JANUARY 6, 1977

DEMAND OUTSTRIPPING SUPPLY OF LIQUID-CRYSTAL DISPLAYS/67

What's hot at the Solid State Circuits Conference/71

Microprocessors in action: keyboard scan saves hardware/110

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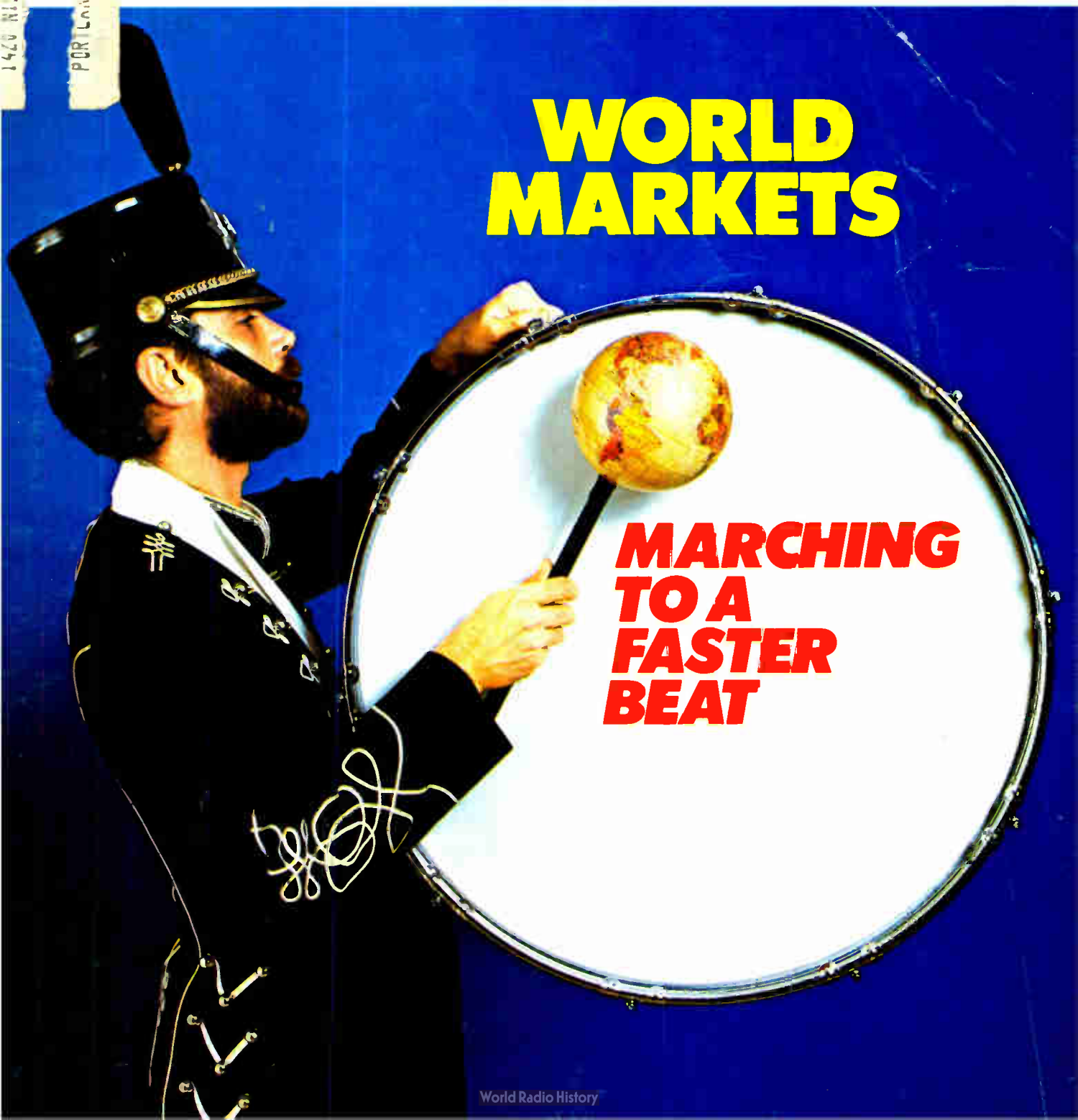

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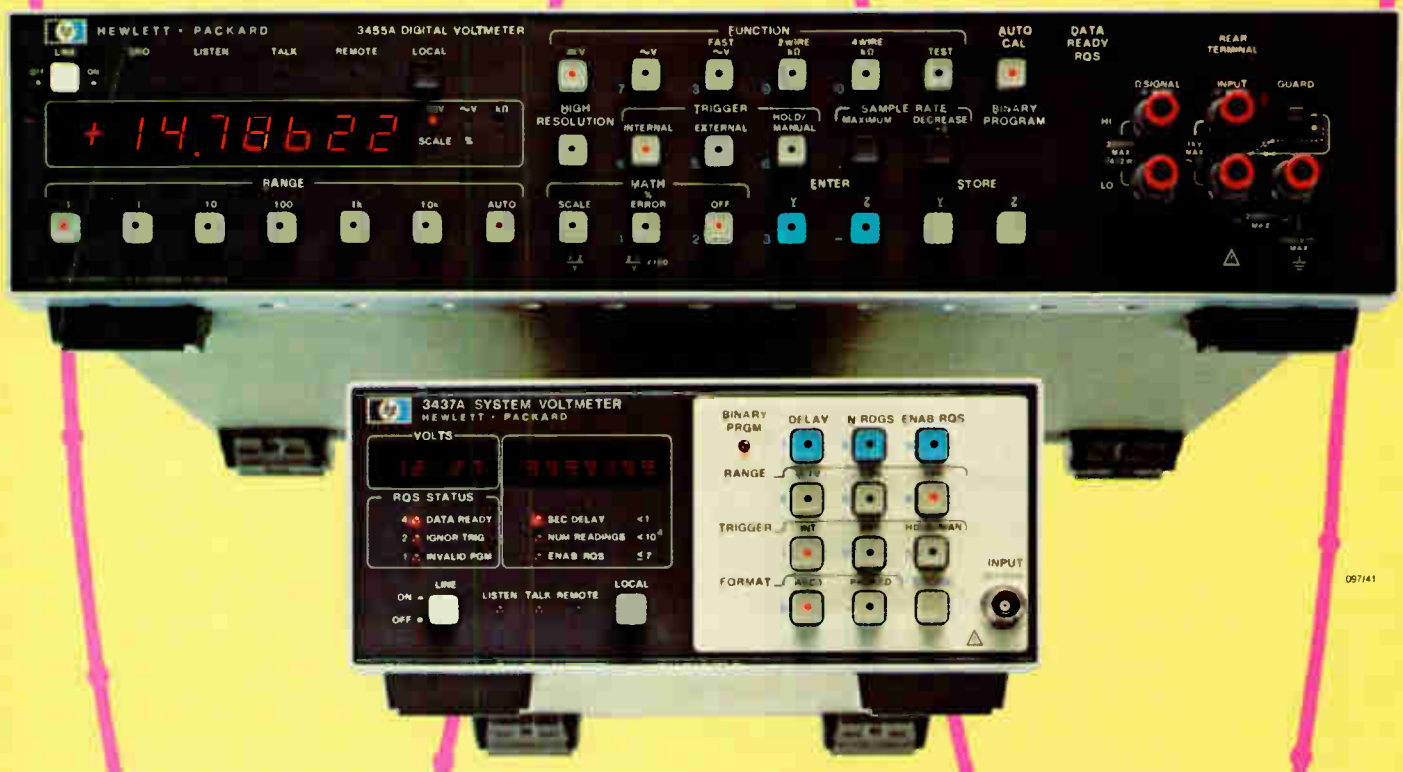

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Electronics
The International Magazine of Electronics Technology
Vol. 50, No. 1 • January 6, 1977

Highlights

Cover: Outlook for 1977: a faster tempo, 81
The world's electronics industries mostly marched through 1976 at a brisk pace, priming them for a faster tempo in the year to come. They promise to outstep the overall economies in the United States, Western Europe, and Japan, although inflation and rising oil prices could act as a drag for some markets.

Electronics' annual survey reaches a consensus prediction of 11.4% growth for American electronics industries, perhaps a percentage point less than in 1976 (p. 82). European electronics growth also looks to be slightly over 11%, but certain countries and some market segments will straggle behind (p. 94). Japan's electronics firms face bright prospects at home and abroad, for anticipated growth of 17% (p. 99).

Art director Fred Sklenar designed the cover; Ed Lada photographed it.

LCD market jumps ahead of supply, 67
Digital watches with liquid-crystal displays are doing well in the U.S. marketplace—so well, in fact, that there's a shortage of LCDs. But there is no agreement among industry executives on the extent or the duration of the shortage.

One less task for hardware, 110
By taking advantage of the software of the F8 microprocessor, the applications designer can set up keyboard scanning that works without electronic interfacing. Another in the series "Microprocessors in action."

And in the next issue . . .
The flood of new memories and their spectrum of applications . . . four key areas for designers of microprocessor-based systems . . . the high-reliability mirage in semiconductor devices.

Electronics

Publisher's letter

For 19 years now, we have been producing a detailed survey of the electronics marketplace in the United States. For a number of years, too, we have been doing the same in-depth surveying of the Western European and Japanese electronics markets. The reports, which were wrapped up in one issue for the first time last year, combine to make one big worldwide market forecast.

As we have long been aware, the electronics marketplace, like electronic technology, does not stop at national boundaries. There are worldwide trade patterns, and by homing in on the main international electronics trendsetters—the Common Market nations and the rest of West Europe, Japan, and the United States—we are sure to capture the major dimensions of the world electronics markets. And, our questionaire- and interview-based breakdown of product consumption—sector-by-sector and component-by-component—affords a fine-grained view, too. So turn to page 81 for this year's edition of the *Electronics* market survey.

We are often asked why *Electronics*, which aims at keeping electronics engineers and engineering managers abreast of technological advances and current industry news, produces such an extensive market report.

The main reason, as we said in this column four years ago, is that the 24 pages of text and tables pinpoint where the action is, right now and for the immediate future. That's the kind of information that is of value to our readers, especially in these times of changing engineering priorities. So our annual market report falls right in with our mandate: keeping you informed—about technology and the many events and trends that impact your job.

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Readers' comments

The n^{th} straw

To the Editor: There appears to be an error in Fig. 1 of the article on the clockless analog-to-digital converter [Sept. 16, p. 103]. In this figure, which allows one to design the n^{th} stage, the resistance value connecting the most significant bit to the comparator can be determined in two ways.

