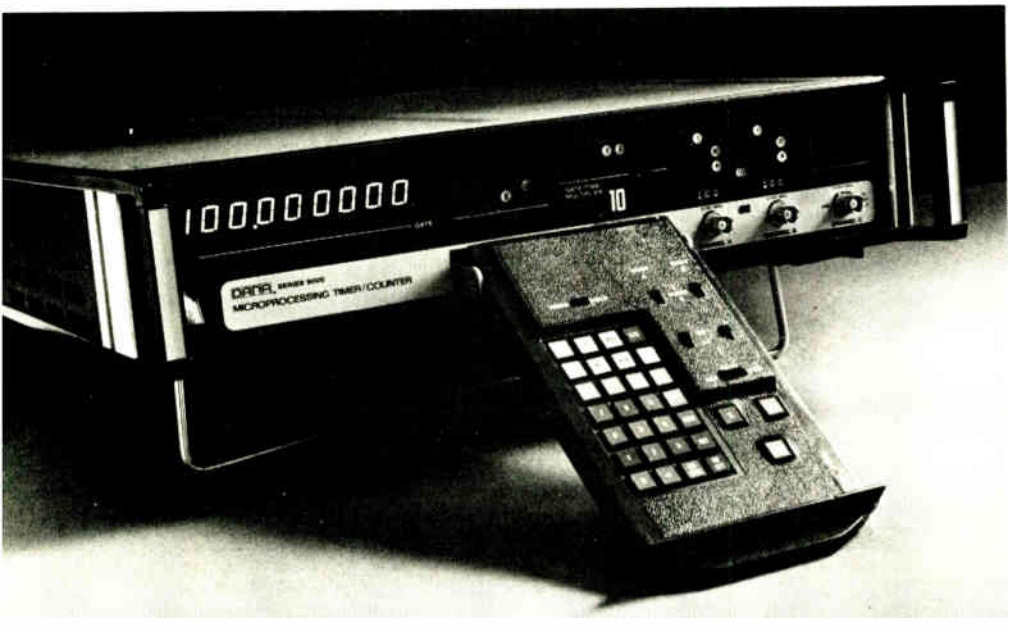
☐ Stirring up most of the action in electronic counters today, as in electronic systems everywhere, is large-scale integration. In this area, however, microprocessors are winning far less favor than custom LSI chips. In low-end counters, custom LSI is enormously enhancing performance, and the high sales volumes more than offset its extra expense. But a microprocessor, for all the flexibility and easier instrument use it promises, has appeared in only one counter to date—a high-end model, which is more than a year old.

Basically, electronic counters fall into four categories:

- Low-low-cost, no-frills, portable units, intended for the hobbyist and service markets, where as little as $120 buys a single-function counter of frequencies up to 30 megahertz. LSI plus packaging accounts for the low cost.
- Low-cost, single-function counters covering frequencies up to around 80 MHz for less than $400 and above 80 MHz for up to about $1,000. Here again, LSI and packaging make the prices possible.
- Universal counter-timers, which measure frequencies every which way—time interval, period ratio, you name it—and therefore cost up to $4,000 or so. Here, Hewlett-Packard Co.'s 5345A still seems to hold sway, even though it is now about three years old.
- Microwave counters, now extending up to about 24 gigahertz, and the preserve of just a few manufacturers.

Overall, Hewlett-Packard still dominates the counter business. Prime Data of San Jose, Calif., a market research firm specializing in instruments, estimates that HP accounts for about 50% of counter sales in terms of dollars. Then the lower in unit price one goes, the greater the competition.

HP steers serenely through the fray. "Our product line is right now pretty well-balanced and is poised to be replaced one at a time," says its Santa Clara division's Duncan MacVicar, marketing manager for counters. But while HP introduced its



Dana Laboratories. An Intel 4004 microprocessor equips the series 9000 timer-counters to help users set up operations like sensing inputs and setting trigger levels.

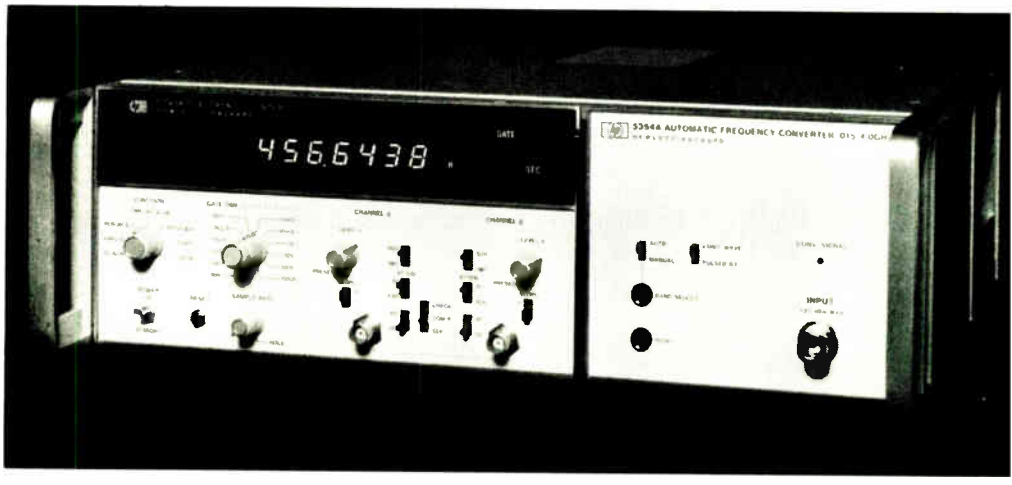
last new counter well over a year ago, other companies have unveiled a number of new models within the last half year.

Systron-Donner Corp., Concord, Calif., for example, has almost completely revamped its product line in that time. At Wescon '76, it introduced several new models, and more recently it also replaced its 80-MHz model 6203A, which sold for $435, with a B version costing $325—about a 25% price cut. The new counters use a custom p-channel metal-oxide-semiconductor chip made by Hughes Semiconductor.

Of its Wescon '76 introductions, the most unusual was the 6361A, a dual universal 100-MHz counter-timer. Both channels have the same capability and can be used simultaneously for measurements of two different frequencies or periods, with each set of figures displayed separately. According to Gail Dishong, Systron-Donner's counter marketing manager, one advantage here is in dealing with alternate periods. Conventional counters measure the period of every other event, whereas the 6361A will measure the periods missed by the other counters. In addition, the counter can simultaneously measure pairs of pulse-train parameters such as repetition rate and pulse width.

Also introduced at Wescon was the company's lowest-cost counter: the 10-MHz model 6202B, a frequency counter selling for $295. Although adequate for most jobs in that frequency range, Dishong does point out that the stability of the 6202B's crystal oscillator is not up to measuring frequencies at Federal Communications Commission standards. "Many users don't need the stability," he says, "but if anyone must meet FCC requirements, he must get the high-stability option"—a temperature-controlled crystal oscillator having about 10 times better stability but adding $100 to the 6202B's price.

At this low end of the market, a very recent entry is the 250-MHz model 585 portable counter from Data Precision Inc., Wakefield, Mass. The instrument, priced at $345, is built around a custom emitter-coupled-logic chip and operates from rechargeable nickel cadmium batteries. Data Precision, which had previously developed a line of portable digital multimeters, moved into portable counters only about two years ago. Company president Harold Goldberg says his low pricing is predicated both on LSI and on



Hewlett-Packard. The 5345A, though three years old, is still the top of HP's line, covering input frequencies from dc to 500 MHz with 20-millivolt sensitivity.

designing for production volumes. "This is no area for timidity," he says. "You've got to grit your teeth and say 'this product will sell so many' and then you can go out and get decent volume buys on the components."

John Fluke Manufacturing Co., Mountlake Terrace, Wash., is also competing heavily in the low-cost area with its model 1900A, a $375, 80-MHz frequency and period counter. However, the company may be ready for an update of its line since its most recent counter, the 1920A frequency counter, was introduced two years ago at Electro75. Selling for $895, the 1920A covers frequencies from 5 hertz to 520 MHz with 15-millivolt sensitivity.

Philips Test & Measuring Instruments Inc., Mahwah, N.J., introduced several units at last year's Wescon, including the $295, 80-MHz model PM6661 and the PM6664, which goes to 520 MHz for $675. Both frequency-only counters, they are portable instruments with 20-millivolt sensitivity.

Basic to their design is a chip made by Philips' proprietary Locmos (local-oxidation complementary-MOS) process, which, according to the company, offers the low power and other advantages of standard C-MOS, while also providing higher speeds, buffered outputs, and higher noise immunity. Worth noting also, says marketing manager Stu Rauch, is that these portable instruments are built with rugged metal, rather than plastic, cases.

Even Tektronix, the world leader in oscilloscopes, plays a part in low-cost counters through its line of TM500 modular instruments. The most recent of these is the lowest-priced of the counter series, the DC504, which was introduced about two years ago. Selling for $425, the unit performs frequency measurements to 80 MHz and period measurement to from 1 microsecond to 999.99 seconds.

Systron-Donner. The 6361A is a dual universal counter-timer that can make two simultaneous measurements on signals at frequencies ranging up to 100 MHz.

B & K Precision. The model 1827 frequency counter covers 100 hertz to 30 MHz with 100-mV sensitivity. It operates from six AA batteries and sells for only $120.

Also worth including here are the industrial panel-mounted counters, an area characterized by their leading manufacturer as a "sleeping giant." These use variable time bases so that industrial users can obtain readouts directly in such engineering units as revolutions per minute, gallons per minute, and the like. United Systems Corp., located in Dayton, Ohio, recently introduced its Digitec 8150 series, designed around a Hughes p-channel MOS chip. Priced at $450, the dc-to-1-MHz counter can be programmed, from the front panel or through a rear connector, to change the frequency of its time base so that the count displayed is directly in the engineering units.

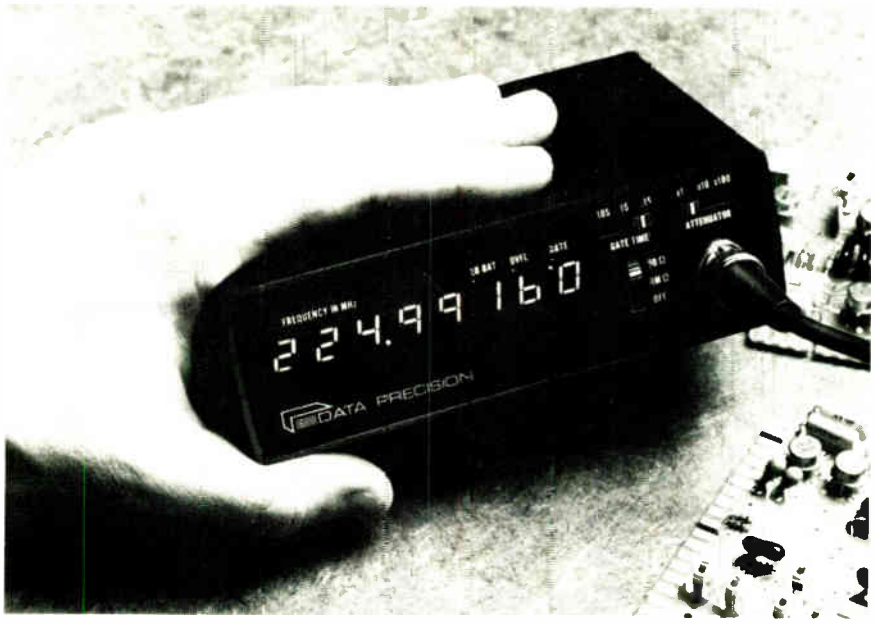
At the very lowest end of the market is the new $120 portable instrument from Dynascan Corp.'s B&K Precision in Chicago, Ill. A 100-hertz-to-30-MHz frequency counter, the model 1827 runs off six AA batteries and has a six-digit light-emitting-diode readout. Resolution is 1 part per million, and the crystal oscillator has 0.25-ppm stability. Sensitivity is 100 mV from 200 kilohertz to 30 MHz; 200 mV below 200 kilohertz. The 1827 uses a custom complementary-MOS chip made by Hughes.

While the B&K Precision counter shows how low the cost can go when a custom LSI chip is used, the use of microprocessors may turn out to be reserved for counters with more capability—and a higher price. For the past year, Dana Laboratories, Irvine, Calif., has been the only counter manufacturer to make a unit in which a microprocessor directly handles some of the operational functions. (Several other manufacturers have incorporated microprocessors to handle interfacing with the IEEE 488 bus.) Based on the Intel 4004 4-bit, p-channel MOS microprocessor, Dana's series 9000 timer-counters cover frequencies up to 512 MHz.

"We use the microprocessor in places where it takes over functions for the user," says Norbert Laengrich, Dana vice president for marketing. "The microprocessor doesn't improve the specs any," he amplifies, "but it does improve the ultimate performance for the user because it allows him to make accurate measurements without having to worry about operator error. One of the biggest problems, for example, is setting up trigger levels accurately. The microprocessor in the 9000 series lets the user do this merely by punching a button."

The basic model in the series, the 100-MHz 9015, sells for $2,995, while the 512-MHz 9035 sells for $3,945. Shipments of the original

Philips. The PM6661 is an 80-MHz portable frequency counter priced at $295, while the PM6664 goes to 520 MHz and sells for $675. Both units have 20-mV sensitivity.



Data Precision. The 585 portable frequency counter covers a range up to 250 MHz with 10-mV sensitivity, and it uses rechargeable nickel-cadmium batteries. Price of the unit is

units began in early 1976. Their most recent updating, at Wescon '76, added new user-oriented options. Among other things, these allow the user to control the measurement gate so that he can measure parameters of only a selected portion of a complex wavetrain—for example, he can select one pulse out of a train and make width and risetime measurements only on that.

With Dana the only manufacturer to have a microprocessor-based counter for more than a year, other manufacturers surely cannot now be far behind. In the next six months to a year, most of the major firms will probably introduce one. What they are saying now, however, is something like "We're not just going to add a microprocessor so that we can say we have a microprocessor-based counter. It has to justify itself by making the instrument better or easier to use." Or, more pointedly: "The microprocessor-based counter is more sizzle than steak. We're not going to put a microprocessor in simply to do some gymnastics."

Nevertheless, all agree there are functions that it would be worth using a microprocessor to perform. For example, HP's MacVicar points out that there are five areas in which a microprocessor would prove useful:

- Making the counter easier to use (for instance, by setting trigger levels, as Dana's series 9000 does).
- Performing averaging and displaying only meaningful digits obtained during repetitive measurements.
- Performing conversion arithmetic on inputs, as for display of results in engineering units, or subtracting offset frequencies, as when an intermediate-frequency amplifier is used to measure an input's frequency.
- Adding extra capabilities, such as a digital-voltmeter function. MacVicar points out that "with a microprocessor in a counter, the block diagram looks a heck of a lot like a DVM. The only difference is one chip—it's either a counter or a DVM—and all the rest is the same." The point is amplified by Philips' Rauch: "We're getting toward a universality of instrumentation. We will find counters and DVMs in a common box, and with digital memories, users will be able to make simultaneous measurements, storing readings for display upon call-up."
- Lowering the cost of high-end instruments. Of the 5345A, MacVicar says, "If we had had a microprocessor when we introduced it, we could have saved an awful lot of hardwired processor circuitry."