Firstly, this resistor can be evaluated using one of the forms:

$$\text{Bit } (n-k) = R/2^j \qquad (1)$$

where $j = k-1$ and $k = 1, 2, 3 \ldots$

Secondly, the value of the resistor can be obtained from the expression that is given in Fig. 1 for the bit 1 (MSB) as:

$$\text{Bit } 1 = R/2^{n-1} \qquad (2)$$

However, if one considers, for example, $n = 3$ and $k = 2$, equation (1) gives a resistance of $R/2$, whereas equation (2) gives a value of $R/4$.

For equation (1) to represent bit 1, $n-k$ must equal 1. Since $n-k = 1$ and $j = k-1$, then $j = n-2$. The correct form of equation (2), therefore, is:

$$\text{Bit } 1 \text{ (MSB)} = R/2^{n-2} \qquad (3)$$

A.E. Marble
G. Dodsworth
Nova Scotia Technical College
Halifax, N. S., Canada

■ *An editing error changed the labeling of the bit 1 (MSB) resistor, which should have been $R/2^{m-1}$. The author writes, "My intention [in Fig. 1] is to convey that, since the bit $(n-1)$ resistor is labeled $R/2^0$, the bit $(n-2)$ resistor is labeled $R/2^1$, etc., then the bit $(n-m)$ resistor is labeled $R/2^{m-1}$. In this case, m is the incremental index of the series."*

If the resistor's value is defined in terms of n, he agrees the label should be $R/2^{n-2}$. "But this only defines the bit 1 (MSB) resistor, and n is not an incremental index but is a constant. I feel that it could be confusing to define the MSB resistor by $R/2^{n-2}$ in Fig. 1, since n fails to index the sequence and could be taken for a variable."

He suggests that the best label for the bit 1 (MSB) resistor would be $R/2^{k-1}$, as in equation (1) above.

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News update

■ It has been a year since Richard Stadin left Timex Corp. to become watch marketing manager at National Semiconductor Corp.'s Novus division, Santa Clara, Calif., and he has not changed his mind about the way to approach the market. The division's philosophy, in its drive to become the Timex of the digital-watch industry, still is that a watch is not only a watch but a piece of jewelry [*Electronics*, Nov. 13, 1975, p. 15]. In the words of Scott Brown, Novus marketing manager, "A person who spends $100 is not just buying something to tell him the time. He's also buying jewelry."

Novus apparently also feels that the customer also wants service. The division has just opened 280 service centers in the watch departments of retail stores and established a toll-free number, (800) 648-5050, from which customers can get the name of the nearest Novus service center. Brown believes that the new centers will "absolutely answer one of the major problems retailers have had with the watch business," especially digital and electric watches.

■ The Grumman Aerospace Corp. project to develop a system of multiple microcomputers to solve large simulation problems [*Electronics*, Feb. 5, 1976, p. 41] is back on the track after a setback when Robert McGill, project leader, died suddenly in May. John Steinhoff has taken over project responsibility at the company's Bethpage, N.Y., research division. He reports that one microcomputer based on the Intel 3000 series bit-slice bipolar microprocessor has been built and connected to a Data General Nova 800 minicomputer. A 10-megabyte disk file will soon be added to the system.

Steinhoff says that his group is proceeding with its plan to build five additional microcomputers. He adds that although the 3000 series somewhat lacks the ability to handle high-speed multiplications, the recent introduction of a 16-by-16-bit multiplier chip from TRW Inc. has helped.

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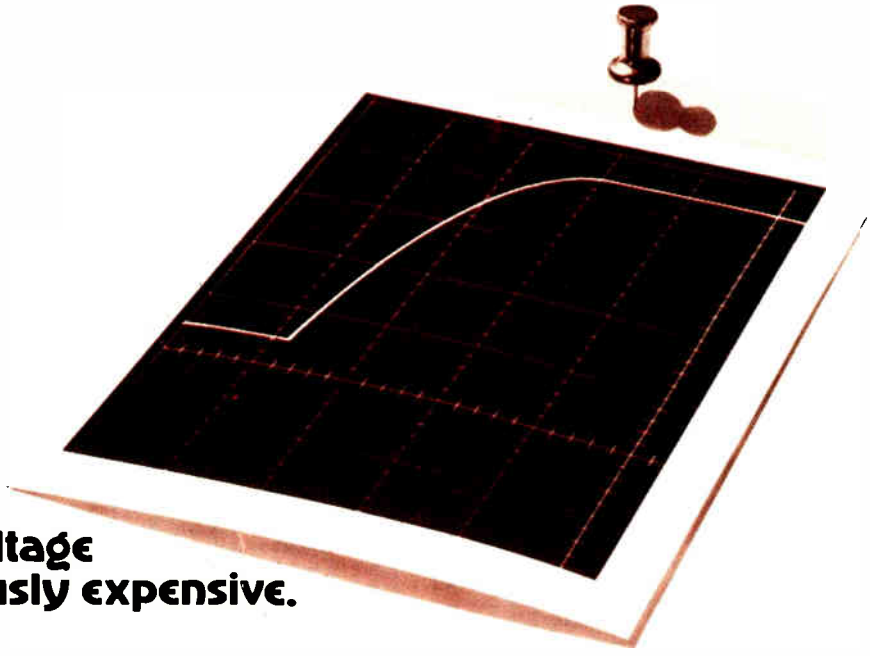

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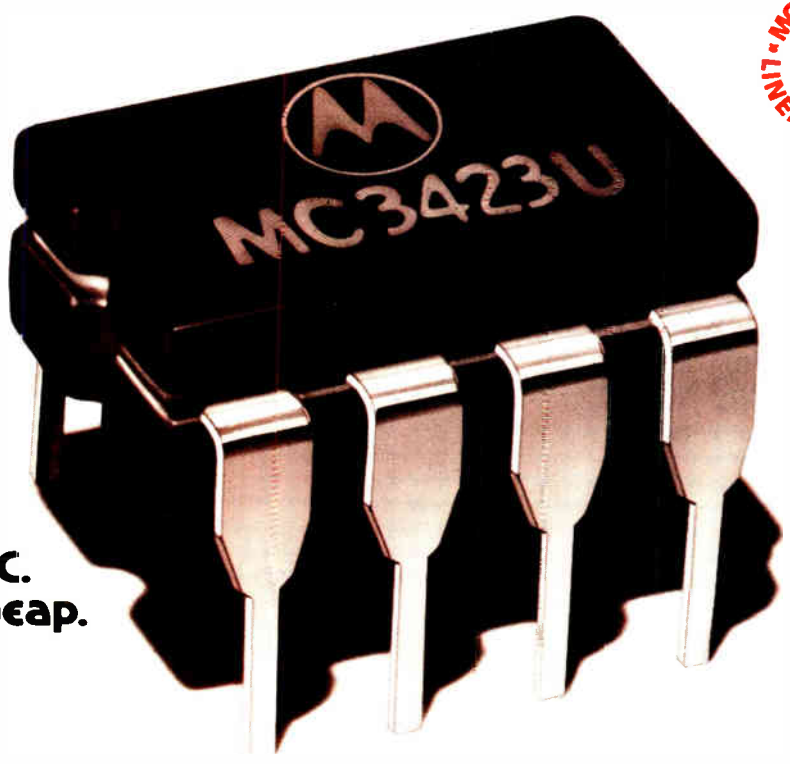

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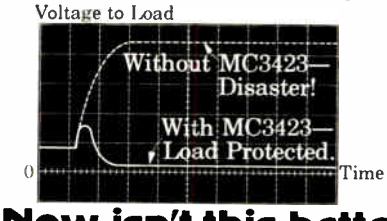

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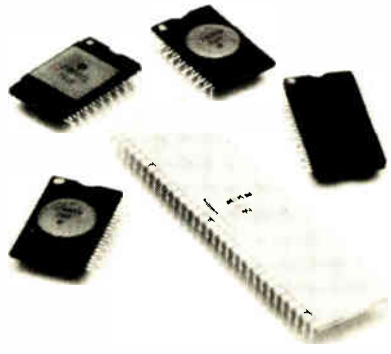

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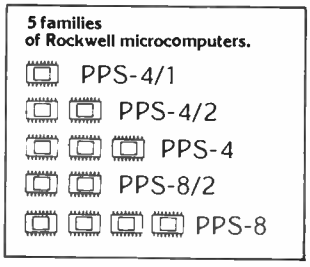

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Automobile computers—A 1977 production car has the first digital computer to control spark firing—based on a custom Rockwell two-chip system.

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People

Gunneson lays quality goals on GI's general managers

Quality assurance begins in the front offices of General Instrument Corp.'s subsidiaries. "We're placing the responsibility for quality on the general manager, not the quality manager," says Alvin O. Gunneson, corporate director of quality assurance for the $400 million-plus manufacturer of electronic components and systems.

It is not just idle talk, either. Starting this month, each of the firm's 29 divisions and subsidiaries must submit a detailed quality-cost report to the controller's office in Clifton, N.J.

"We believe that the only practical measure of quality is the cost of quality, and the dollar is the standard measuring tool," says the 41-year-old Gunneson, who holds degrees in electrical engineering, industrial psychology, and management. "Quality costs will be reported as a percentage of sales so that we can compare divisions. We want to identify every dollar that's been spent unnecessarily on rework, scrap, inspection, warranty repairs, field service, and preventative measures."

Percentage of sales. The company's goal is to keep quality costs, which include the salaries of each plant's quality manager and his staff, to within 2% to 4% of sales. They are currently running as high as 10% in some divisions, Gunneson estimates. "But we don't want to use the quality-cost figures as a way of beating on the managers to reduce their cost of quality," he adds. "We're going to measure the cost of doing it wrong. Then we'll let the manager determine what his acceptable quality level should be and pay for it."

Very few firms have a quality-cost system as structured as General Instrument's, Gunneson believes. "It's difficult to get managers to accept a system that will highlight their inefficiencies." In the long run, however, it's such a system that pinpoints priorities for correcting problems and even justifies spending money to make improvements in quality.

Controller. High quality means lower costs, according to GI's Alvin Gunneson.

The quality-cost accounting program is an outgrowth of the firm's recent efforts to establish regional councils that bring quality managers from diverse operations together. A 10-step quality improvement program has been put together that general managers can implement in their plants.

Eastern and Western regional councils have been set up that number a dozen members each. The Western council met for the first time last month in Chicago; the Eastern council is a year old. And Gunneson, who left International Telephone & Telegraph Corp. in 1975 to head up GI's quality activities, plans to continue expanding. European and Far East groups will be established this year.