Even so, the HP 5345A, although three years old, still appears to be the top of the line in universal counter-timers. Priced at $4,250, it performs direct counting to 500 MHz with dc input amplifiers, and it has 20-millivolt sensitivity across the band. An unusual feature is the high-frequency 500 MHz clock, which allows the 5345A to make all frequency measurements by first measuring period and then converting to frequency. As a result, the counter takes only 1 second to measure any frequency from 1 Hz to 500 MHz with nine-digit resolution.

The 5345A also serves as the mainframe for microwave counter plug-in units in HP's line. Generally, the top frequency for today's microwave counters is about 23 or 24 GHz, which is obtained with a transfer oscillator technique. These counters sell for about $6,000 and, in fact, have been at that price level for several years, primarily because of the continuing high cost of microwave components. □

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GENERAL ELECTRIC

CRT controller showcases processor

Mostek's one-chip version of the F-8 handles communications, character generation, and formatting

by Larry Armstrong, Midwest bureau manager

Casting about for a way to demonstrate its new single-chip microcomputer, Mostek Corp. has put it into a controller that provides the intelligence for cathode-ray-tube terminals. While the mask-programmable device will eventually find its niche as a replacement for discrete logic in simple control applications, its debut will be in a new CRT terminal interface that Mostek will start selling next month.

"We figured the terminal application was a good example of a microcomputer displacing a lot of logic," says Robert F. Schweitzer, microprocessor marketing manager at the Carrollton, Texas, firm, "and CRT terminals make up a good part of the computer peripheral business." Built around Mostek's one-chip MK 3870, the single-board VAB II—for video adapter board—can be mated with an ASCII keyboard and video monitor—all that's needed for a complete CRT terminal. The board will sell for $195, which means a full terminal can be built for less than $450. That is substantially less money and a bit more capability than is presently offered by so-called dumb terminals, now being marketed for $850 and up.

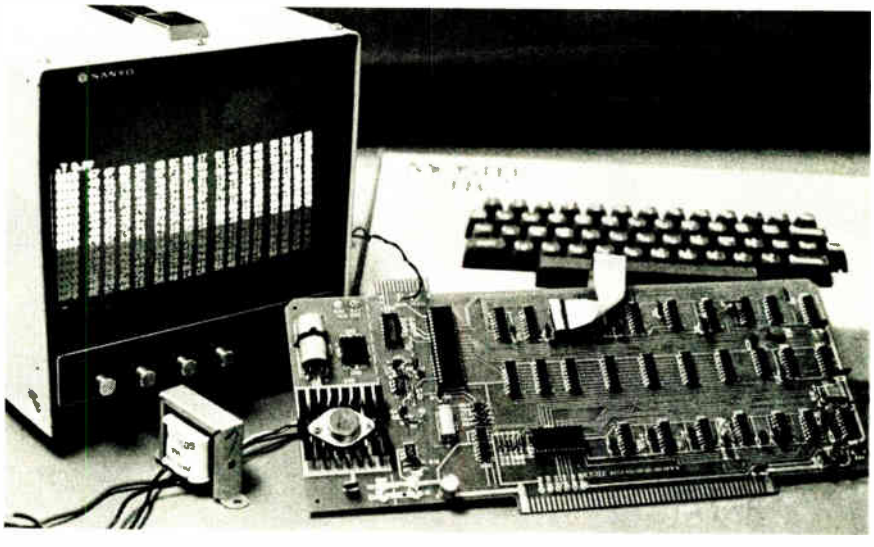
The 3870 is Mostek's single-chip version of the two-chip F-8 microcomputer originally developed by Fairchild Semiconductor [*Electronics*, Nov. 25, 1976, p. 46]. When programmed as a CRT controller, it replaces between 40 and 70 packages, Schweitzer says. The version being sampled provides full cursor control including character, line, and screen erase, and direct cursor addressing. Moreover, it handles full-duplex asynchronous communications with four baud-rate options. The device also formats the CRT screen into 16 lines of 64 5-by-8-dot-matrix characters. Other features that could be incorporated into custom mask programs include keyboard scanning, debouncing, and decoding; various code conversions; flashing and alternate-color fields; and screen readback control.

In addition to the microcomputer chip, the VAB II board has a character-generator ROM that supplies 96 symbols and alphanumerics, including lower case, and seven 1,024-by-1-bit static random-access memories for refreshing the display. Synchronization and timing of the video monitor, along with parallel-to-serial conversion of the character-generator output, are handled by standard TTL circuits.

The 3870, programmed as a CRT controller, complements the dedicated monitor scan controllers coming on the market from such firms as Standard Microsystems Corp. [*Electronics*, Feb. 17, p. 119], Intel Corp., Texas Instruments Inc., Fairchild Semiconductor, and Motorola Inc. "We're not trying to eliminate the dedicated CRT controller chips—they basically provide the high-speed counter chains that synchronize the refresh RAM with the CRT monitor," Schweitzer says. "The 3870 provides terminal intelligence, such as recognizing special control characters for editing. The two chips together will make a complete terminal interface," he points out, "but we're going to where the user options are, and that's where a mask-programmable device is going to be very attractive."

Mostek is not going into the terminal business, however, although it will probably eventually market a VAB II-based CRT terminal to support its own F-8 and Z-80 microprocessor development systems.

Mostek Corp., 1215 West Crosby Road, Carrollton, Texas 75006. Phone Bob Schweitzer at (214) 242-0444 [338]



Signal analyzer is fully calibrated

Digitally controlled 25-kilohertz instrument performs frequency- and time-domain analyses on signals and systems

by Stephen E. Scrupski, Instrumentation Editor

Today's electronics engineers have spent many hours in class learning how to analyze signals and systems with Fourier transforms, correlation functions, transfer functions, and so on. It's just too bad they didn't have the new Hewlett-Packard model 5420A digital signal analyzer, which handles signals up to 25 kilohertz and can determine such time- and frequency-domain functions as time-record averages, cross-correlation, autocorrelation, impulse responses, Fourier spectra, coherence, and so on. Well suited for servo-loop analysis, the instrument can even make Nyquist and Nichols plots, and it is equally useful for analyzing shock, vibration, and noise signals.

"The big thing about it is that it is fully calibrated," says HP's product marketing manager for the 5420A, Dick Watts. "In the past, instruments of this type required a great deal of user effort—taking into account gain settings, attenuator positions, and the like. Now, with the 5420A, all the user has to do is connect a signal to the front panel, check for overload, and push the run button to get an automatically calibrated result."

The $29,900 unit comes in three stacked cases. The bottom box holds the input-signal-conditioning circuitry and a digital filter, which has about 80-decibel rejection in the stop band and can translate a higher frequency (up to 25 kilohertz) down to near dc, where resolution is best. The middle box is actually an HP 2108-K computer on a board with a new front control panel. The upper box holds the cathode-ray-tube display and a minicartridge tape drive, which stores results.

The unit operates over a 25-kHz bandwidth with a dynamic range of 75 dB. Resolution to at least 0.004 hertz can be achieved anywhere in the frequency range, while down between dc and 250 Hz, the resolution can be as fine as 20×10^{-6} Hz.

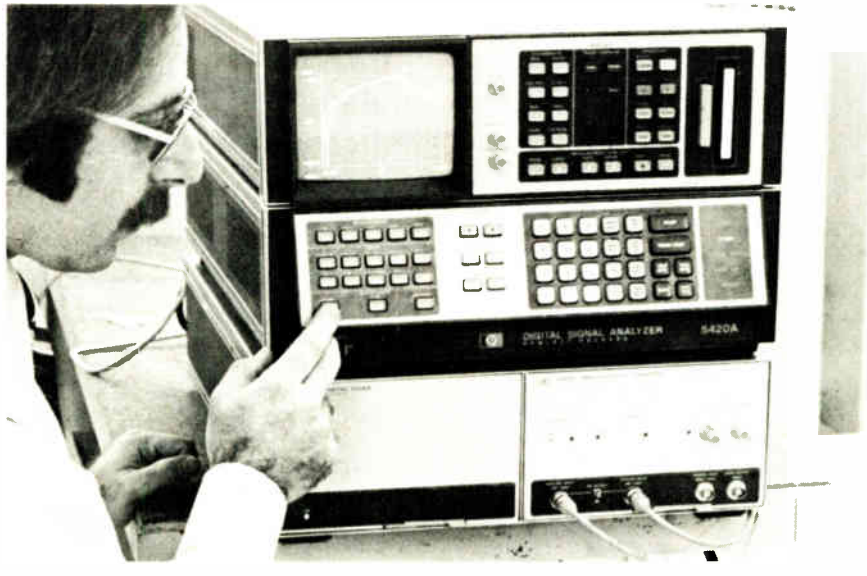
The unit has dual-trace capability so that signals stored on the minicartridge can be displayed and compared with incoming signals to reveal differences—for example, in signature analysis of vibrations, which would indicate impending mechanical failures.

In the time domain, the unit performs such measurements as time-record average, autocorrelation, cross correlation, histograms, and impulse response, while in the frequency domain, it performs such measurements as linear Fourier spectrum, power spectral density, cross power spectrum, transfer function, and coherence function.

One application, according to Watts, is in servo-loop analysis. Here the 5420A can measure the closed-loop gain and calculate the open-loop gain, which can be difficult to measure directly because it is often quite high. The instrument then can display a Nyquist plot on the CRT so that the user can determine stability criteria for the system. Watts cites the servo in a disk drive as typical of such analyses.

The instrument also takes over many of the calculations that previously were left up to the user. In Fourier spectrum measurements, for example, it is necessary to select a "window" in time for which the spectrum will be calculated, because otherwise there could be discontinuities at the edges. The system will set up the window and automatically smooth the edges without the user having to understand the complex mathematics involved.

Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif. 94304 [339]



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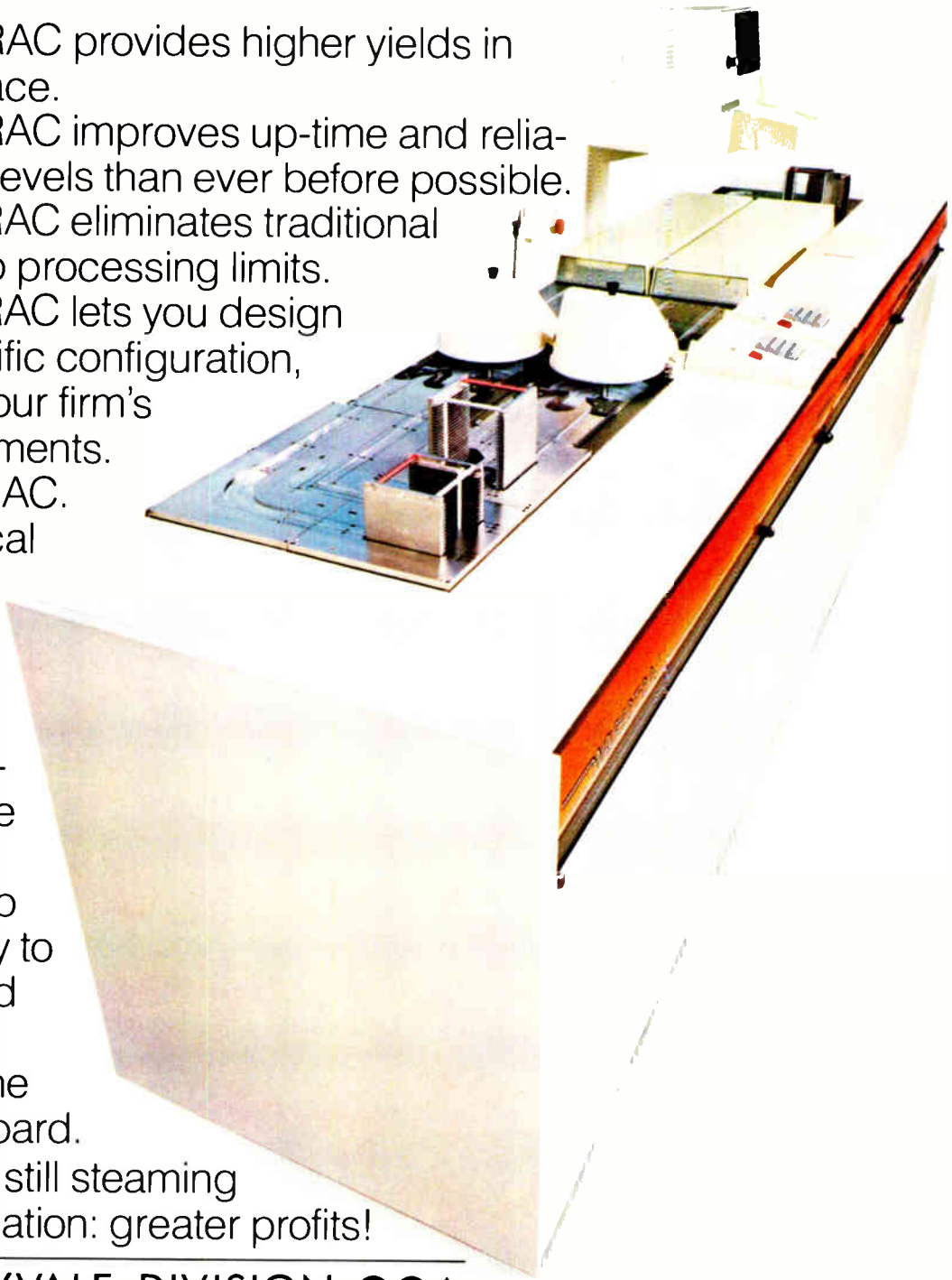

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Components

Cheap trimmers get better

Bourns enters market with low-cost cermet and conductive-plastic devices

The vast market for trimming potentiometers selling for a quarter or less has finally attracted the attention of the Trimpot Products division of Bourns Inc. One of the largest producers of trimmers, Bourns is introducing its first 25-cent and 15-cent devices: two open-frame units containing a cermet and a conductive-plastic element respectively.

The company wanted to produce low-cost units for the industrial-grade sector that maintained performance characteristics consistent with its higher-priced units, and the only way to do this, says Ronald P. Zimmerman, sales manager for trimmers, was to employ a different element material from competing open-frame devices. "It was ridiculous to take one more stab at carbon," he asserts.

Bourns wanted a contact-resistance variation of 1%, ease in setting, and board-washability. "None of these is possible with carbon elements," Zimmerman says.

Accordingly, Bourns chose cermet for its 25-cent 3354 model, and conductive plastic for its 3355 trimmer, to sell for about 15 cents in production quantities. "We knew both materials would work, but the trick was to build them at a low price," he says. In fact, development of the low-priced trimmers should be viewed primarily as improvements in production processes.