Butler sees expansion as way to keep AVX competitive

The domestic color-television industry is here to stay, says Marshall D. Butler, president of AVX Corp., Great Neck, N.Y., a major manufacturer of ceramic capacitors. "Both Zenith and RCA will be making major investments to stay in, be competitive, and keep their market share of color TV," he says. This commitment by these big users of his capacitors is the reason for the $4 million capital investment this year by the firm, which had $27 million in sales in 1975.

Just as TV makers must keep up with Japanese competition, so must AVX, says Butler, who became presi-

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If you're tired of dirty, noisy, power guzzling zeners, PMI has a neat new answer for your voltage reference problems:

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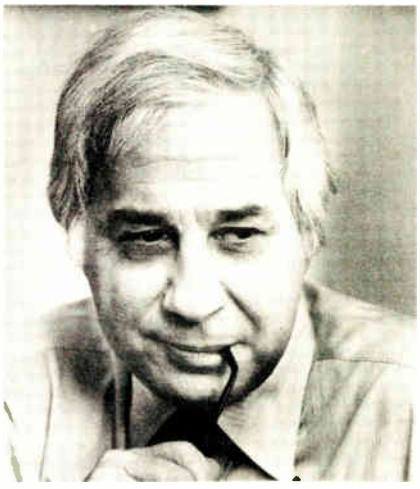
People



In the offing. Sales of more than $50 million by 1980 look possible to Butler.

dent three years ago. He is perhaps better known as a cofounder in 1957 of Alloys Unlimited Inc., a specialist in electronics materials. In 1970, the $150 million company was sold to England's Plessey Ltd.

Butler's capital plans for 1977 amount to double those in each of the last two years. In addition to boosting the firm's capacity to produce its traditional ceramic capacitor lines, Butler also wants to expand a recently established line of precious-metal pastes and inks. Developed originally for AVX's capacitor electrodes and terminals, the materials will be offered to semiconductor and hybrid-circuit makers. He also hopes Europe will expand multilayer capacitor sales.

Butler is also counting on new capacitor products. Two of them, poised for production, are designed to lower a user's assembly costs. One is a series of low-cost epoxy-coated axial-lead disk capacitors, to be in production by the end of this month. The other, scheduled for March production, is a series of molded two-pin capacitors in dual in-line packages. Both can be automatically inserted in boards with the equipment used for integrated circuits.

Butler is sanguine about the future. "We have the ability to double our business by 1980," he asserts. "The market is there, the opportunity is there, the resources—capital, people and technology—are here."

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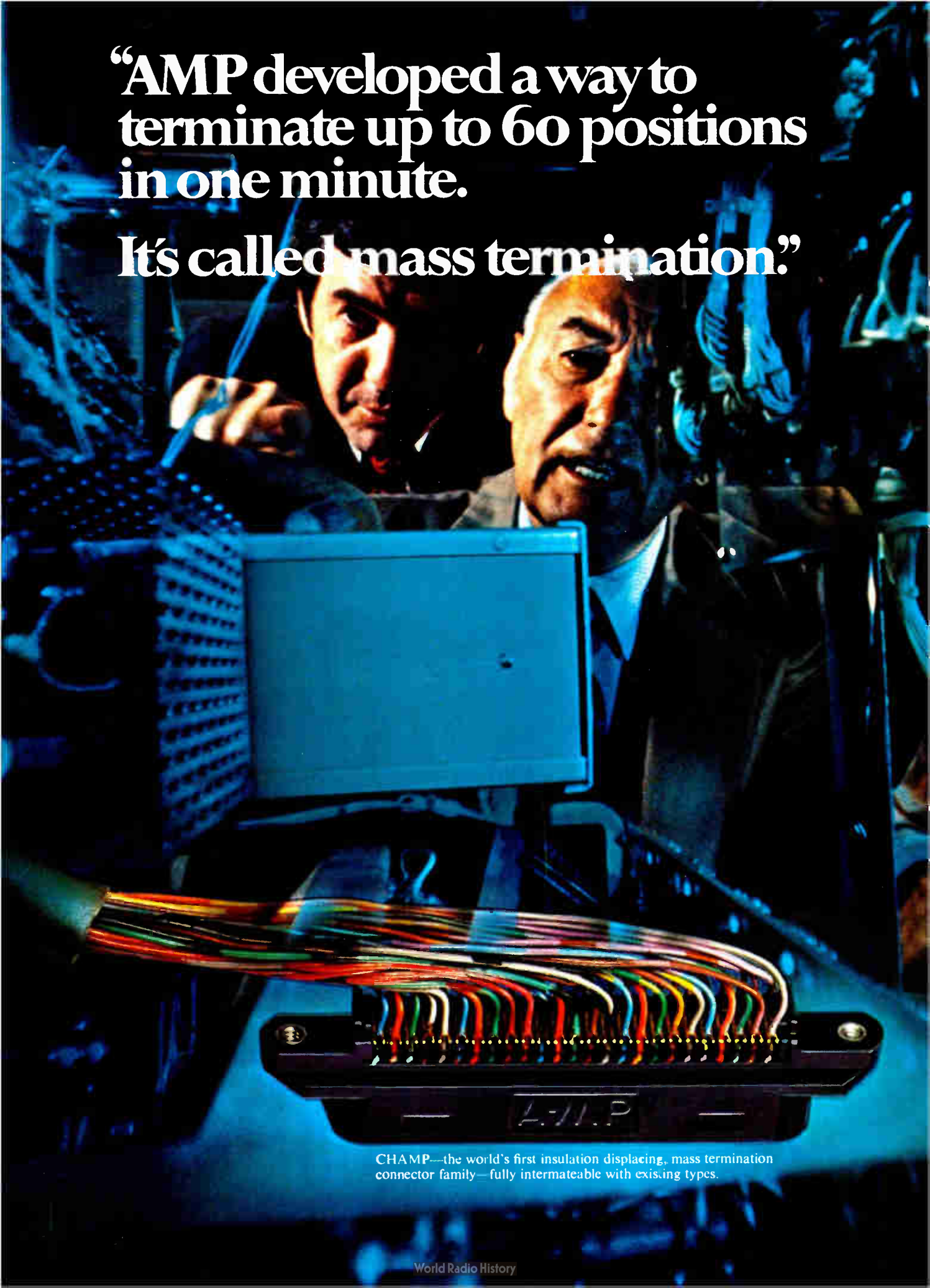

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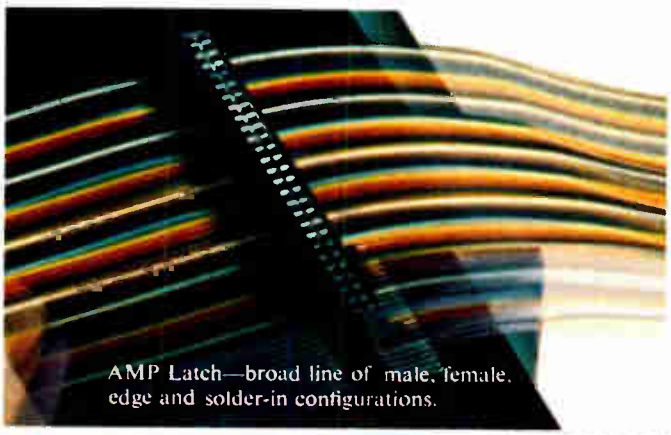

AMP Latch—broad line of male, female, edge and solder-in configurations.

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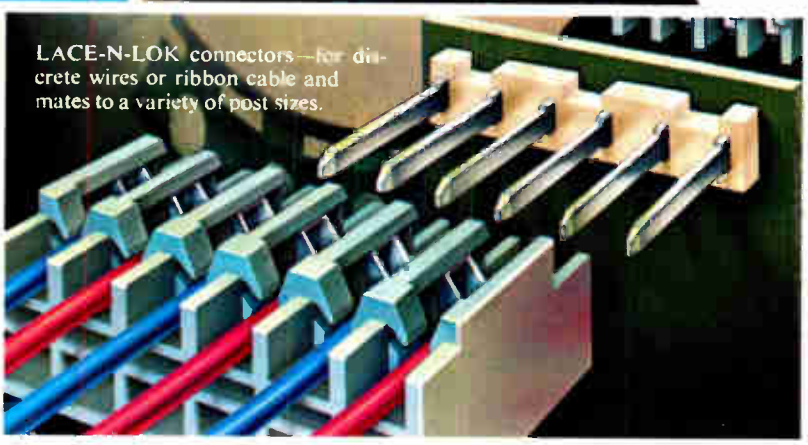

LACE-N-LOK connectors—for discrete wires or ribbon cable and mates to a variety of post sizes.

Meetings

1977 Reliability and Maintainability Symposium, IEEE, ASME, ASQC, *et al.*, Marriott Hotel, Philadelphia, Jan. 18 – 20.

Power Engineering Society Winter Meeting, IEEE, Statler Hilton Hotel, New York, Jan. 30 – Feb. 4.

Fifth Annual Computer Science Conference, ACM, Marriott Motor Hotel, Atlanta, Jan. 31 – Feb. 2.

Distributed Data Processing Conference, American Institute of Industrial Engineers, Americana Hotel, New York, Feb. 1 – 4.

Electro-Optical Warfare Technical Symposium, Association of Old Crows Cabrillo Coven (San Diego, Calif.), Naval Electronics Laboratory Center, San Diego, Feb. 3 – 4.

Wincon—Aerospace and Electronic Systems Winter Convention, IEEE, Sheraton-Universal Hotel, N. Hollywood, Calif., Feb. 7 – 9.

PC-77—Personal Communications Two-Way Radio Show, EIA, Las Vegas Convention Center, Las Vegas, Feb. 15 – 17.

ISSCC—International Solid State Circuits Conference, IEEE, Sheraton Hotel, Philadelphia, Feb. 16 – 18.

Optical Fiber Transmission Conference, IEEE, Williamsburg Lodge, Williamsburg, Va., Feb. 22 – 24.

Compcon Spring, IEEE, Jack Tar Hotel, San Francisco, Feb. 28 – March 3.

1977 SAE International Automotive Engineering Congress and Exposition, Society of Automotive Engineers, Cobo Hall, Detroit, Feb. 28 – March 4.

Nepcon '77 West—National Electronic Packaging and Production Conference, Industrial and Scientific Conference Management Inc. (Chicago, Ill.), Anaheim Convention Center, Anaheim, Calif., March 1 – 3.