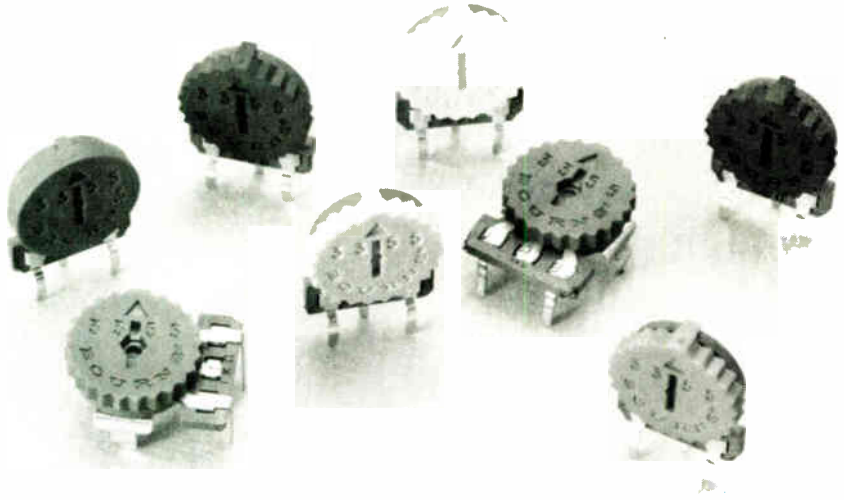
While using conductive-plastic elements on a plastic substrate is not unusual in other potentiometers, it is new to trimmers, Zimmerman explains. "It is faster and cheaper to work with and lends itself to continuous processing." So to get as "much hands-off production as possible," Bourns developed new types of ovens, handling equipment, and test equipment.

The 1% contact-resistance variation of the single-turn 3355 trimmer is considerably better than the 3% to 6% of comparable carbon models, Zimmerman says. The temperature coefficient of 500 parts per million per degree Celsius is also about half the competition. Settability on the smooth plastic surface is improved over the rough carbon material, and holes do not result from wear on the element at frequently set spots. Resistance range is 100 ohms to 5 megohms. The unit comes in three adjustment types: thumbwheel and smooth wheel with screwdriver slot, and thumbwheel with hexagonal adjustment.

With a cermet element on a ceramic substrate, the 3354 trimmer has a power rating of 1.25 watts at 40 C°, which Bourns says compares to 0.5 or 0.75 w for carbon elements. The temperature coefficient of 150 ppm/°C also is an improvement over the 250 ppm/°C of competing devices. Within the 100-ohm-to-5-megohm resistance range, special fixed values are available by request. Like the lower-cost 3355, the cermet trimmer is board washable.

Both trimmers are in stock.

Bourns Inc., Trimpot Products division, 1200 Columbia Ave., Riverside, Calif. 92507. Phone (714) 684-1700 [341]



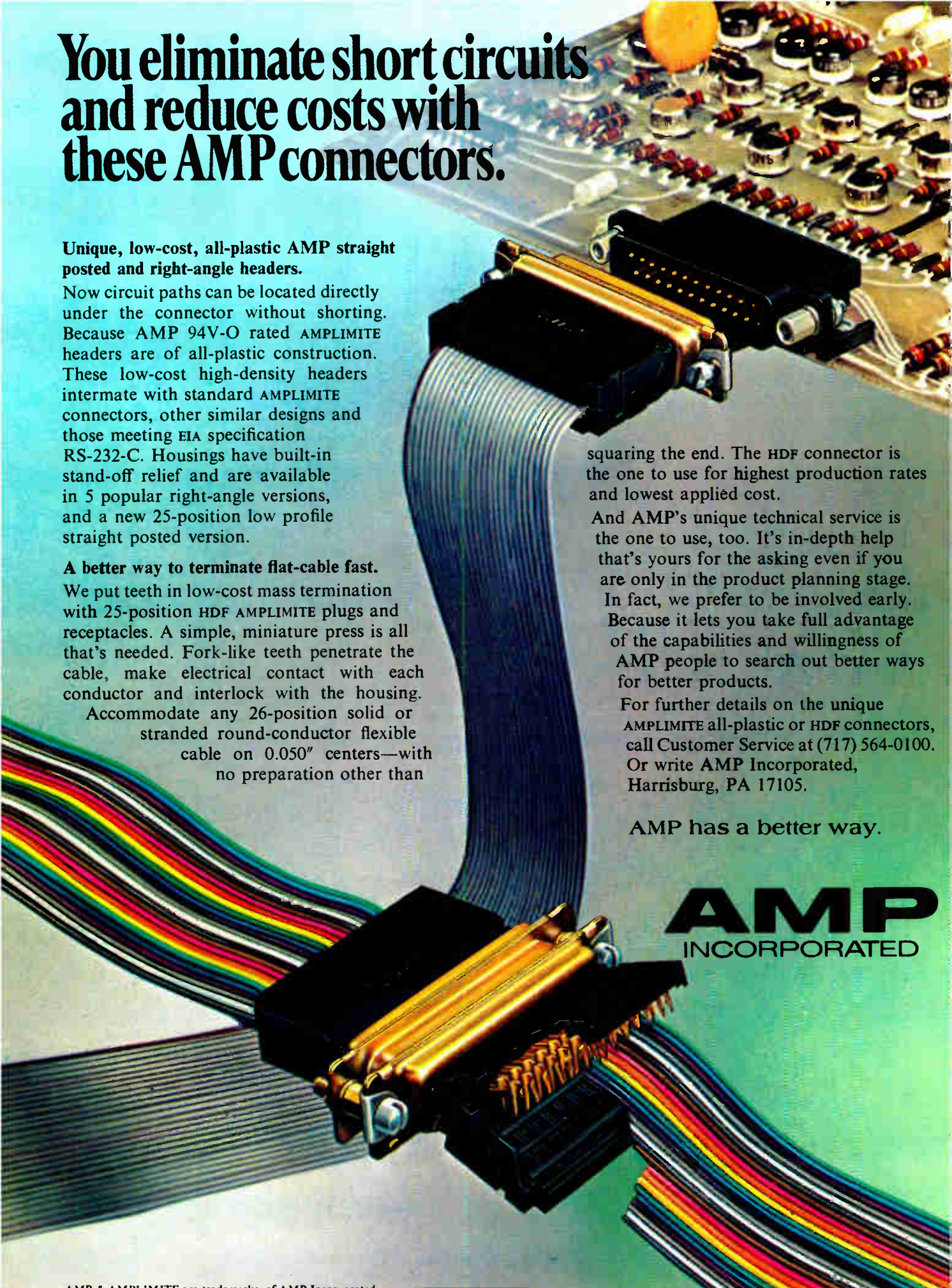
Tapped capacitors save on size and weight

A new type of capacitor with metallized dielectric windings can be tapped at different points to provide two or more capacitance and voltage ratings. It weighs less and takes up less space than two or more separate capacitors. Called a Multipacitor, a typical unit might provide 4 microfarads at 200 volts, 2 μF at 200 v, 1 μF at 400 v, and 0.47 μF at 400 v.

This typical unit would occupy only 70% as much volume and weigh only 70% as much as four discrete capacitors with the same ratings. Another advantage claimed for the patented device is increased reliability over discrete film-and-foil capacitors.

Multipacitors are available with individual sets of leads for each capacitor they embody, or they can be supplied with a common lead at one end and multiple leads at the

You eliminate short circuits and reduce costs with these AMP connectors.



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We put teeth in low-cost mass termination with 25-position HDF AMPLIMITE plugs and receptacles. A simple, miniature press is all that's needed. Fork-like teeth penetrate the cable, make electrical contact with each conductor and interlock with the housing. Accommodate any 26-position solid or stranded round-conductor flexible cable on 0.050" centers—with no preparation other than squaring the end. The HDF connector is the one to use for highest production rates and lowest applied cost.

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Precision Capacitor Division, American Radionic Co. Inc., 51 Austin St., Danbury, Conn. 06810. [343]

SIP resistor networks stand only 0.175 inch high

The latest addition to Stackpole's line of thick-film resistor networks is a family of miniature single in-line packages with 4, 6, 8, 10, or 12 pins. The SIPs, which are rated to dissipate 0.125 watt, measure just 0.175 inch above standoff; standard is 0.350 in. Resistances from 33 ohms to 10 megohms are offered in 64 standard values. Standard tolerance is 2%. A typical network sells for less than 15 cents.

Stackpole Components Co., P.O. Box 14466, Raleigh, N.C. 27610. Phone Joseph Slater at (919) 828-6201 [344]

Latching relays resist mechanical shock

A new type of latching relay consists of two relays mounted on a common plate. Either relay, when momentarily energized, is mechanically held in by the other one. Intended for on/off switching, power reversal, and similar applications, the arrangement is highly shock-resistant and can be supplied with either identical or different voltages for each coil. The contacts are rated to handle 5 amperes at 120 v ac. Available coil voltages are 6, 12, 24, 120, and 240 v ac. Required coil power is nominally 2.5 watts dc, 7.0 volt-amperes ac. Maximum power-dissipation capability of the coil is 4.0 w.

Artisan Electronics, 5 Eastmans Road, Parsippany, N.J. 07054 [346]

Subminiature indicator lamps offer mechanical dimming

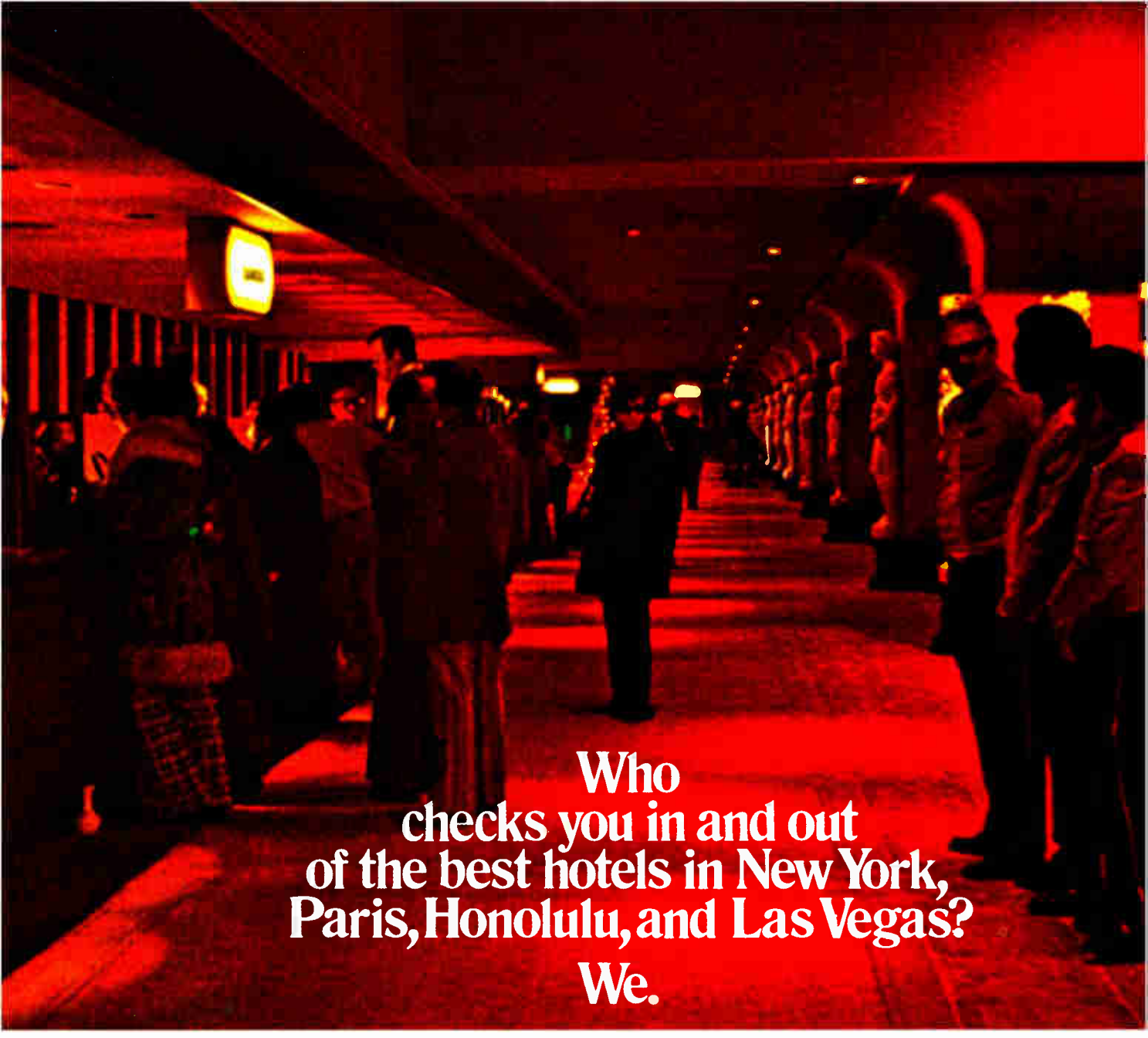
Two types of operator-actuated mechanical dimming are offered on Dialight subminiature indicator lamps to allow lamp brightness to be adjusted to ambient illumination. In both cases, a knurled portion of the lens cap is rotated to dim the light. In one case, a mechanical diaphragm is operated; in the other, the dimming mechanism is a Polaroid filter. All the lamps that offer the dimming feature use T 1¾ lamps and meet the requirements of MIL-L-6723 and -3661B. Prices, in lots of 1,000 pieces, range from $2.57 to $2.91 each.

Dialight, a North American Philips Co., 203 Harrison Place, Brooklyn, N.Y. 11237 [345]

Miniature high-resistance units have 1% tolerance

A line of miniature film resistors with resistance values from 2 to 100 megohms boast tolerances of 1% and temperature coefficients of 80 ppm/°C. Both the model MK 632 (0.3 inch square) and the MK 620 (0.25 in. square) measure only 0.1 in. thick. The resistors operate over the temperature range from −55°C to 175°C. The MK 620 units can dissipate up to 0.5 watt, while the MK 632 are rated at 0.75 w. A typical price is $1.05 each for a 10-megohm model MK 632 in quantities of 500 or more.

Caddock Electronics Inc., 3127 Chicago Ave., Riverside, Calif. 92507. Phone Richard Caddock at (714) 683-5361 [347]



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Data handling

Tough disk drive stores 2 Mbytes

Sealed moving-head unit operates at 131°F, resists shock and vibration

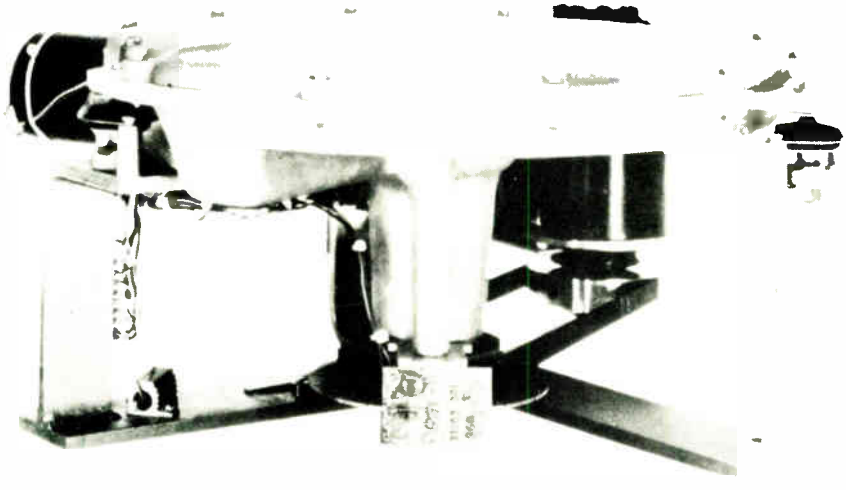
Because moving-head disk drives are physically delicate mechanisms, it has not been practical to use them in such otherwise promising applications areas as machine-tool control, oil exploration, and moving platforms (land vehicles, ships, aircraft, etc.) Now the D-100 disk drive from Digimetrix promises to change all this with its ability to operate at a temperature of 131°F, at a tilt of up to 45° from the horizontal, and while undergoing up to 10 g of shock and 1 to 2 g of vibration. (The drive can take 1 g of vibration from 5 to 30 hertz and 2 g from 30 to 500 Hz.)

Because it is completely sealed, the unit operates reliably in dusty, dirty, and humid environments. To further enhance its reliability, its dual flying heads are designed to land harmlessly at very low rpm, thus making it unnecessary to employ troublesome head-retracting mechanisms. The two parallel flying heads share a common ceramic slider unit that is positioned by a stepper motor and lead-screw assembly. The wear-compensating head carriage, for which a patent is pending, rigidly controls the head-to-disk spacing and effectively dissipates the stepper motor torque while providing necessary damping.

The D-100 is offered with storage capacities of 0.5, 1, and 2 megabytes. Two bit-transfer rates are available: 1.1 and 2.2 megabits per second. With a disk speed of 1,800 rpm, the drive has an average latency time of 7 milliseconds, a random average access time of 130 ms, and an average access time of 240 ms.

The recording medium is a 9-inch solid aluminum disk with nickel-cobalt plating and a nickel conversion wear coating. Track density is either 64 or 128 tracks per inch depending upon system capacity, with an error rate of 1 in 10^{11} in both cases. Both formatted and unformatted versions are available.

The D-100 measures 7 by 15 by 15 inches and weighs 20 pounds. In small quantities (1 to 9) the 524,000-byte D-100-2 sells for $1,350, the 1,048,000-byte D-100-3 for $1,650, and the 2,096,000-byte



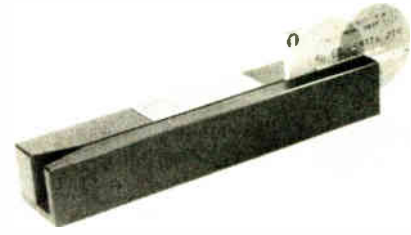
New products

D-100-4 for $1,950. In hundreds, these prices drop to $995, $1,195, and $1,395, respectively. The drives are also offered with Diablo 31-compatible electronics, with a formatter that includes an 8- or 16-bit parallel interface, and as a complete turn-key system.

Digimetrix Inc., 20954 Corsair Blvd., Hayward, Calif. 94545. Phone Dennis Setera at (415) 783-5614 [361]

Magnetic-card reader minimizes bit drop-out

The model 40 Magstripe card reader uses a gimbal-mounted card head suspended in a yoke by parallelogram springs to provide precise spacing between the head gap and the card. This minimizes spacing losses and bit dropout when warped, old, and dirty cards must be read. The unit provides C-MOS or TTL outputs consisting of a data stream



and a strobe. A companion unit, the model 50, has the same output, but offers a special security feature: the card must remain in the reader until the transaction or access is completed. Both units are manually operated; they thus require no electrical power for transport.

American Magnetics Corp., 2424 Carson St., Torrance, Calif. 90501. Phone (213) 775-8651 [365]

$400 computer terminal has built-in display

Designed for two-way communication with any RS-232-equipped device, the KDM/1 terminal has a built-in display and a price of only

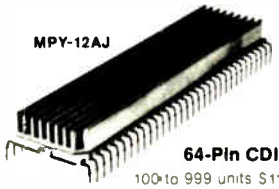
the Fastest Biggest Bipolar Multipliers you can buy

130 ns

100 to 999 units $70

8 by 8 Bits – Ideal for on-line multiply in micro and mini computers – operates directly on most data bus lines – consumes only 1.8 watts (typical)
Price $100 each in 1-9 quantities.

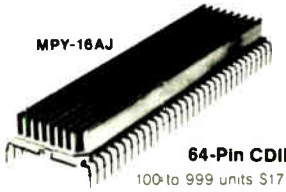
150 ns



100 to 999 units $115

12 by 12 Bits – New size multiplier for data communications and Signal Processing – needs only 3-1/2 watts for room temperature operation – single TTL Clock – fully TTL compatible – Price $165 each in 1-9 quantities.

160 ns



100 to 999 units $175

16 by 16 Bits – Smaller chip improves performance – 64-pin DIP easy to use – dissipates 5 watts with built-in heat sink – perfect for micro/mini applications – signal processing – price $300 each in 1-9 quantities.

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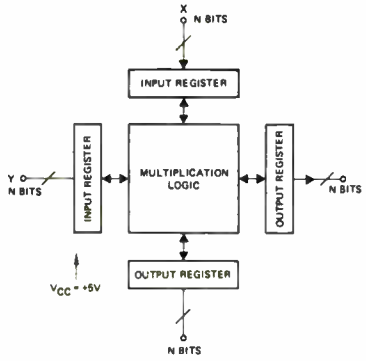

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New products

$400. The terminal includes a full ASCII keyboard and a 32-character alphanumeric LED display. The companion model KDM/2 is a similar device displaying 16 rows of 64 characters on a standard TV set. It sells for $500. The KDM/3, which uses a CRT monitor as a display, provides

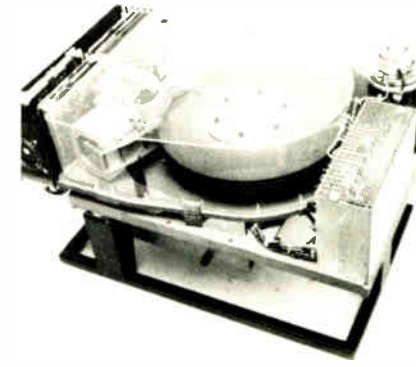
24 lines of 80 characters at a price of $700.

All KDM models operate at any of eight switch-selectable speeds up to 9,600 bauds. They are intended for use with computers, computer-controlled test equipment, bar-code readers, optical-character-reading scanners, and microprocessor development systems. Options include an acoustic coupler, cassette tape storage, and a badge reader. Delivery is from stock to 30 days.

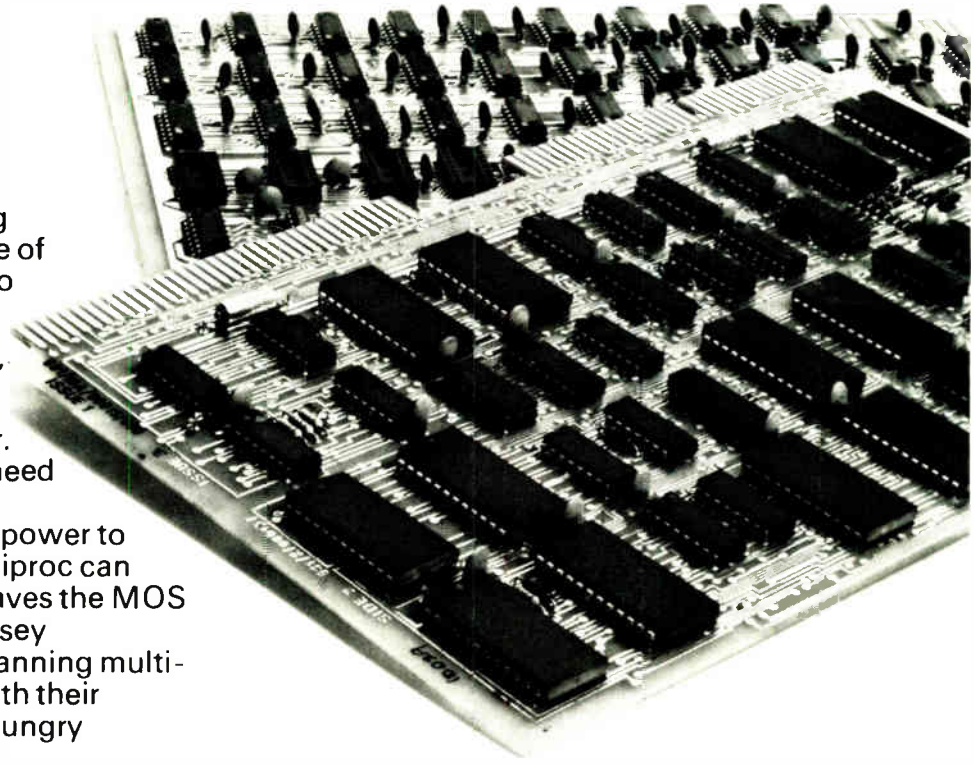
Micon Industries, 252 Oak St., Oakland, Calif. 94607. Phone (415) 763-6033 [363]

Small-system disk drive stores up to 75 megabytes

Designed specifically for use with small computer systems, the model 601 disk storage drive is offered with storage capacities of 25, 50, or 75



miproc gives the systems man 1980s micropower now



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West Germany
Tel: (089) 351-60-21

Jay Jhu
Plessey Microsystems
1674 McGaw Avenue
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megabytes. To maximize reliability, the system's read/write heads, rotary actuator, spindle, filter, and disks are housed in a factory-sealed airtight module. A special disk-coating technique and surface shield, which are proprietory to Memorex, are said to provide high output and resolution and to extend the useful life of the disk more than 100 times that of unshielded disks.

Memorex Corp., San Tomas at Central Expressway, Santa Clara, Calif. 95052. Phone (408) 987-2203 [366]

Tape cartridge carousel stores 32 megabytes

A compact mass-storage system that resembles a 35-millimeter circular slide projector holds 16 quarter-inch cartridges in a removable pack. The system, which has a capacity of 32 megabytes, includes a dual-microprocessor formatter to simplify interfacing, handle routine housekeeping functions, and reduce user programming requirements. Designed for unattended operation, the system is well suited for small and medium-size computer applications in which

short response time is not as important as low cost and large storage capacity.

A complete one-station carousel lists for $3,215 in quantities of 50. Four-station carousels go for $6,185 in similar quantities.

National Computer Systems, 4401 W. 76th St., Minneapolis, Minn. 55435. Phone (612) 831-4100 [367]

DEVICES	INPUT	DRIVERS PER PACKAGE	OUTPUT CURRENT	OUTPUT VOLTAGE	TYPICAL SPEED	CLAMPED DIODES	PACKAGE
SN75401-404	TTL	2	500mA	35V	33ns	No	14-pin NE DIP
SN75411-414	TTL	2	500mA	70V	33ns	No	14-pin NE DIP
SN75416-419	TTL/MOS	2	500mA	70V	100ns	Yes	14-pin NE DIP
SN75430-434	TTL	2	300mA	15V	15ns	No	8-pin DIP*
SN75450B-454B	TTL	2	300mA	30V	21ns	No	8-pin DIP*
SN75460-464	TTL	2	300mA	35V	33ns	No	8-pin DIP*
SN75470-474	TTL	2	300mA	70V	33ns	No	8-pin DIP*
SN75476-479	TTL/MOS	2	300mA	70V	100ns	Yes	8-pin DIP
ULN2001A-4A	**	7	500mA	50V	1μs	Yes	16-pin DIP
SN75466-469	**	7	500mA	100V	130ns	Yes	16-pin DIP
SN75441	ECL	2	100mA	30V	22ns	No	14-pin DIP

*SN75431-434/451B-454B/461-464/471-474 (AND, NAND, OR, NOR functions) are 8-pin devices. SN75430/450B/460/470 (AND function with externally connected output transistor bases) are 14-pin devices.
**Input capabilities include TTL; CMOS (5V and 6V-15V); and PMOS (5V, 6V-15V, and 14V-25V).

INTERFACE ICs

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The 401 series has a 35V off-state output voltage; the 411 and 416 series, 70V. The 416 series features output clamped diodes.

Series SN75430/75450B/75460/75470 – general-purpose duals with 300mA output current. These series offer a broad choice of voltage/speed combinations.

Series SN75476 – dual drivers with 70V off-state output voltage and output clamped diodes on the chip. No longer are external clamped diodes required to drive inductive loads.

These monolithic linear ICs deliver the specs you need. Within each series you have a complete choice of logic functions – AND, NAND, OR, NOR.

In addition to these dual drivers, TI also offers two series of seven-channel Darlington transistor array inverting buffers. The SN75466 series has an off-state output voltage of 100V; the ULN2001A, 50V. Input compatibilities include TTL; CMOS (5V and 6V-15V); and PMOS (5V, 6V-15V, and 14V-25V).

And there's also the SN75441 dual driver with positive OR logic, compatible with Series 10K ECL inputs.

Take stock of your peripheral driver needs today and place your order with Texas Instruments or your local authorized TI distributor.

Free data book. For your personal copy of the new 120-page Peripheral Driver Data Book, circle the reader service number indicated below or write Texas Instruments Incorporated, P.O. Box 5012, M/S 308, Dallas, Texas 75222.

TEXAS INSTRUMENTS
INCORPORATED

93102A

Circle 151 on reader service card

Packaging & production

Wiring system is multifaceted

Machine solder wraps twisted pairs, wraps wires, and aids in part insertion

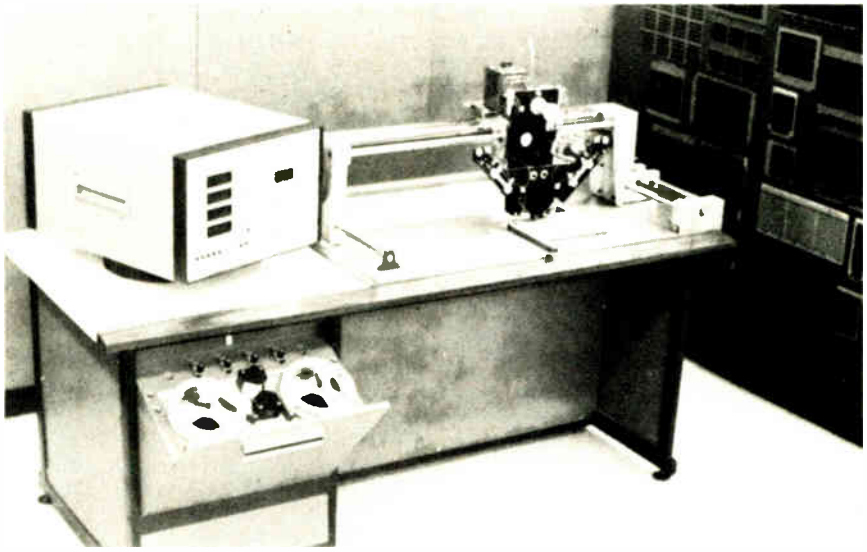
All automatic wiring systems are built around accurate X-Y positioning systems that move a special-purpose wiring tool only suited to its particular wiring method. In a departure from these single-purpose wiring machines, United Wiring and Manufacturing Co. has designed and produced a relatively low-cost automatic Solder-Wrap machine that, in a semiautomatic mode, can be adapted to laying down solder-wrapped twisted pairs, wire-wrapping, or inserting components. In addition, the machine can verify finished wiring panels or drill tapes.