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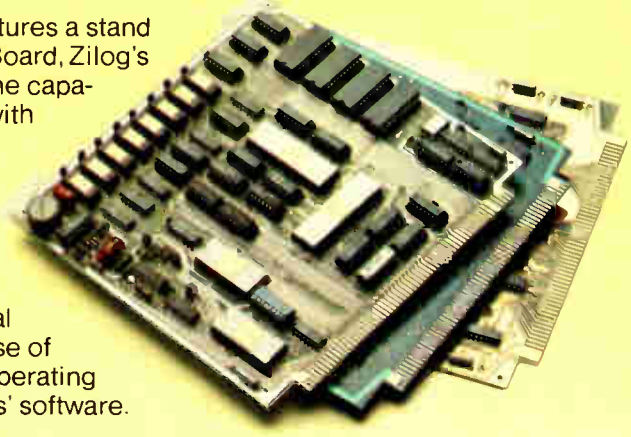
More weapons for The Battle of the 80's

Now a multiple attack against outmoded, large and bulky microcomputers.

This multiple attack features a stand alone Microcomputer Board, Zilog's mighty MCB, that has the capability to communicate with both serial and parallel I/O devices, has its own RAM and ROM capability and is backed up by a second board containing a disk controller and additional memory allowing the use of Zilog's complete disk operating system and applications' software.



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Announcing the Z80-MCB. An assault against big board computers.

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A squad of fighters against obsolete hardware.

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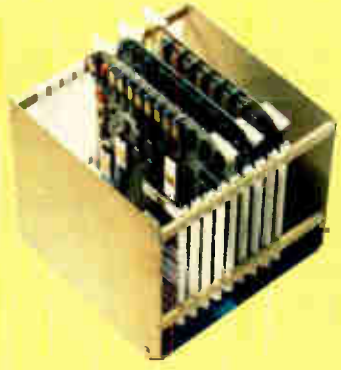
- 19.6608MHz crystal oscillator divided to 2.457MHz for Z80-CPU operation and dividable by Z80-CTC to provide any other desired system frequencies.
- 4K bytes dynamic RAM.
- Capacity for 4K bytes on non-volatile memory.
- Programmable serial I/O port with RS-232 or current loop interface.
- Universal parallel I/O with two independent 8 bit ports.
- Z80-CTC for programmable baud rate generation or other user functions such as real time clock.
- Bus drivers are provided for memory and I/O expansion to other boards.
- One-half K-byte monitor software has terminal handler, load and punch routines as well as set and display memory commands. A GoTo command begins execution of user programs. The 1K-byte version adds more debug aids such as set and display registers and breakpoints. The 2K and 4K-byte versions include a floppy disk controller and even more debug capability.

A second board gives you the advantage.

A second board gives you a 4-drive floppy disk controller and additional RAM backed up by a full disk operating system. Plus, you get the applications software you need: file, edit, assemble, debug, and high level languages such as BASIC, and more will be announced soon. This second board contains 12K of dynamic memory and additional 8 bit programmable parallel I/O ports.



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- Z80-MCS Microcomputer System includes a standard card cage, up to 2 floppy disks, power supplies and a push button front panel.

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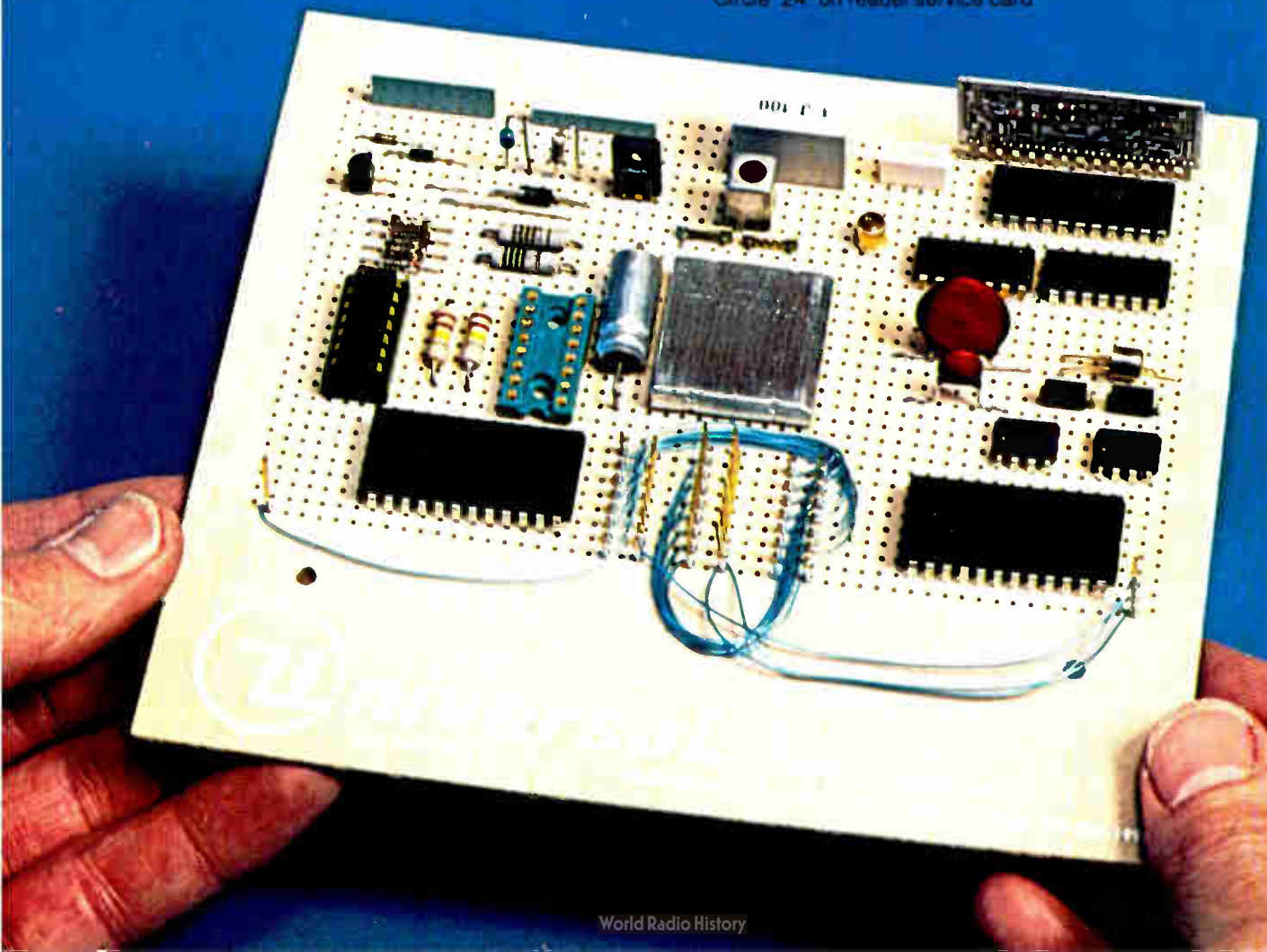


Electronics newsletter

HP building first sapphire devices into some terminals

Hewlett-Packard Co.'s investment in sapphire technology is starting to show results. Complementary-MOS on sapphire read-only memories are being phased into some 2640-series cathode-ray-tube terminals—but the purchasers of those terminals won't know it because designs and performance won't be changed. Actually, the firm is using the ROM as **a way to get production experience with the low-power, high-performance process.** It hopes the big payoff will come from its central-processing-unit design program, which promises a full 16-bit parallel processor that will execute instructions as fast as 500 nanoseconds.

Another minicomputer maker, General Automation Inc., dropped an earlier attempt to use sapphire CPUs—n-channel chips supplied by Rockwell International's Microelectronic Device division [*Electronics*, Dec. 11, 1975, p. 70].

Liquid-crystal techniques used in color display

The Integrated Display Systems Inc. subsidiary of Solid State Scientific Inc. in Montgomeryville, Pa., has samples ready of a new continuous display for digital watches. Tom Saldi, Integrated Display's president, says they are made with liquid-crystal-display production techniques, but don't require a polarizer and can be made any color in the spectrum. To be available in production quantities in April, **the display uses liquid-crystal compounds along with chemical additives** that produce the polarizing effect. The firm already has displays with such colors as blue, purple, orange, red, and yellow that it's offering to select watch companies.

Among those reported to be evaluating the new display are Bulova Watch Co. in New York, for which Integrated Displays supplies large quantities of digital watch modules, and Wyler Watch Co. of New York and Switzerland, a prime customer for the firm's cased modules.

GI cuts size of 16-k ROM, drops price 50%

General Instrument Corp.'s Microelectronics group in Hicksville, N.Y., will soon have sample quantities of a new 16,384-bit read-only memory that's 40% to 45% smaller than present 16-k ROMs. The firm will sell the new n-channel metal-oxide-semiconductor memories for about **half the price of its current 16-k ROMs.** The price move is an attempt to make ROMs more attractive to equipment manufacturers, which use programmable ROMs in the early stages of the system development cycle and have been sticking with them through prototyping and then into small-scale production.

Designated the 9316C, the new part will have an access time of 300 nanoseconds—the company's current fast 16-k ROM, the 9316B, has a 450-ns access time. The new chip also is pin-for-pin compatible with the company's other 16-k ROMs.

National to sell first bi-FET a-d converter

Looking for new worlds to conquer, National Semiconductor Corp. of Santa Clara, Calif., will soon be producing **the first monolithic analog-to-digital chip built with the bipolar field-effect-transistor process.** Designated the LF13300, the integrating, or ramp, a-d building block is the key element in a low-cost, high-precision binary data-acquisition system for microprocessors offering 12 bits plus sign. It works with a companion digital controller chip, the MM5863, a p-channel metal-oxide-semiconductor device that features auto zeroing, polarity and over-range indication, and continuous conversion in the 30-to-40-millisecond range.

Electronics newsletter

TI shipping 150-ns version of 4-kilobit RAM

Texas Instruments, like National Semiconductor Corp., thinks there's a market for even faster 18- and 22-pin 4,096-bit random-access memories. While National seeks to develop a niche in the under-200-nanosecond RAM market [*Electronics*, Dec. 23, 1976, p. 32], **TI is speeding up its earlier designs to yield parts with maximum access times of 150 ns.** It just started shipping the 4060-3 version of its 22-pin TMS 4060 and plans to follow with a 150-ns 18-pin TMS 4050 later this quarter. Unlike National, TI still plans to second-source Mostek Corp.'s high-performance 16-pin RAM, the MK 4027, with a part that's expected in the third quarter [*Electronics*, Nov. 11, 1976, p. 31].

Terminal due from Inforex will handle 1974 Cobol version

A new terminal for distributed processing systems, **one that will handle Cobol 1974** enhanced for data entry instead of the 1968 version of the language, is coming from Inforex Corp. of Burlington, Mass. To be called the System 7000, the terminal will be built for Inforex by Beehive Terminals of Salt Lake City, Utah, around a Nova 16-bit one-board microcomputer. In a system, terminals will be able to concurrently handle data entry, data processing, file management, and data communications tasks.