The Model 100, which is priced at $35,000, is basically a fully automatic solder-wrapping machine that tests its wiring continually during the wire routing and soldering process [*Electronics*, April 14, p. 111]. It can position, solder, and cut 250 to 300 wires per hour on printed circuit boards as large as 20 by 29 inches.

With a $5,000 option, the new machine can be converted to a twisted-pair semi-automatic solder-wrapping machine. A light source, programmed with twisted-pair wiring data on paper tape, shines on the proper row/column address of a board. The operator then routes the twisted-pair wires with a motor-controlled tool by following the light's programmed positions. The result is a continuous net of twisted pairs that can be soldered and cut with the standard automatic mechanism of the machine. From 130 to 150 twisted pairs per hour can be put down with this special head.

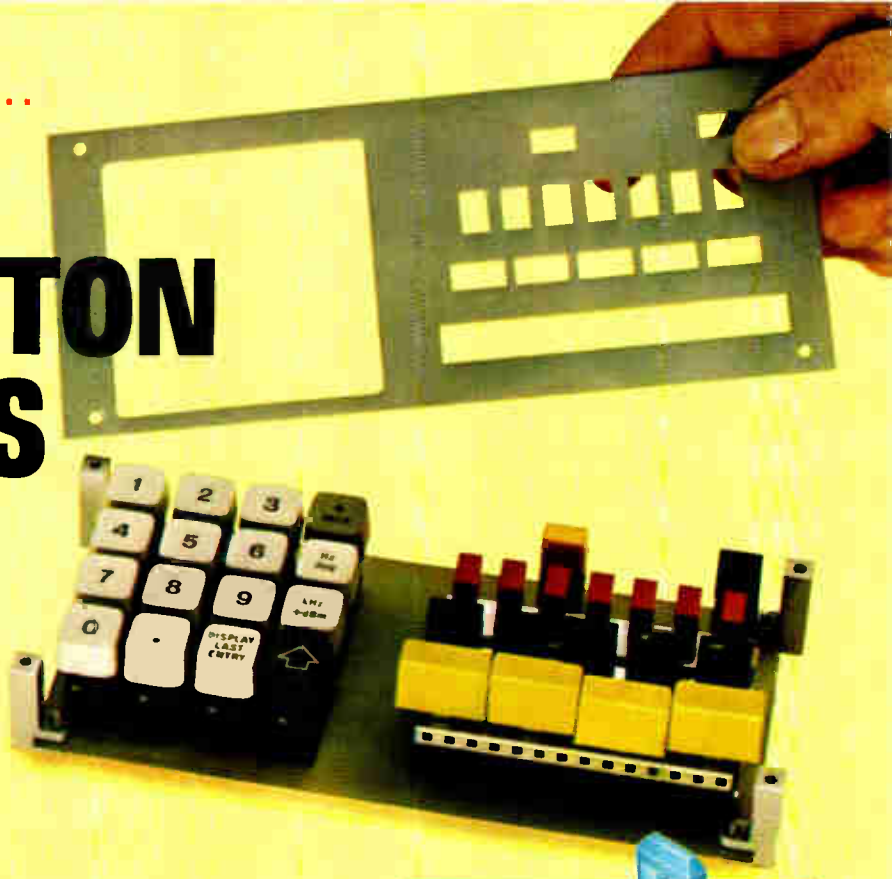
The model 100's Solder-Wrap mechanism can be removed, and a $2,000 Wire-Wrap head secured in its place in about ten minutes. While wrapping connections at a pace of 200 to 250 wires per hour, the machine displays the address location of the point being wrapped and also the wire length required for any particular wire on its console.

With the add-on light-pointing system, the machine can be programmed—for an additional $2,000—for component insertion. Guided by light shining on the board, an operator inserts a programmed component. The unit's three 5-digit console displays can be programmed to display bin number, part type, and address location on a pc board. From 500 to 600 components per hour can be inserted by



New from Centralab...

IMPS PUSHBUTTON SWITCHES



A new miniature modular building block system that offers microprocessor control designers more of what they need.

To meet the special digital and analog needs of today's μP-based controls, Centralab offers design engineers a whole new system of modular pushbutton switch building blocks. We call it IMPS — Integrated Modular Panel System. IMPS saves PC board and panel area and simplifies front panel design, cuts assembly costs, reduces back-panel space requirements, and meets the digital-analog needs of μP-based controls. Check these space saving, cost-cutting features.

Simplify front panel interface.

All IMPS switches regardless of function, are uniform in size, simplifying design and selection of front panel hardware. They have high volumetric efficiency, occupying .505" x .388" PC board area and require only .608" of space between PC board and front panel.

Cut assembly costs.

IMPS switches may be mounted on the front panel, and are designed for automatic wave soldering installation and PC board cleaning. Insert molded terminals prevent flux and solder wicking and contact contamination. Integral PC board stand-offs provide for efficient board cleaning.

Meet analog and digital needs.

IMPS switches are available with momentary, push-push and interlocking actions, with a long-life contact system that switches both digital and analog signals. To accommodate critical signal requirements, housings are high-insulation molded plastic with UL 94V-0 rating.

Available options.

Optional installations include ganged assemblies, front-panel mounting and wire-wrapping.

All IMPS pushbutton switches are built to Centralab's highest quality standards (see specifications at right). They're priced as low as 41 cents in 1,000 quantity. For full technical details, samples and quotation, call (515) 955-3770, or write to the address below.

CENTRALAB
Electronics Division
GLOBE-UNION INC
P O BOX 858
FORT DODGE, IOWA 50501

Built To Centralab Quality Specs.

IMPS Pushbutton Switches combine compact size, low cost and highest quality throughout.

- Silver or gold inlay wiping contacts for long-life and low-contact resistance.
- Less than 2 milliseconds contact bounce.
- SPST, SPDT, DPST, and DPDT switch contacts.
- Printed circuit, DIL socket or wire-wrap terminations available.
- 2.5 to 3.5 oz. actuation force (momentary).
- Choice of button interface — square or blade shaft (shown) — permits use of a variety of Centralab and industry standard buttons and keycaps.
- 10, 15, 20 or 25mm center-to-center spacing.

Circle 153 on reader service card

utilizing this assembly aid.

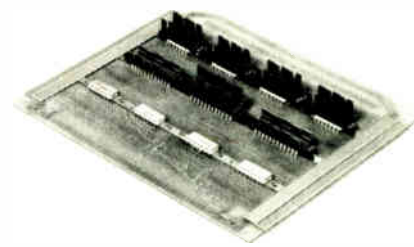
The light-pointing system can be also used to test for wire verification of both Wire-Wrap and Solder-Wrap panels. The wire-net number under verification is shown on one of the console's 5-digit displays.

The Model 100 also can be programmed to be a flat-bed plotter for checking drill tapes, and the Solder-Wrap stringer mechanism can be adapted to hold a plotter pin. This pin can be programmed up or down to verify tapes for Solder-Wrap, Wire-Wrap, and pc boards of all types.

United Wiring and Manufacturing, 2612 Electronic Lane, Number 404, Dallas, Texas 75220. Phone (214) 350-4978 [391]

Heat-dissipation system cools board-mounted DIPs

A heat-dissipation system for circuit boards loaded with dual in-line packages uses copper strips to carry heat from the DIPs to the board edges, and, subsequently, to the surrounding environment. The copper strips, called conduction planes, are the heart of the system. They are arranged in parallel rows across the circuit board so that the DIPs straddle them.



Each strip makes good thermal contact with the DIPs in its row and carries an estimated 25% to 35% of the heat generated by those devices to transfer bars that attach to the sides of the boards. From the transfer bars, the heat is carried to the outside world. The system can be augmented by the addition of ordinary staggered-finger radiators that clip onto the DIPs.

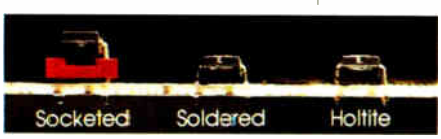
A major benefit of the system is

AUGAT ANNOUNCES THE PC BREAKTHRU OF THE DECADE

The card you're looking at is an ordinary printed wiring board with an extraordinary difference. There's not a solder joint anywhere. Every component is plugged into place.

It's this simple: Augat has invented a way to turn plated-through holes into plug-in sockets.

Think what that means: all the benefits of component



plugability with no need for sockets or the headaches of soldering. You get socketed components with card spacing as low as .400"!

And the cost? Less than the total soldered cost of typical inexpensive sockets.

Intriguing, yes? So is the way it works. At the heart of our new method, (which we call the Augat Holtite™ system), is a special adaptation of the long-proven, beryllium copper precision contact that we've turned out by the billions over the past decade for reliable component lead interconnections

You simply insert the contacts into your plated-through holes, press them into place...

and just like that you've got a component "socket" built right into your board. It's that simple.

Another thing you'll like: switching to our new Holtite system is totally painless. You continue to use the same artwork, drill tapes and process specs. Simply drill the holes to the recommended diameter.

As to mass loading the contacts into your boards, that's easy too. We lease you a machine that does it automatically at a rate of 30,000 contacts an hour, which includes pressing them into place using a standard hydraulic press.

We're confident our Holtite system is going to revolutionize PC component socketing, and we invite you to be a part of it.

To get started, order one of our Holtite prototyping kits (for $94.50) from your Augat distributor, or from us. It has everything you need (1,200 contacts, tools, instructions and test report) to try out our idea firsthand on your own boards. Give it a whirl—this week!

Order Kit No.
398-HK-001

Augat Inc., 33 Perry Avenue, P.O. Box 779, Attleboro, Mass. 02703. Tel. (617) 222-2202.

AUGAT®

Augat interconnection products, Isofranic microcircuit packaging, and Alco subminiature switches.

Circle 155 on reader service card

New products

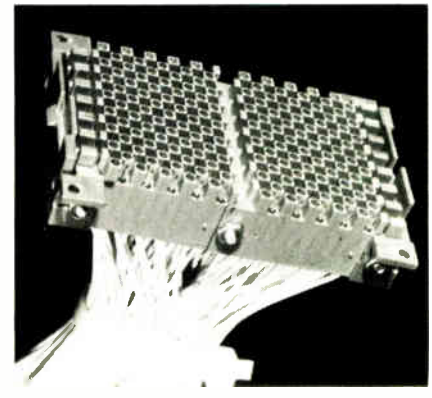
its flexibility, according to the manufacturer. Where competitive systems force the user to work within fixed dimensions, the company supplies conduction plane strips and transfer bars in any desired lengths or in bulk. The heat-dissipation system was unveiled in New York last week at Electro77.

International Electronic Research Corp., a subsidiary of Dynamics Corp. of America, 135 W. Magnolia Blvd., Burbank, Calif. 91502. Phone (213) 849-2481 [393]

Brush-contact connectors cut mating forces up to 90%

A line of connectors for printed-circuit boards are said to provide reductions in mating and unmating forces of 70% to 90%. Called the Bendix Bristle Brush (B^3) Line, the connectors incorporate the brush-contact concept in which connector mating is accomplished by the meshing of bundles of brush-like wires, rather than the mating of conventional pins and sockets.

Each brush contact is a bundle of fine gold-plated beryllium-copper wires retained in a metal holder. The wire clusters provide redundant current paths and minimize constriction



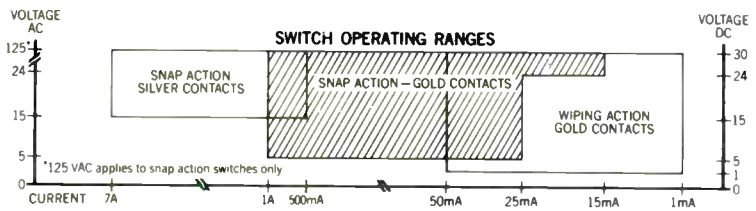
resistance. Designed for durability, they are reported to have a lifetime in excess of 20,000 mating/unmating cycles.

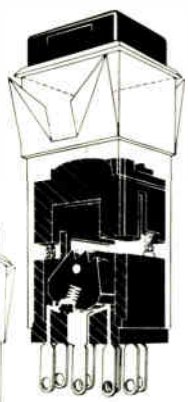
The new connector line includes mother and daughter board connectors, pc receptacles, and input/output connectors. Versions with two, three, and four rows are available

Dialight Switches

A switch for all reasons.

Reason 1: Dialight offers three switch configurations to meet all your needs—*snap-action switches with silver contacts* for moderate-level applications, *snap-action switches with gold contacts* for intermediate-level applications, and *wiping-action switches with gold contacts* for low-level applications. Each of these ranges is served by two switching actions—momentary (life: 750,000 operations) and alternate (life: 250,000 operations).





Reason 2: Dialight's snap-action and wiping-action switches come in a new modular design concept . . . a common switch body for either high or low current operation. All 554 series switches and matching indicators have the same rear-panel projection dimensions.

The snap-action switching mechanism guarantees a fast closing and opening rate. This insures that contact force and contact resistance are independent of the switch's actuation speed.

In the wiping-action switch, the contacts are under constant pressure (A unique Dialight design). This insures long life with a minimum build-up of contact resistance.

Both switch types are tease-proof.

PRODUCT SELECTOR GUIDE

SWITCHING ACTIONS	Snap-Silver contacts		Snap-Gold contacts		Wiping-Gold contacts	
	SPDT	DPDT	SPDT	DPDT	SPDT	DPDT
MOMENTARY	○	○	○	○	○	○
ALTERNATE	○	○	○	○	○	○

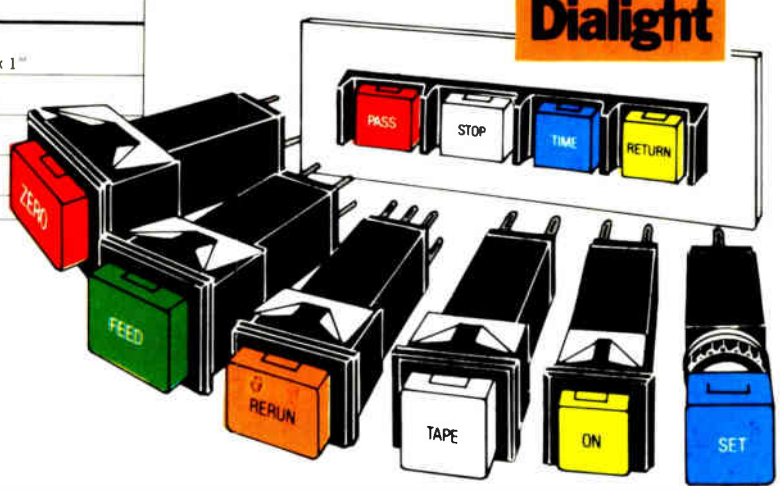
OPTIONS	PUSH BUTTON CAP SIZES				
	½" Sq.	⅝" Sq.	⅝" x ¾"	¾" Sq.	¾" x 1"
BEZEL MOUNTING TO ACCOMMODATE	○	○	○	○	○
BEZEL MOUNTING WITH BARRIERS TO ACCOMMODATE		○	○	○	○
PANEL MOUNTING TO ACCOMMODATE	○	○	○	○	○
MATCHING INDICATORS	○	○	○	○	○

Reason 3: Dialight offers a wide variety of panel and snap-in bezel mounting switches with momentary and alternate action configurations in SPDT and DPDT types. There are over 240 switch variations to choose from.

The 554 illuminated switch, designed for front of panel lamp replacement, gives you a choice of five different bezel sizes . . . ¾" x 1", ⅝" x ¾", ¾" square, ⅝" square, and ½" square. The first four sizes are also available with barriers. You also get a choice of six cap colors . . . white, blue, amber, red, green, and light yellow . . . four different underlying filter colors . . . red, green, amber, and blue and a variety of engraved or hot-stamped legends . . . over 300 cap styles . . . over 100,000 combinations.

There is also a variety of terminal connections . . . solder blade, quick connect, and for PC board insertions.

Reason 4: Dialight's 554 series is designed as a *low cost* switch with *computer-grade quality.*



DIALIGHT

A North American Philips Company
203 Harrison Place, Brooklyn, N.Y. 11237
(212) 497-7600

Circle 157 on reader service card 157

New products

with lengths of 10 to 100 contacts. Marketing Dept., Bendix Electrical Components Division, Sidney, N.Y. 13838. Phone (607) 563-9511 [394]

Monitor checks wiring during and after assembly

The model AM-200 electronic assembly aid is a portable instrument designed to monitor the wiring of cables with connectors at one or both ends. It requires no special programming and is used to alert assemblers to wiring errors during and after assembly. Audio and visual alarms are energized each time a wrong termination is attempted, and the miswired conductors are identified on a LED display.

The AM-200 can also be used as an automatic continuity tester. It sells for $995.

T&B/Cablescan, 145 E. Emerson Ave., Orange, Calif. 92665. Phone (714) 998-1961 [395]

Tester checks microprocessor boards at full rated speed

Designed specifically to test microprocessor boards, the 3040A Logictester can apply user-defined test sequences at rates up to 1.5 million words per second. According to the manufacturer, this will more than match the instruction execution speeds of today's microcomputer boards and provides for the testing of devices not yet announced.

In addition to the application of user-defined sequences, the 3040A can also run its own automatic sequences at rates up to 5 megahertz. It can intermix both types of sequences to minimize programming time while maintaining a high test confidence.

As a diagnostic tool, the 3040A uses cyclic redundancy checks. Offered in 128- and 240-pin versions, the tester sells for $60,000 to $95,000 depending upon options.

Fluke Trendar Corp., 630 Clyde Ave., Mountain View, Calif. 94043 [396]

VACTEC Photodetectors

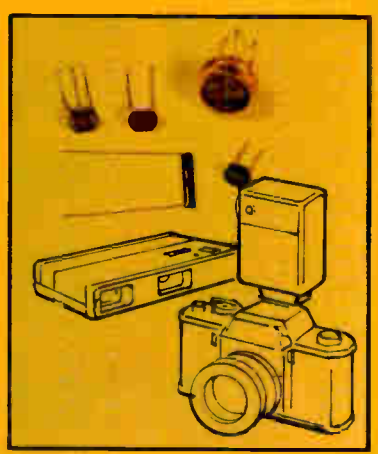
The Industry's Broadest Line Provides More Semiconductor Detectors for More Design Applications

Vactec serves manufacturers of a wide range of modern electronic products. Pictured are a few examples. All these devices are both made and sold by Vactec, including complete lines of LDR's (photoconductive cells, CdS and CdSe); silicon solar cells, as well as silicon high speed and blue enhanced cells; NPN phototransistors and darlingtons; opto-couplers (LED/LDR, lamp/LDR and neon/LDR); selenium photovoltaic cells; silicon photodiodes, blue enhanced and PIN; and custom C-MOS and bi-polar IC's. Write for technical bulletins on the types that suit your requirements. Or send your application, and Vactec will recommend the right cell for the job.

Vactec, Inc.
2423 Northline Industrial Blvd.
Maryland Heights, Mo. 63043
(314) 872-8300

Electronic Organs

LED or lamp/LDR Vactrols for audio, and CdS cells for swell pedal controls.



Cameras and Projectors

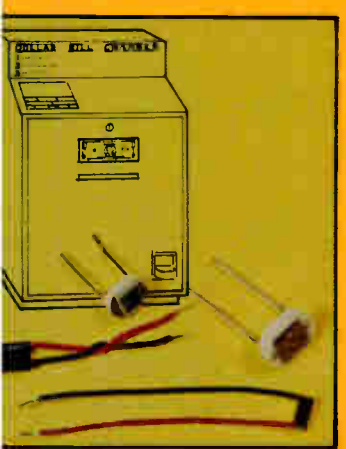
CdS or blue enhanced silicon photodiodes for automatic shutter timing, aperture servo systems for automatic projector focus; and slave flash controls

Triac Motor Controls

A special Vactrol gates a triac for forward and reverse motor operation as in hospital beds.

LED Watches

Photoconductive or phototransistor chip controls LED brightness.



Dollar Bill Changers

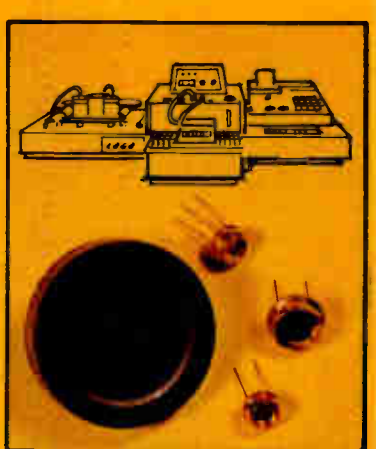
Silicon photovoltaic cells analyze optical characteristics.

Machine Tool Controls

High-speed photovoltaic cells or transistor arrays help computer control repetitive operations, non-contact sensing, and counting and weighing.

Telephone Equipment

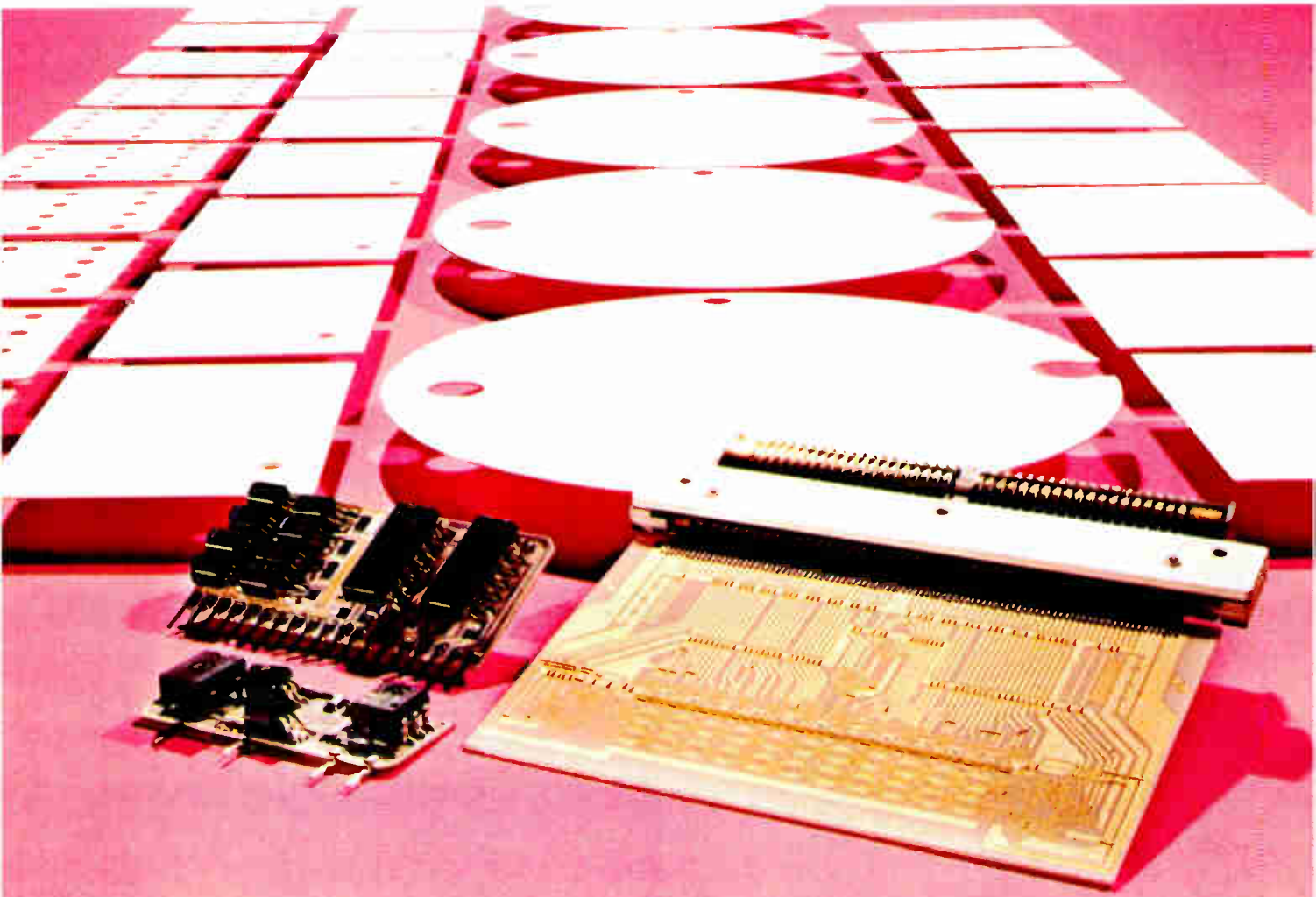
Neon/LDR Vactrols sense ringing. Direct a-c coupling, slow LDR response isolates electronics from noise.



Scientific Instruments

Blue enhanced silicon or selenium photovoltaic cells detect solutions densitometrically for precise blood chemistry and other analyses.

Circle 159 on reader service card



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You've told us fast response to customer orders is critical to your success in hybrid markets. Coors understands. We've made a commitment to give you the fastest delivery of thick- or thin-film substrates.

Through continuing investment in production facilities, we've cut lead times to give you better service on the largest or smallest orders. A new plant, under construction now, will significantly expand capacity for even faster delivery in late summer, 1977.

But plant capacity is just one factor in Coors ability to cut your lead times. A special substrate service group—with a direct Substrate Hotline—gives you fast quotes and personal follow-through on all orders.

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Circle 160 on reader service card

Subassemblies

High-voltage op amp is fast

Thick-film hybrid device swings up to ± 145 V dc at slew rates to 150 V/μs

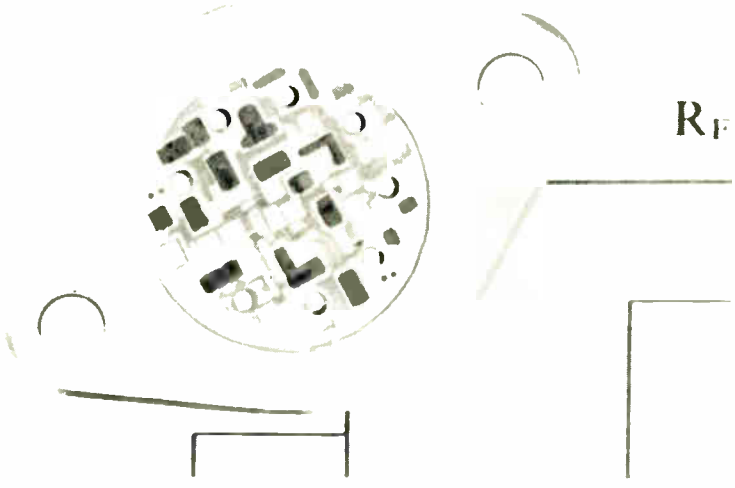
Although high-voltage operational amplifiers are fairly fast devices, their output slew rate has heretofore been limited to about 30 volts per microsecond. Now, however, Burr-Brown has produced a truly high-speed, high-voltage op amp—one capable of slewing at 150 V/μs, and swinging over an output range of ±65 to ±145 v dc.

Designated the 3584, the new amplifier is a thick-film hybrid circuit packaged in a hermetically sealed TO-3 metal can. Among the applications that design engineer Bill Olschewski ticks off are: analog computers, digitally controlled power supplies, electrostatic transducers, and deflection amplifiers for cathode-ray tubes.

Most of the resistors in the op amp are thick-film cermet components, but a few critical ones were fabricated in thin-film nichrome, Olschewski notes. "We attach the capacitor, semiconductor, and thin-film resistor dice with epoxy," he says, "while the output transistors are attached using the eutectic-gold reflow method." Interconnects between the chips and the package are made with 1-mil-diameter gold and aluminum wire.

At a voltage gain of 100, the 3584 provides a minimum gain-bandwidth product of 20 megahertz, with 50 MHz being typical. It operates over a wide range of supply voltages, from ±70 to ±150 v dc. Common-mode rejection is 110 decibels.

Input bias current is kept down to 20 picoamperes by means of a field-effect-transistor input stage. Input offset voltage is a maximum of 3 millivolts, and it drifts no more than 25 microvolts/°C.



The secret behind the 3584's excellent common-mode performance is its true cascode input stage and its overvoltage protection circuitry. Voltage-limiting diodes prevent damage caused by reverse-bias breakdown of the input FET pair, and current-limiting resistors hold the steady-state input current to a maximum of 1 milliampere even with the maximum supply voltage applied to the input terminals.

Additionally, the 3584 contains thermal-sensing and shut-off circuitry that automatically turns the amplifier off when the internal substrate temperature reaches approximately 150°C. This feature, says the firm, means that the 3584 does not require a massive heat sink for protection in case the power dissipation should become abnormally high.

Because of the cascode input stage, the unit's input bias current is virtually independent of the applied common-mode voltage. Also, since its metal case is electrically isolated, the device need not be mounted with insulating spacers. In quantities of 1 to 24, the op amp is priced at $86 each, dropping to $68.80 each for 25 to 99. Delivery is from stock to within six weeks.