The System 7000 is based on microprocessor chips from Monolithic Memories Inc. that run Nova software. The same chips were used in Beehive's B-800 terminal, introduced last June.

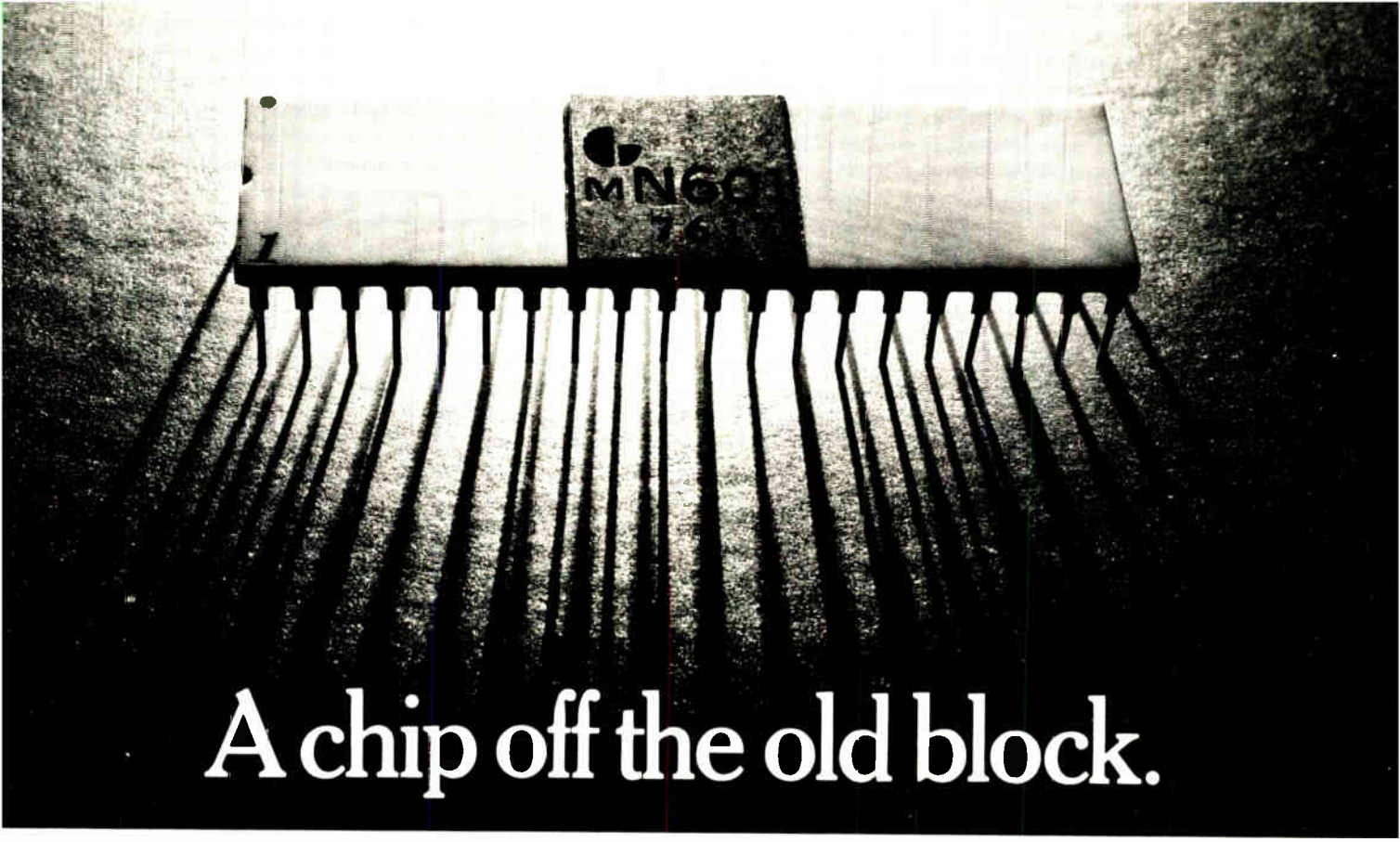
Air target to test triservice electronic warfare systems

The Air Force has successfully tried out a new high-speed tow target designed for all three services to permit **the first tests of electronic warfare systems and avionics under realistic flight conditions.** The new TDU-30/B is intended to evaluate the effectiveness of air-to-air missiles in the presence of electronic or infrared countermeasures, according to the Air Force Systems Command.

It says flight tests of the 13½-foot-long recoverable target using F-4 and F-101B fighters as tow planes were recently performed at its Armament Development and Test Center at Eglin Air Force Base, Fla. The triservice system was developed under a $750,000 three-year engineering development award made last July to Hayes International of Birmingham, Ala.

Addenda

The earth station that will control the position of the Marisat maritime communication satellite over the Indian Ocean **will go into service Jan. 15 at Fucino, Italy.** The station includes an antenna 11 meters in diameter and a new feed system supplied by GTE International Systems Corp., Waltham, Mass., which won out over Scientific Atlanta and Comtech Laboratories for the $722,000 contract from Comsat General Corp. at the site 40 miles east of Rome. The station is paired with another ground terminal that serves the Intelsat Comsat system. . . . The forerunner of a new generation of transportable Air Force Loran navigation systems has begun initial tests in the southeastern U.S. The system consists of three transmitter elements, each with a 400-foot antenna, and is built by the Sperry division of Sperry Rand Corp. The equipment transmits signals that can be picked up by conventional Loran receivers on ships, aircraft, or even by manpack units. **Earlier Loran transmitters weren't portable,** or, at best, had only limited portability. The new units, still in development, can be assembled in 25 hours.



A chip off the old block.

As you can see, this chip is housed in ceramic and mounted in a forty pin, dual in-line package.

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Inside that packaging sits a full 16-bit, silicon gate, NMOS microNOVA CPU. The mN601.

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The mN601 has the 16-bit NOVA instruction set including hardware stack for easy programming. And 16-bit data for efficient memory use.

It also has hardware multiply/divide for fast program execution. Integral data channel logic for easy interfacing to high performance peripherals. Control and timing for high density RAM memories. Integral hidden refresh logic that overlaps instruction execution timing. Plus a unique I/O encoding scheme for efficient easy interface design. Even the real-time clock is included. All of which reduces the chip count.

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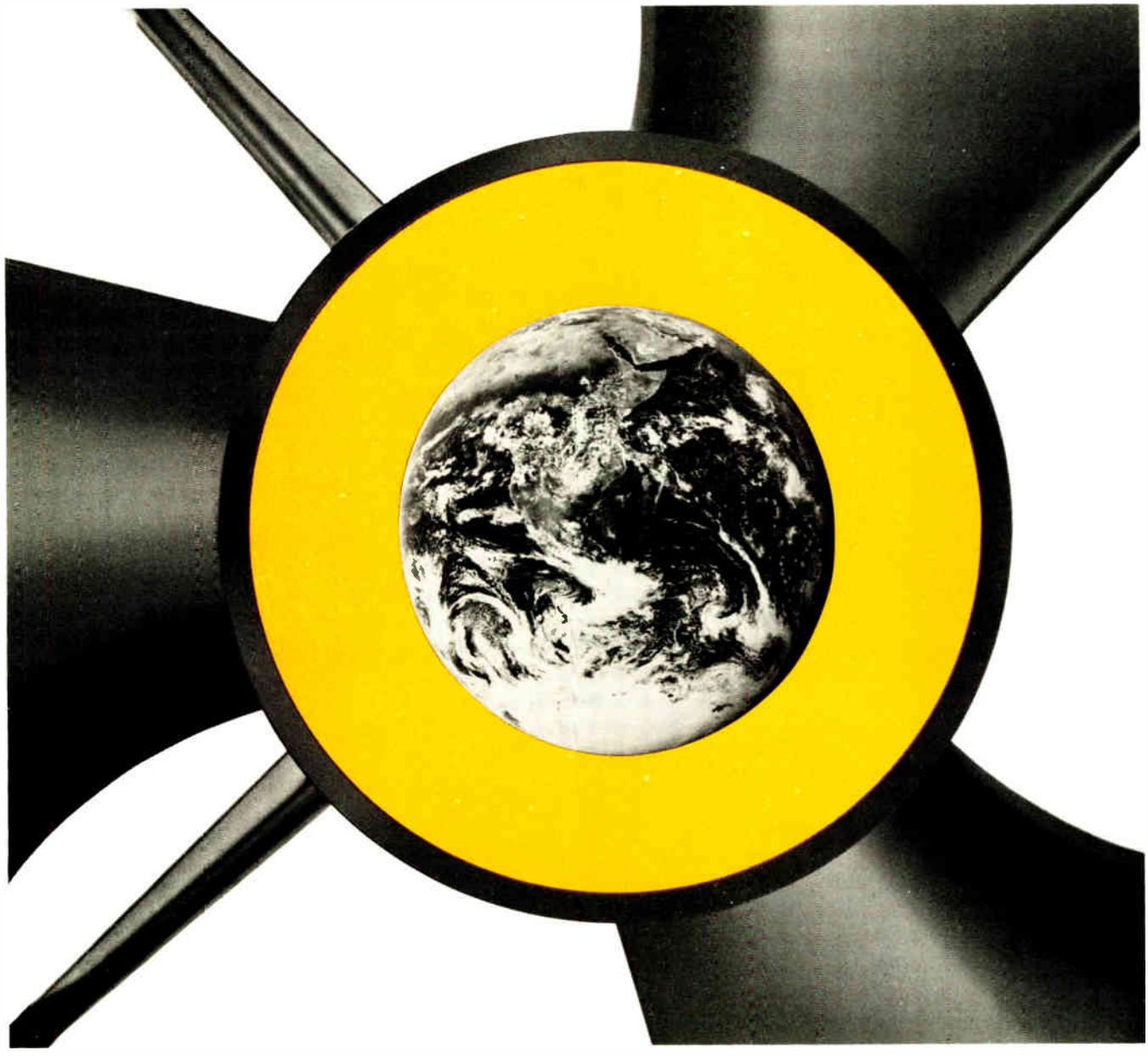