Burr-Brown Research Corp., International Airport Industrial Park, Tucson, Ariz. 85734. Phone (602) 294-1431 [381]

10-kHz v-f converter sells for only $21

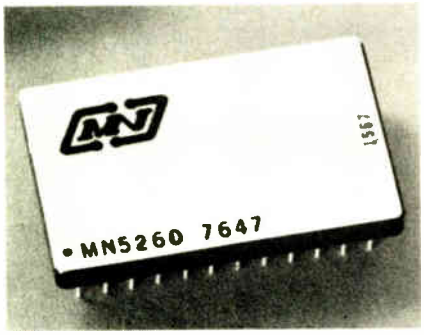
Priced at only $21 apiece in hundreds, the model 4723 voltage-to-frequency converter is a 10-kilohertz unit that can be used to make a 10-bit a-d converter for about $25. The converter has a maximum nonlinearity of 0.01% of full scale, a maximum full-scale error of 0.5%, and a temperature coefficient of 50 ppm/°C. Its initial zero-offset error is no more than 5 millivolts.

The 4723 is housed in a module that measures 1.14 inches square by 0.4 in. high. It requires a ±15-volt power supply from which it draws a maximum of ±18 milliamperes. It is available from stock.

Teledyne Philbrick, Allied Drive at Route 128, Dedham, Mass. 02026. Phone (617) 329-1600 [386]

Adjustment-free a-d converter pulls only 230 mW

Housed in a hermetically sealed dual in-line package, the MN5260 is a 14-bit analog-to-digital converter that consumes only 230 milliwatts of power. The adjustment-free device operates over the temperature range



from 0°C to 70°C with a maximum nonlinearity of one least significant bit and a maximum total error of 0.4%. At 25°C its maximum nonlinearity is reduced to half an LSB and its maximum total error to 0.04%. The unit's 14-bit conversion time is typically 175 microseconds.

Typical applications for the MN5260 include remote-site seismological monitoring, precision portable instrumentation, and high-accuracy industrial equipment. In small quantities, the converter sells for $275.

Micro Networks Corp., 324 Clark St., Worcester, Mass. 01606. Phone (617) 852-5400 [385]

Dot-matrix display can be programmed

The model SSD0132-0081 Self-Scan display is a dot-matrix, gas-discharge panel that can show up to 32 characters at once. Its repertoire of 64 characters is contained in a pair of programmable read-only memories so it can be changed at any time. The 0081 can be outfitted with a 128-character repertoire by providing 64 standard characters in

a masked read-only memory with an additional 64 custom characters in the pair of PROMs. Maximum character entry rate is 166,000/s.

The panel's 5-by-7 dot-matrix characters measure 0.2 inch high by 0.14 in. wide; they are easily readable at distances up to 15 feet. In thousands, the display sells for $172 each, without ROMs or PROMs. Delivery is from stock.

Burroughs Corp., Electronic Components Division, P.O. Box 1226, Plainfield, N.J. 07061. Phone John Pittman at (201) 757-5000 [384]

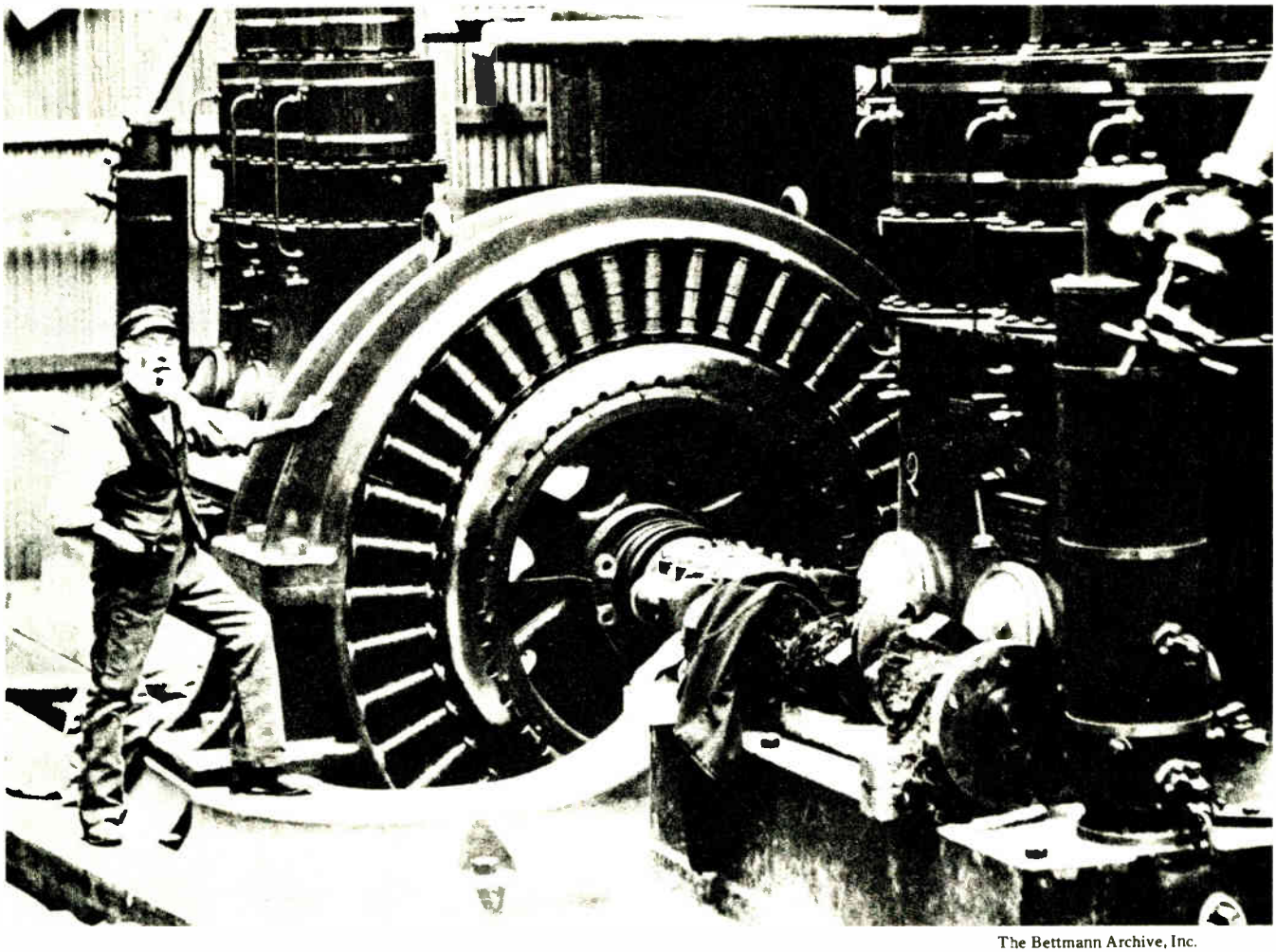
Modular digital-to-analog converter resolves 18 bits

The model DAC1138 digital-to-analog converter is a modular unit with a resolution of 18 bits. Capable of settling to within one least significant bit within 18 microseconds, the high-resolution converter is offered in two versions: the DAC1138J, which sells for $750, is linear to within 1 LSB; while the DAC1138K, priced at $950, is linear to within half an LSB. Both devices will operate over the temperature range from 5°C to 50°C. The "K" version will maintain 18-bit accuracy over any 20°C span in that range.

Expected applications for the 18-bit d-a converters include high-resolution cathode-ray-tube displays, automatic semiconductor testing, typesetting, frequency synthesis, and reactor control. Delivery of the converter is from stock to 30 days.

Analog Devices Inc., P.O. Box 280, Norwood, Mass. 02062. Phone Alan Haun at (617) 329-4700 [383]

If high start-up costs have delayed your expansion, contact Georgia.



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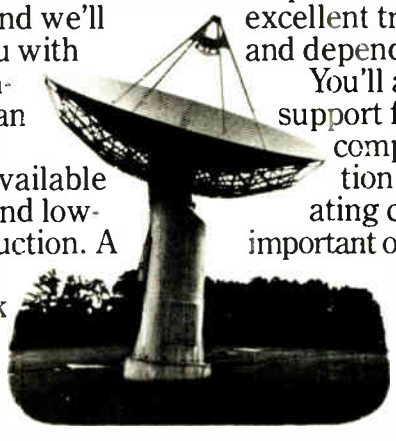

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For more information contact Milt Folds, Commissioner, Georgia Bureau of Industry & Trade, P.O. Box 1776, Atlanta, Georgia 30301, Dept. EL-77.

Georgia

Now Norden gives DIGITAL's PDP-11/34 all the muscle it needs to work in any military environment.

New PDP-11/34M uses exactly the same software as commercial PDP-11/34.

First in a new family of militarized computers, the PDP-11/34M combines Norden's experience in military electronics with DIGITAL architecture and DIGITAL software.

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Familiar features plus militarized peripherals.

Packaged in half or full ATR chassis, the PDP-11/34M offers standard PDP-11 features as well as modular core memory from 16K to 128K words in increments of 16K and 32K. Also, a full range of militarized peripherals is available including tape drives, disk drives and display terminals.

First shipments go out in July 1977.

For more information, call or write Director of Marketing, Computer Products Center, Norden Division, United Technologies Corporation, Norwalk, CT 06856. Telephone (800) 243-5840 toll-free, or call (203) 838-4471.

PDP-11 data processing with Norden military muscle.

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Semiconductors

Two-chip set converts 4½ digits

Quantized feedback reduces sensitivity to frequency drift and comparator error

By combining a "quantized feedback" conversion technique with an ion-implanted mixed MOS and bipolar process, Siliconix Inc. has developed a two-chip analog-to-digital converter for a 4½-digit (20,000-count) voltmeter.

Designated the LB120/121, the chip set consists of an analog processor (the LD 120) fabricated with Siliconix' mixed process and a digital controller (the LD 121) made with standard depletion-load p-channel metal-oxide-semiconductor technology. In quantities of 100 or more, the price of the chip set is $14.81. Purchased separately, the LD 120 costs $6.43 each and the LD 121 $8.38 each in 100-up quantities.

According to Marvin Vander Kooi, manager of IC product marketing, the LD 120/121 can sample over a range from one to five samples per second and has 0.5-count stability on a 2-volt range. Intrinsic features of the chip set are auto-polarity, auto-zero, and ratiometric operation. "No critical components are required externally except for a stable voltage reference," says Vander Kooi. Unlike other converter products on the market, he adds, the integrator output voltage is never more than 100 counts. "Thus, critical, high-resolution performance is not required of either the integrator or the comparator."

The proprietary quantized feedback gives the Siliconix chip set superior linearity and normal-mode rejection and stability, according to Vander Kooi, because of the simultaneous integration of the unknown input voltage and the reference voltage. The technique is charge-balancing, like the dual-slope method. But where dual slope measures and counts in sequence, quantized feedback allows the two operations to be done simultaneously. Additional benefits of this approach are reduced sensitivity to frequency drift and comparator errors, plus a fixed conversion time.

Incorporated on the LD 120 analog processor are five amplifiers and some control logic fabricated with a combination of p-MOS FETs and bipolar transistors. The input buffer amplifier, the auto-zero buffer amplifier, and the analog switch control logic are MOS FET, while the reference buffer, integrator, and comparator are bipolar. The reference voltage input is fully buffered on the LD 120 to eliminate the reference-switch resistance as a source of error. All the amplifiers are internally compensated.

The LD 121 contains all the digital circuitry for the quantized feedback system. Device outputs supply two over-range signals, underrange, sign, and 4½ digits of multiplexed binary-coded-decimal data. All outputs are TTL-compatible. Overrange above 20,000 counts is indicated by blinking digit strobes. An output is provided to inhibit this feature at user option. Microprocessor-controlled operation is simplified by a start-conversion input that allows conversion on command. An external capacitor provides frequency control for the internal timing generator.

Available now, the LD 120 has 16 pins, the LD 121 has 18. Both are supplied in 300-mil dual in-line plastic packages.

Siliconix Inc., 2201 Laurelwood Rd., Santa Clara, Calif. 95054 [411]

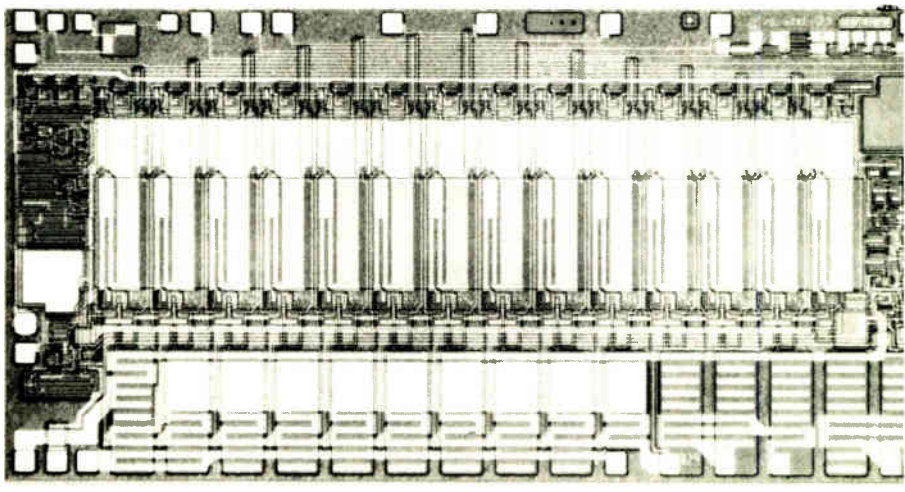
12-bit d-a converter settles within 100 ns

The HI562A monolithic 12-bit digital-to-analog converter from Harris Semiconductor division settles to within half a least significant bit in only 100 nanoseconds. Ernest Thibodeaux, the division's marketing manager for data-acquisition systems, attributes this unprecedented speed to the low capacitance of the device—a direct result of using the company's proven dielectric isolation process to build it, instead of the junction isolation used in competitive devices. He looks for the HI562A to be used in high-speed analog-to-digital converters, in cathode-ray-tube graphics applications, and in other video systems.

The converter can be considered a faster one-chip version of the two-chip AD562 made by Analog Devices Inc., Norwood, Mass. Like the AD562, it consumes 400 milliwatts, but its 100-ns conversion time is 1/15 of the AD562's 1.5 microseconds.

Harris guarantees that the HI562A is linear to within half an LSB over the full −55°C to 125°C military temperature range.

Four versions are available from stock. The HI562A-2, which covers



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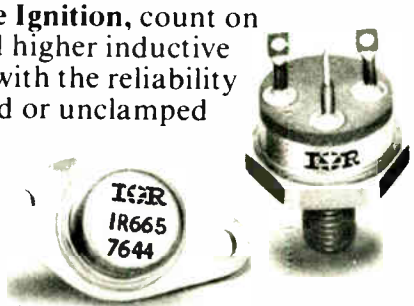

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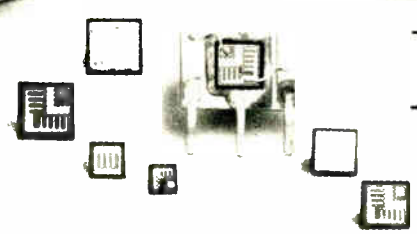

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New products

the full military temperature range, sells for $108 in quantities of 100. An industrial version, the HI562A-4 (−25°C to 85°C), is priced at $43, while the commercial HI562A-5 (0°C to 70°C) carries a $29 price tag. Finally, prices are available on request for the HI562A-8, which is processed to MIL-STD-883.

Harris Semiconductor Division, P.O. Box 883, Melbourne, Fla. 32901. Phone Ernest Thibodeaux at (305) 724-7217 [412]

Switching transistors drop only 0.7 V at 70 amperes

A family of double-diffused npn switching transistors is characterized by a saturation voltage of only 0.7 volt at a collector current of 70 amperes. The devices have a cutoff frequency of 30 megahertz at a collector current of 10 A, plus a typical beta of 10 at an I_C of 70 A. Voltage ratings from 80 to 150 volts are offered. Available package configurations include TO-3, TO-59, TO-61, and TO-63—either standard or isolated.

Semicoa, 333 McCormick Ave., Costa Mesa, Calif. 92626. Phone (714) 979-1900 [413]

4-k static RAM retains data while pulling only 1.2 mW

The MK 4104P-3 is a 4,096-bit static random-access memory with a maximum access time of 200 nanoseconds, a maximum cycle time of 310 ns, a maximum power dissipation of 165 milliwatts, and a typical standby power requirement of only 0.3 microwatt per bit, or about 1.2 mW total.

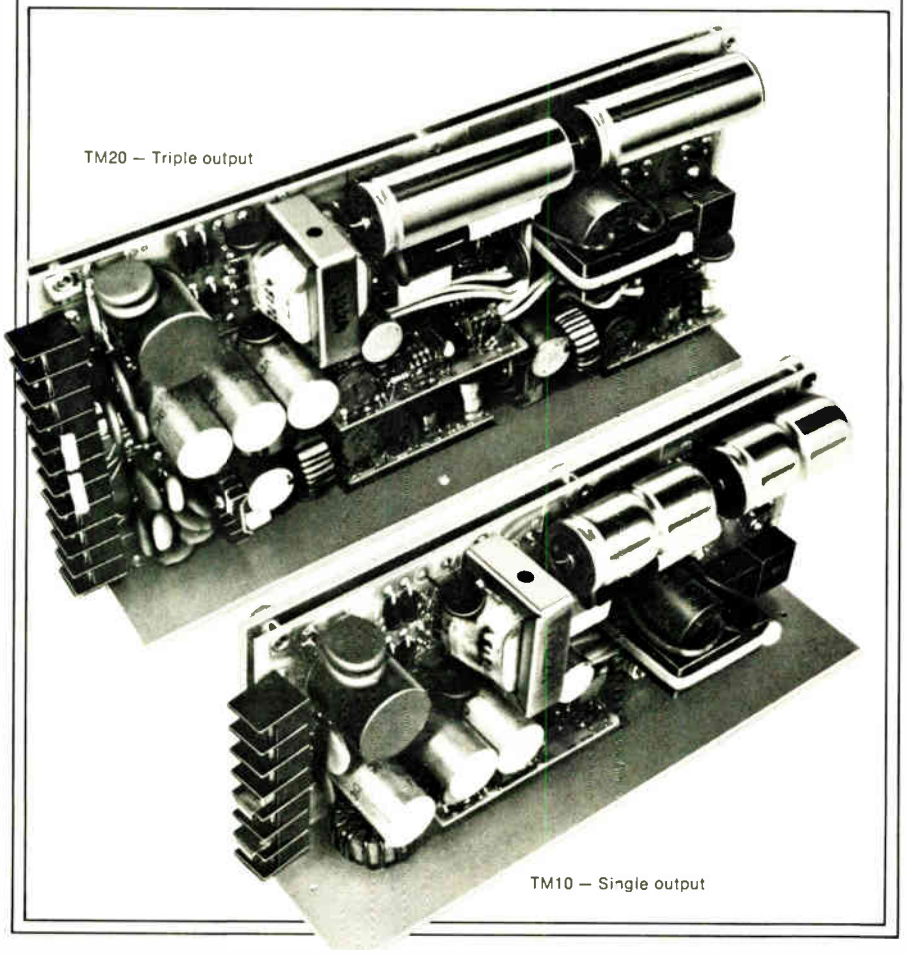
The low-power memory actually has two standby modes. If its chip-enable line is forced to an inactive state, the power consumption drops to a maximum of 27 mW. To cut power consumption further, the supply voltage must be reduced.

Housed in an 18-pin ceramic DIP, it sells for $18.75 each in hundreds.

Mostek Corp., 1215 W. Crosby Rd., Carrollton, Texas 75006. [414]

FROM THE WORLD'S LARGEST SWITCHER MANUFACTURER . . .

NEW *Tiny-MITE* Open-Frame Switchers



Single- and multiple-output switchers for OEM computers and terminal systems.

Power density of 1w/in.³

With LH's Tiny-MITE switchers you get power density of 1 watt/in.³ in small, *open-frame* packages offering up to 75-percent efficiency — at a price much lower than switchers usually sell for.

The single-output TM10 packs 100 watts in a package that's only 9.5 in. L x 4.0 in. W x 2.5 in. H and weighs only 3 lbs. The triple-output TM20 produces 150 watts in a package that's 12.0 in. L x 5.0 in. W x 2.8 in. H and weighs less than 4 lbs.

Single- and triple-output units

TM10's single-output voltage is 5 volts adjustable ±5 percent at 100 watts; other outputs are available including 12, 15, 18, 24, and 28 volts standard. The TM20's primary output is 5 volts adjustable ±5 percent at 20 amperes with second and third outputs in any of the following combinations: 5 volts at 5 amps, 12 volts at 5 amps, 15 volts at 5 amps, 18 volts at 3 amps, 24 volts at 2 amps, or 28 volts at 2 amps. (Combined power outputs may not exceed 150 watts.)

More power, less space

TM10 and TM20 are perfect choices for OEM computer and terminal system applications. Why? Because the new Tiny-MITE switchers were specifically designed for high volume, low cost production and to pack more power in less space. This high power density is especially important when circuit redesign demands more power and there is no more space in your package.

Technology used in the new TM Series was developed by LH and has been proven in over 30,000 switchers now in the field. And to further assure reliability, every LH switcher is tested and burned-in before shipment.

Advanced circuitry = versatile specs

- Wide input variation standard — 92-130 VAC and 180-260 VAC, 47-450 Hz.
- 50 mv or 1% peak-to-peak ripple and noise on output.
- 0.4% line regulation over entire input range.
- 0.4% load regulation from no load to full load.
- Power failure signal and remote on/off control standard.
- Response time of 200 μsec to 1% after 25% load change at 5 amps/μsec.
- 0°C to 50°C operating temperature range in natural convection. Derated to 50% load at 70°C.
- Designed to meet UL 478.
- 1-cycle ride-through (16 msecs) before power fail is signaled.
- Fold-back current limit on outputs.
- Overvoltage protection standard (on main output) — factory-set at 125% ±5%.
- Remote sense (main output only) compensating for load cable loss up to 250 mv.
- — and a whole lot more.

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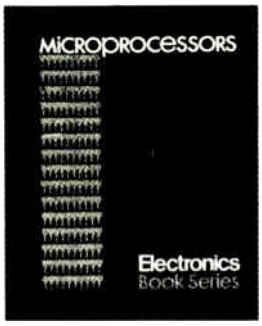

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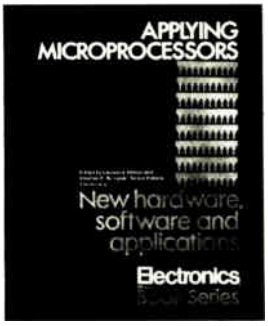

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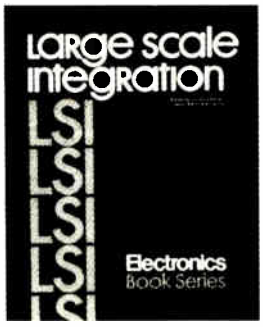

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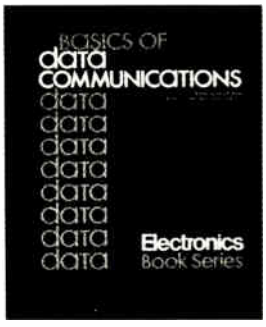

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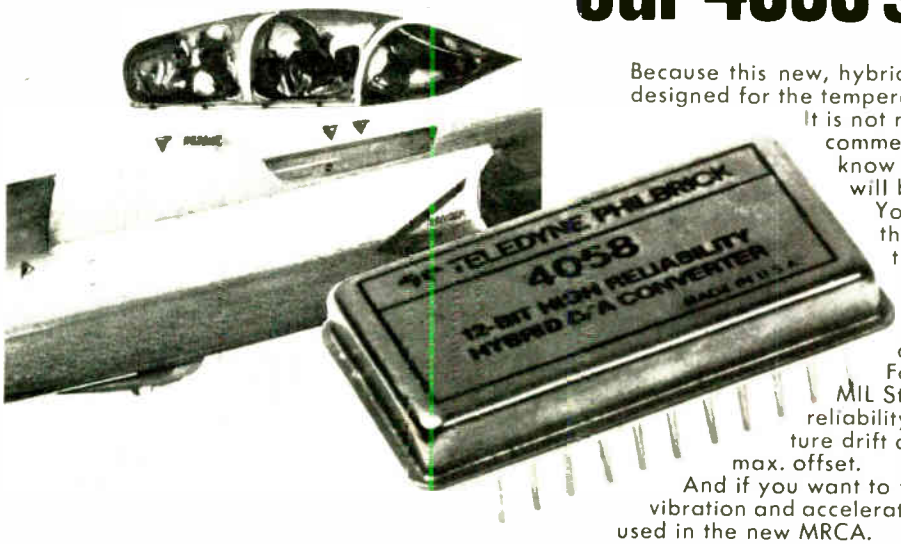

Because this new, hybrid 12 bit DAC was specifically designed for the temperature range – 55 to + 125°C. It is not merely a top-end selection of commercial DAC's, where you don't know today what tomorrow's yield will be.

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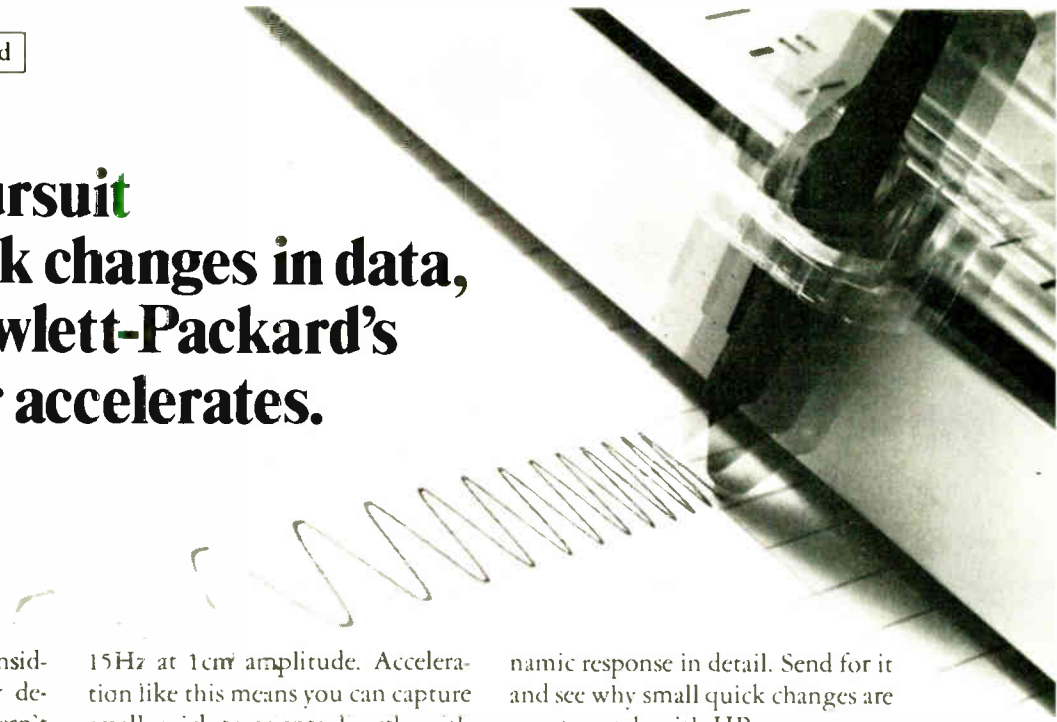

Ordinarily, XY recorders are considered to be very low frequency devices. But Hewlett-Packard doesn't build ordinary XY's. Ours give you the definite advantage of high speed combined with acceleration to almost 10G. To demonstrate, we took our model 7045A and swept frequencies from below 5Hz to 15Hz at 1cm amplitude. Acceleration like this means you can capture small quick transients directly with an HP XY recorder.

Hewlett-Packard builds this kind of acceleration into both one and two pen XY recorders. We've just published a new technical note that explains this extraordinary dynamic response in detail. Send for it and see why small quick changes are easy to catch with HP.

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RTR22	D	L,P,W,X	½" square
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CERMET

Style	Characteristics	Qualified Terminals	Description
MIL-R-22097			
RJ12	C,F	L,P,Y	1¼" long
RJ22	C,F	L,P,W,X	½" square
RJ24	C,F	L,P,W,X	⅜" square
RJ26	C,F	P,W,X	¼" square
RJ50	C,F	P	¼" round
MIL-R-39035			
RJR12	C,F	L,Y	1¼" long
RJR24	C,F	P,W,X	⅜" square
RJR26	F	P,W,X	¼" square
RJR28	C,F	P	½" long
RJR32	C,F	D	¾" long DIP

. . . and at a new level of reliability

Not only did we invent the trimming potentiometer in 1952, but we're reinventing it all the time. Patented design innovations incorporated into our Mil-Spec line have brought a new level of reliability unequaled in the industry:

NEW DRIVE SYSTEM — Substantial reductions in material wear and increased rotational life are derived from this "pin-free, lock-free" construction.

SWAGE BOND—High energy "sonic swaging" transforms the cermet element and the termination into an integral one piece unit, providing a connection that is electrically and mechanically more reliable.

CHEVRON SEAL—This unique shaft-to-housing environmental seal is "O-ringless," resulting in uniform torque without any springback.

WRAP-AROUND WIPER — With this feature, wiper pressure is consistent, allowing for better "setability" and lower CRV.

Find out for yourself why we're number one, send for complete technical information from the award winner — Bourns, direct or through your local distributor.

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