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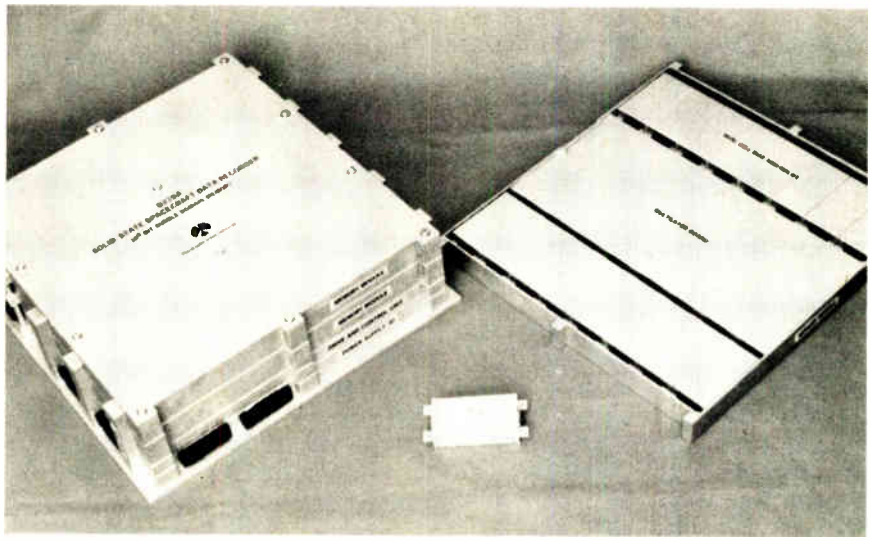
Bubble memory gets NASA check for use in space

Building-block "cell" with 1.6 million bits goes into 102.4-billion-bit recorder ready for flight in 1978



Cell block. Autonetics' 1.5-by-3-by-0.5-in. memory cell, foreground, made up of 16 102,400-bit chips, is used in memory board, right, and data recorder shown in mockup.

A prototype of a building-block "cell" for a 102.4-billion-bit bubble-memory data recorder is undergoing tests at NASA's Langley Research Center in Langley, Va. Developed by Rockwell International's Autonetics Group, the cell contains more than 1.6 million bits of storage. Some 64 cells will be used in the data recorder, also being developed by Autonetics in Anaheim, Calif., which NASA says it wants ready for use in space during 1978.

The recorder could be one of the first bubble-memory systems to operate in space, says Robert L. Stermer, who directs the project for the National Aeronautics and Space Administration. The space agency has been a major force pushing development of bubble-memory technology, mainly because of life and reliability problems in mechanically driven recorders.

Stermer says these conventional tape recorders, which store data gathered from experiments in satellite and other space missions, constitute "one of our most frequent failure points. The estimated 40,000-hour mean time between failures of the bubble-memory recorder represents a factor-of-two-or-three improvement."

The bubble cell itself measures 1.5 by 3 by 0.5 inches and consists of a pair of printed-circuit boards, each with eight 102,400-bit bubble chips. Separating the two boards is a bias structure/drive coil that supplies a magnetic field to propagate and preserve the bubbles. The 250-mil-square chip of magnetic garnet film grown on gadolinium-gallium-garnet substrate is identical to those marketed by Rockwell in sample quantities for commercial applications [*Electronics*, Sept. 30, p. 29].

"Building the recorder is no problem," explains Rockwell program manager Roy Sligh. "Once we got the chip and cell, we were home free." The chip resulted from research started in 1972 by Rockwell with its own and NASA funds.

In the 100-million-bit recorder, each of two memory modules will hold 32 cells. Rockwell has designed the system architecture for flexibility, Sligh says. For instance, "it can act like four separate recorders, operating independently with 25 million bits each. Or, if you need an 8-bit parallel, one-channel format, it can do that too."

Less expensive. NASA's Stermer sees the bubble-memory recorder offering more advantages than just reliability. "In a buffer mode, two tape recorders are needed to switch back and forth between experiments, so one, less expensive bubble may replace two, more expensive tape machines." While no cost figures can yet be put on the bubble recorder, both NASA and Rockwell believe it will be substantially cheaper than tape recorders.

The $1.5 million contract with Rockwell calls for delivery of a 25-million-bit prototype in March 1977 and a 100-million-bit space-qualified machine a year later. If the product measures up, NASA is considering developing a smaller standard 10-million-bit recorder, Stermer says.

"A standard 10^7 bubble recorder would satisfy 60% to 70% of all our

spacecraft requirements," he notes. An important feature of the memory is that it will keep working even if individual cells go out. The memory is partitioned into 64 cells, and loss of any one cell would cause only the loss of 1.6% of total memory capacity. In addition, NASA controllers on the ground will be able to obtain information in random, 1-million-bit increments.

The Rockwell recorder will occupy a 600-cubic-in. volume, weigh about 40 pounds, and require a maximum of 103 watts. In multichannel serial format, the composite data rate is 1.2 megahertz and 2.4 MHz for one-channel parallel operation. Average access time for the recorder will be 0.5 second. Sligh says the entire memory can be filled or dumped in 1 second. □

Computers

National reorganizes to go after broad range of computer market

As many in the electronics industries may have guessed, National Semiconductor Corp.'s recent decision to build hardware emulations of two of IBM Corp.'s mainframe central processing units is only the tip of the iceberg. National is setting its sights on shares of each of several market segments—all the way from calculator-oriented controller-processors up to IBM's 370/168 series.

"Our objective is to have a complete line of processors compatible with IBM all the way down the line," asserts David Martin. He now heads National's new Computer Products group in which the Santa Clara, Calif., manufacturer consolidated late last month its diverse computer and memory operations. Before then, he was general manager of the Memory Systems group.

The new organization will include the Large Systems, General Systems, and Microcomputer Systems groups, plus a new Memory Systems group. Martin says that each has a charter to "go after as much of the business as their markets and competition and our resources will bear."

More CPUs. The Large Systems group, says Martin, will absorb Exsysco Inc., National's mainframe-computer subsidiary in San Diego, Calif., and continue to build its Advanced System line, AS-4 and AS-5, software-compatible with IBM's 370/148 and 158 series [*Electronics*, Oct. 14, p. 29]. The company plans eventually to build other CPUs fully compatible with the 360 and 370 systems. "And we're not excluding the 370/168 either," Martin adds.

"One thing the consumer marketplace has taught us is that to stay in any growth market long-term, you've got to build the end product or be squeezed out eventually," he says. He does not want to be squeezed out of a market that is projected to grow to $50 billion by 1980.

The new General Systems group will be in charge of the existing IBM-compatible add-on memories and will also start a new endeavor for National—medium to low-end mainframe computers below the IBM 370/138 down to the System 32 small business computer. The first CPU of this type, in the final definition stage, will be announced in about six months, he says.

The group's first new add-on memory will be a universal memory system, called the System 370, which can be used with the IBM 370/135, 138, 145 and 148 machines. It will be built with high-speed static 4,096-bit n-channel metal-oxide-semiconductor, random-access memory packages. These have four times the density of the 1,024-bit static RAMs usually used for such systems.

Through the company's new Memory Systems group, which is responsible for original equipment and non-IBM-compatible systems, National plans to offer so-called "add-in" units—board systems that can be plugged into the chassis of minicomputers made by such companies as Digital Equipment Corp. and Hewlett-Packard Co.

Microcomputers. Finally, the Microcomputer Systems group plans to design a wide range of 8- and 16-bit microcomputers that will approach some minicomputers in speed and sophistication of instructions. Also in the works, says Martin, are board and boxed subsystems based on the 8080A built by National.

National hopes that the size of the Computer Products group will soon rival its Components division, which accounted for about 75% of the company's $300 million to $350 million total sales last year. "Don't be too surprised," says one company executive, "if you see National at least approaching $1 billion in sales annually by 1980." □

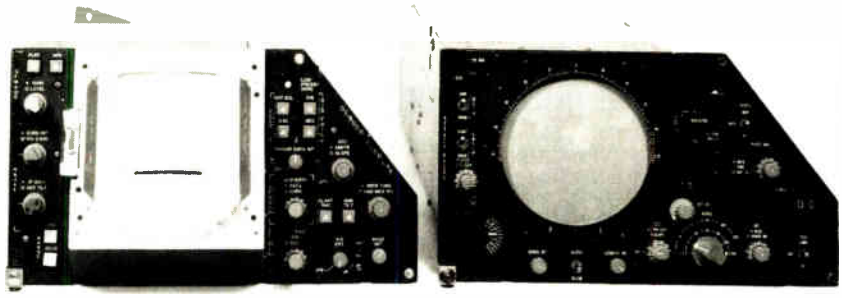
Military

Aircraft display doubles its images

The ground-mapping radar display in the Air Force's hundred or so F-111F swing-wing fighters is getting a new image—in fact, two new images. An improved digital scan converter will produce a continuous picture that looks like and has the same gray scale as conventional television. In addition, the double screen of a new virtual-image display that is also being designed for the cockpit will show concurrently the two magnified pictures produced by radar and electro-optical sensors of the aircraft.

The scan converter is part of the new high-resolution AN/APQ-144 ground-mapping radar system being built for the General Dynamics Corp. aircraft by General Electric Co.'s Aerospace Electronics Systems Department in Utica, N.Y. It will be flight-tested by the Air Force sometime next year.

The scan converter's performance



New view. Engineering model of the F-111F's new sensor display, left, fits two cathode-ray tubes into the space usually occupied by one circular display, right. GE's virtual-image magnification system would fit over and enlarge the twin CRT images.

depends on the use of "about twice as much memory as do traditional scan converters," asserts Nathaniel Vivians, project engineer at the Air Force's Aeronautical Systems division at Wright-Patterson Air Force Base in Ohio. This adds up to 750,000 bits, in the form of militarized 4,096-bit static random-access memories that are mounted on eight interchangeable boards.

The new radar display system stores scanned target information in memory and reads it out at a TV rate, so that the operator sees a continual, rather than a decaying image. The information includes target range and azimuth, as well as gray-scale equivalents obtained by quantizing the video signals into 10 amplitude levels. Radar returns from targets are displayed in relative brightness levels.

Relatively new. Digital scan converters are relatively new for aircraft. The McDonnell Douglas Corp. F-4 fighters have the only digital scan converters in actual use, says Vivians. But earlier this year, the Air Force began tests on an advanced development unit of a Hughes Aircraft Co. modular digital scan converter that contained 400,000 bits of 4-k RAM [*Electronics*, Feb. 5, p. 29]. Its modularity supposedly enables the unit to work with almost any airborne radar, but for the F-111F, the modular unit was not far enough advanced for operational units to be installed in the time frame the Air Force had in mind, Vivians notes.

The virtual-image display is part of the Air Force's Pave Tack program, which will add a variety of forward-looking sensors to various aircraft. For the F-111F, the radar operators will have radar and electro-optical images displayed one above the other.

GE's virtual-image display contains two high-resolution rectangular cathode-ray tubes with 6- and 4-inch diagonals, rather than one 6-inch circular CRT. A four-lens magnification system enlarges the CRT dimensions to 10.5 and 5.5 inches respectively, yet both vertical images fit in the area where there once was a single image. "We [incorporate the] magnification system as part of the hood assembly over the CRTs," explains Ray Gardner, GE's Pave Tack manager.

The Air Force expects to begin retrofitting the lens system in aircraft cockpits within two to three years, adds Vivians. The next step, he says, is delivery of pre-production F-111F display units around March for flight-testing during the second half of 1977. "This is to be followed by a production decision in early 1978," says Vivians. □

CATV

Small stations OK'd for satellite CATV

Cable-television systems can expect a happy New Year. Late last month the Federal Communications Commission approved the use of antennas 4.5 meters in diameter as receive-only earth stations by CATV-system operators. Previously 10-m antennas were required for domestic-satellite transmissions.

The FCC's ruling on the petition of the Community Antenna Television Association of Washington, D.C., was unanimous, despite strong opposition from two powerful antagonists of cable TV: commercial TV broadcast networks, represented by the American Broadcasting Co., and the American Telephone & Telegraph Co.

CATV officials say that the networks see the use of small receive-only earth stations as a serious threat to their dominance of major TV market audiences. The broadcasters fear an accelerated intercity exchange of TV programs—for example, of local sports events or movies—that would strengthen CATV's appeal. AT&T is reportedly concerned at the potential loss of revenue when TV programs are transmitted via satellite rather than over the utility's long-distance communications lines.

Issues. ABC, strongly supported by Bell, petitioned the FCC for further study of the issue's "public policy questions" in what was widely regarded as a delaying tactic. But the formal objections put before the FCC by the two objecting companies were that the 4.5-m antennas would make such inefficient use of the 4-to-6-gigahertz bandwidth reserved for domestic satellites that users of the 10-m antennas would be excluded from it.

The FCC rejected those arguments, saying that the use of the small antennas would not affect either satellite spacings or service quality. Commissioner Abbott Washburn

Mind readers at Scientific-Atlanta?

Scientific Atlanta Inc. appears to have anticipated the Federal Communications Commission's favorable ruling on the use of small Domsat stations by the cable-TV industry. Almost two weeks before the FCC action, the Atlanta-based telecommunications equipment maker disclosed it had developed a new dual-polarized antenna 5 meters in diameter "designed specifically for the CATV industry." The company, which supplies the small shipboard transceivers for use with the Marisat maritime satellite system, says its new antenna offers improved wide-angle sidelobes by using a prime focus feed that provides greater protection from interference. The dual-polarized feed can receive both vertically and horizontally polarized signals simultaneously, the manufacturer says, while the lightweight, all-aluminum dish and support structure is designed to maintain an rms surface tolerance of 0.044 inch.

summarized the FCC view by noting that the order is not only "in keeping with the established policy of flexibility in Domsat development," but also "allows individual operators to exercise their own good engineering judgment regarding particular uses" of satellites. "This will encourage innovation and development without imposing unnecessary technical constraints," Washburn concluded.

As if to support its landmark decision, the FCC also approved in a separate action the application of Southern Satellite Systems to use the RCA American Communications Inc.'s domestic satellite system. The company wants to distribute the signal of Atlanta's ultra-high-frequency channel 17 to a number of CATV systems throughout the southeastern states. When the service begins, FCC officials say it will represent the first multipoint distribution of programing to CATV systems by domestic satellite. □

Space

Air Force wants to update Spacetrack to identify man-made objects faster

The Air Force's Spacetrack network has been used for years to keep a daily log of all man-made objects orbiting the earth. But, working as it does from its radar and photo images of the sky, the Air Force faces a delay in pinpointing what is flying around up there.

This is why the service wants a near-real-time system called Geodss, which stands for ground electro-optical deep-space surveillance system. It is based on a moving-target-indicator approach of differentiating between the rates of motion of the man-made objects and the star field behind. The system will cover a cone extending from 30° above the horizon to zenith in all directions and a range from 3,000 to 20,000 nautical miles.

Maj. John Dunkle, Geodss program manager at the Air Force Electronic Systems division, Hanscom Air Force Base, Bedford, Mass., says the system will provide data such as range, apogee and perigee, and even the shape of both friendly and potentially hostile satellites. Eventually, some $70 million may be spent to construct and equip five sites.

Competitors. The Air Force has begun testing three competing approaches at White Sands Missile Range, N.M. Requests for proposals for the final version of the system will probably go to industry next June. In essence, the idea is to look at the night sky through an optical telescope that has its scan rate synchronized with the motion of the star field. The telescope is linked to a low-light-level television camera which, in turn, is tied to a moving-target indicator. This will work with a computer to process the images in such a way that a satellite appears as a streak in a stationary star background or as a single light source after the star background has been removed.

The competing approaches are from MIT Lincoln Laboratory, Mitre Corp., and a TRW Systems Group-Itek Corp. team. Lincoln Lab, says a source there, has an analog system using a video disk that capitalizes on some of the techniques employed in commercial television instant replays. The others have adopted digital approaches.

Itek and TRW have what an Itek engineer calls a "smart focal plane" for the telescope. A computer drives the camera and video processor in a pattern-recognition exercise governed by hardware and software algorithms that look for a streak or trail.

That is what is left in a sequence of images when the telescope is matched to the movement of the stars while the satellite moves. For the White Sands demonstration, Itek is providing the hardware and hardware algorithms, TRW the general-purpose software algorithms.

Snapshots. Mitre's approach, says James Berry, leader of the Optical Technology group, is to take three snapshots about 10 seconds apart in the same field of view. Frames one and two and then two and three are compared digitally by minicomputers that cancel out light sources in the same position in the image pairs.

That leaves only the target and so-called "leak stars," the ones above the light threshold for which the system is optimized. The minicomputers—11 in all—process the images left in the first and third frames against stored projections of the straight-line path a moving satellite would take, leaving only the satellite in the image. Six minicomputers are used in the star-cancellation step, four to collect the images and do track correlation operations,

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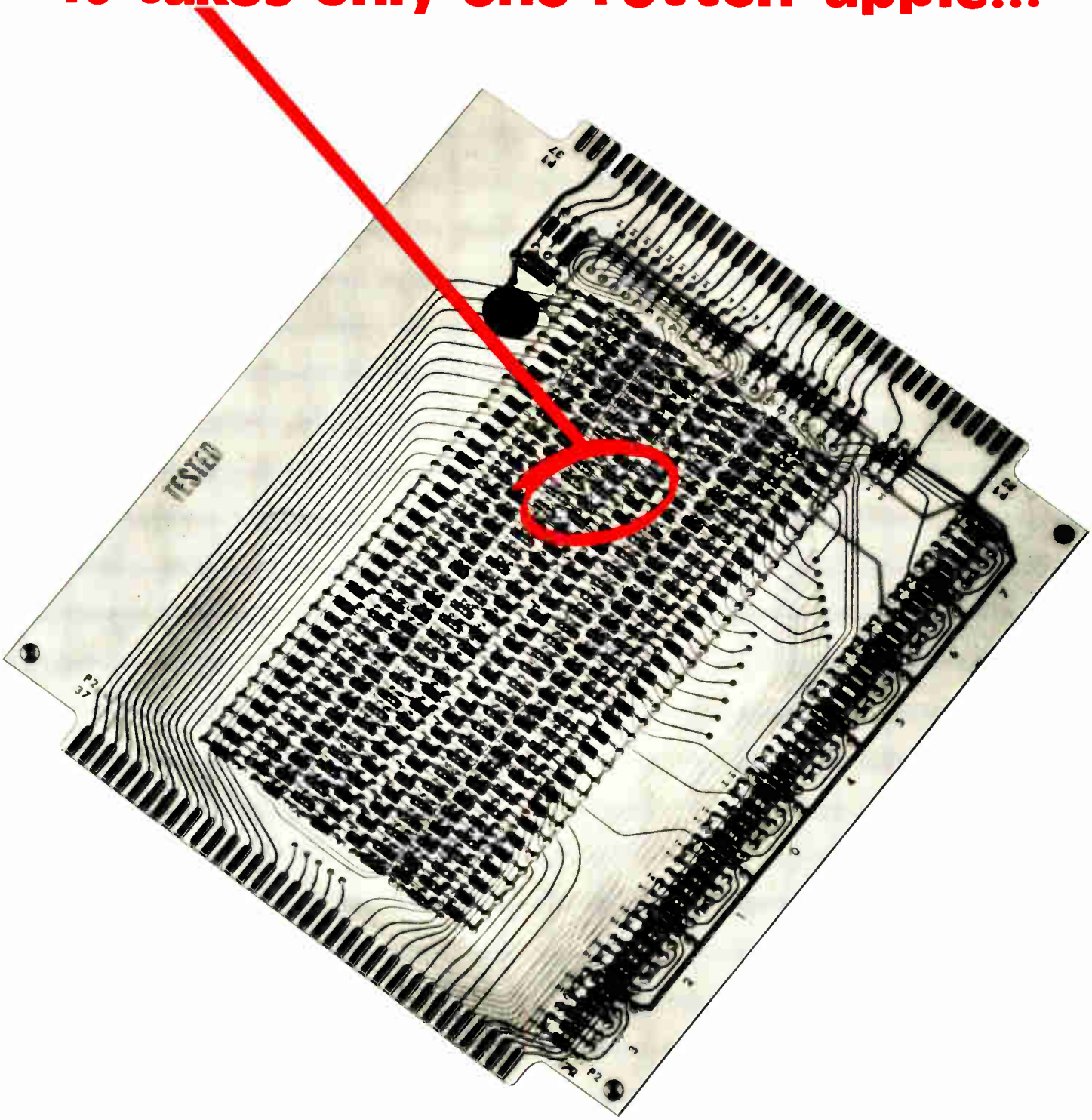

and a pre-processor to digitize the video data initially and clean up any "blooming" or enlargement of the stars in the background. □

Communications

Navy antenna boosts signal security

Spillover radiation outside the main-beam region of millimeter-wave communication systems has long plagued designers of secure military systems. But that problem—which makes it simpler for the enemy to intercept signals and detect and locate transmitters—has been significantly reduced by the Naval Research Laboratory's development of a new millimeter-wave antenna.

The antenna has a low-side-lobe configuration enhanced by a special shield. At about 35 gigahertz, it has produced radiation levels in the far-out side lobes and back lobes "that were more than 75 decibels below the main beam beyond the first few side lobes," says H. Paris Coleman, head of the three-man team in NRL's Radar division in Washington, D.C., that developed the antenna. That reduction in radiation levels during tests "is a significant achievement for an antenna having a half-power beamwidth of approximately 1.7°," he adds.

Queries. According to Coleman, the test results have produced inquiries from Bell Telephone Laboratories and telecommunications agencies of several foreign governments. The new antenna's design, mechanically scaled, could be used to enhance the capability of commercial microwave-relay systems now handicapped by interference between separate antennas in the relay chain. In one-way transmissions, the new antenna could improve the quality of a received microwave signal by as much as 20 decibels, he says.

The six-month project involving Coleman and colleagues Russell M. Brown and Billy D. Wright was partially funded by the Naval Elec-

News briefs

ITT takes license for n-channel MOS
International Telephone & Telegraph Corp. in New York has been licensed by Standard Microsystems Corp., Hauppauge, N.Y., to fabricate high-speed, high-density, n-channel MOS LSI devices using SMC's Coplamos technology. ITT Semiconductors' operations in Foots Cray, England and West Palm Beach, Fla., will use the n-channel technology initially to produce 4,096-bit random-access memories. Larger RAMs will follow, as well as microprocessors and other devices. The deal with ITT calls for substantial up-front money, much more than when SMC recently swapped patents with Texas Instruments Inc. of Dallas [*Electronics*, Oct. 14, p. 25], plus royalties that will extend over a 10-year period.

Navy awards Sylvania $950,000 for Seafarer
GTE Sylvania Inc., Needham, Mass., has received a $950,000 award from the U.S. Navy for continued work on Seafarer, the extremely-low-frequency system designed to communicate with submerged submarines. Under the contract, GTE Sylvania will continue studies aimed at refining the design of a shore-based transmitter. In addition, the company will recommend ways to reduce the size and improve the performance of a shipboard receiver.

Canadians boost FET power output
Field-effect transistors, normally reserved for small-signal applications, may soon be vying for power jobs up through ultra-high frequencies. Canada's University of Toronto has developed a simple high-density process for fabricating V-groove, power junction-type FETs that may lead to large chips capable of handling hundreds of watts in the vhf through uhf regions.

The first developmental device made by the Canadians is a 30-channel interdigitated structure. It has a cutoff frequency of 900 megahertz and delivers an output power of 25 watts per square millimeter of chip area. Its nonplanar, V-shaped conduction channels are short—only 2 micrometers long. They are formed by etching V grooves in an n-type epitaxial layer grown on a p^+ substrate. (The p^+ substrate serves as the gate, while n^+ diffusions form the drain and source.)

RCA wins military satellite ground-station award
RCA Corp.'s Government Communications Systems division in Camden, N.J., has landed a $29.5 million U.S. Army contract for super-high-frequency ground stations that, for the first time, will provide military forces with worldwide satellite communications. Under the contract from the U.S. Army Electronics Command at Fort Monmouth, N.J., RCA will build 19 transportable satellite terminals, each with a 500-watt transmitter.

FCC weighs new plan for up-grading uhf TV . . .
Federal Communications Commission chairman Richard Wiley and commissioners Joseph Fogarty and James H. Quello say they want a plan to establish complete parity between uhf and vhf television at the earliest possible time. Their views became known just prior to Christmas following the FCC disclosure that, effective July I, 1978, all TV sets shipped with a vhf antenna attached will be required to have a uhf antenna attached also.

. . . and renames services, suspends fees
On Jan. 27 the Federal Communications Commission's Citizens Radio Service will acquire new names that are more descriptive of the services offered. The citizens' service will be called Personal Radio Services, with the present Class A, C, and D services being renamed General Mobile Radio Service, Radio Control Service and Citizens Band Radio Service, respectively. Meanwhile, the FCC has suspended fees on all equipment, effective Jan. 1, pending its review of a Dec. 16 ruling by the U.S. Court of Appeals that the commission justify fees for broadcast, cable television, and common-carrier equipment.

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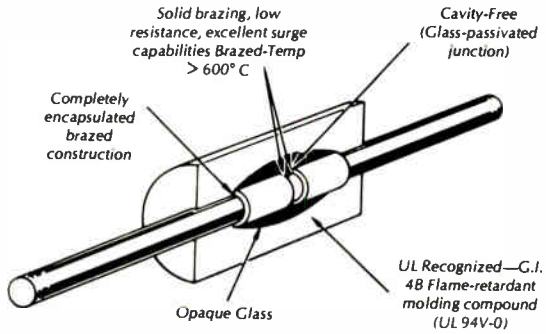

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tronic Systems Command. It produced an antenna design employing a parabolic reflector offset-fed with an internally corrugated conical horn.

The special shield, which enhances the performance of low side lobes, encloses the space between the feed horn and the reflector and ends in a cylindrical tunnel surrounding the antenna aperture. "It is the combination of corrugated horn and shield that drastically reduces the spillover radiation normally encountered in offset reflector systems," Coleman explains.

The laboratory has not developed any cost estimates for its newest product, nor does it expect to. "That's a job for people who want to use it," explains another Navy official, who points out that the laboratory's primary mission is technology, not economics. But Coleman and his colleagues are convinced that the antenna's performance shows great potential for applications in which low interference is important. □

Justice spells out how to split AT&T

The Department of Justice thinks Bell Telephone Laboratories Inc. would do just fine out from under the umbrella of AT&T, with part of its operations going it alone and the rest joining an independent Western Electric Co. The existing relationship is just one of many weapons the American Telephone & Telegraph Co. wields to keep competition out of the telecommunications field, the department alleges.

In a largely unnoticed series of December filings with the U.S. District Court in Washington D.C., dealing with the Federal antitrust suit against AT&T, the Government's lawyers spelled out in more detail than ever before not only how but also why it would split up the world's largest communications conglomerate. The proposals turned up in the Government's responses to a list of 69 AT&T questions put to Justice earlier—a standard legal procedure in such suits [see p. 49].

In its answers filed with the court—a package running to more than 650 pages—the Justice Department recommended splitting Bell Labs into at least two parts. The laboratory's research on information systems should be established as an independent company, the agency argues, while its activities related to product design and development for Western Electric, AT&T's manufacturing subsidiary, could become a part of that organization.

Competitive market. As for the Government-proposed divestiture of Western Electric itself, Justice Department attorneys believe it would "reduce the incentive of AT&T and the Bell operating companies to delay the purchase of innovative equipment pending manufacture by Western Electric of competing equipment and to obstruct and impede the interconnection of customer-provided terminal equipment." In short, it would permit a competitive equipment market.

The agency is less certain at this point about the method AT&T should use to separate some or all of its Long Lines department from some or all of the Bell operating companies. If they are separated, the Justice Department believes the nation's telephone network will survive without common ownership of the necessary hardware.

The Justice Department documents deal extensively with the Government's allegations that Bell has moved deliberately to eliminate competition and maintain its dominance in a wide variety of markets. This includes transmission services for commercial TV networks and cable television, land-mobile radio services, and private microwave services such as those developed by specialized common carriers like MCI Communications Corp. and the now-defunct Data Transmission Co. According to the documents, AT&T deliberately stalled the provision of digital facilities to Datran.

In land-mobile communications, the Government alleges Bell has

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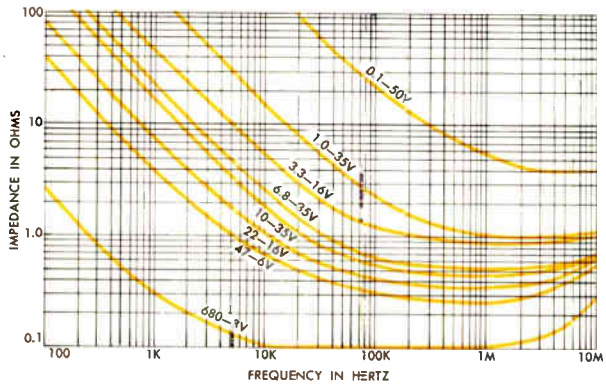

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eliminated development of competitive large-scale systems "by restricting interconnection [with Bell System facilities] and by acquiring new frequencies with which to meet all anticipated demand." □

Manpower studies to crystal-gaze less

Unwilling to quit publishing studies of the demand for engineers, despite all the criticism they attract, the Engineering Manpower Commission has decided to downplay the "predictive" nature of its conclusions. Late last month in New York, its executive committee adopted a final draft statement of its revised policy and on Jan. 13 will submit it to a meeting of the full commission.

A research arm of the Engineers' Joint Council of 36 professional societies, the commission has been under pressure to discontinue its demand projections or to modify its method of making them public [*Electronics*, Oct. 14, p. 36]. Its projections, say the critics, have encouraged colleges to pump too many engineers into an already overcrowded marketplace.

Imprecision. The draft statement concedes that the commission's projections at present are "imprecise and subject to change because of unforeseen or poorly understood circumstances" and that the data currently available for making them suffers from "serious deficiencies, uncertainties and inconsistencies". It therefore recommends eliminating any reference to predictions from the manpower studies. Instead, according to EMC's chairman, Art Gilmore of Grumman Aerospace Corp., the studies will confine themselves to supplying "current and trend data which will be valid over a very limited period."

In essence, Gilmore says, the EMC has for the first time made explicit the guidelines it uses in weighing its supply and demand data and will define the limitations it has experienced. But apart from this, nothing will be different since "we feel that EMC has been exercising due care and consideration" in handling data.

Breakthrough. David Reyes-Guerres, executive director of the Engineers' Council for Professional Development and chairman of EMC's *ad hoc* committee, views the changes much more radically, as a "major breakthrough." "We have decided" that comparing data on supply and data on demand is "like comparing apples and oranges," he says.

"We can project supply with a fair amount of accuracy over the next five years. But demand is on a yearly cycle, therefore [the EMC] will no longer publish projections on demand that exceed two years from the

The data and nothing but the data

Finally admitting the softness of its demand data, the Engineering Manpower Commission has had a revised policy statement drafted that calls for future EMC studies to meet the following criteria:

- Assessments of supply-versus-demand relationships will be based on analysis of all available data sources, never just on one single source.
- When numbers are projected, the assumptions on which they are based must be clearly and prominently identified, and an accompanying discussion will appraise the reliability of assumed conditions and biases in the data.
- The terms "engineer," "technologist," and "technician" will be carefully defined wherever used. Whenever supply and demand data are compared, the comparison will employ compatible definitions and criteria.
- Exaggerated terms in reference to potential shortages or surpluses of manpower will be avoided at all times.
- There will be no encouragement to undertake careers in engineering and technology based on data and opinions about supply and demand.

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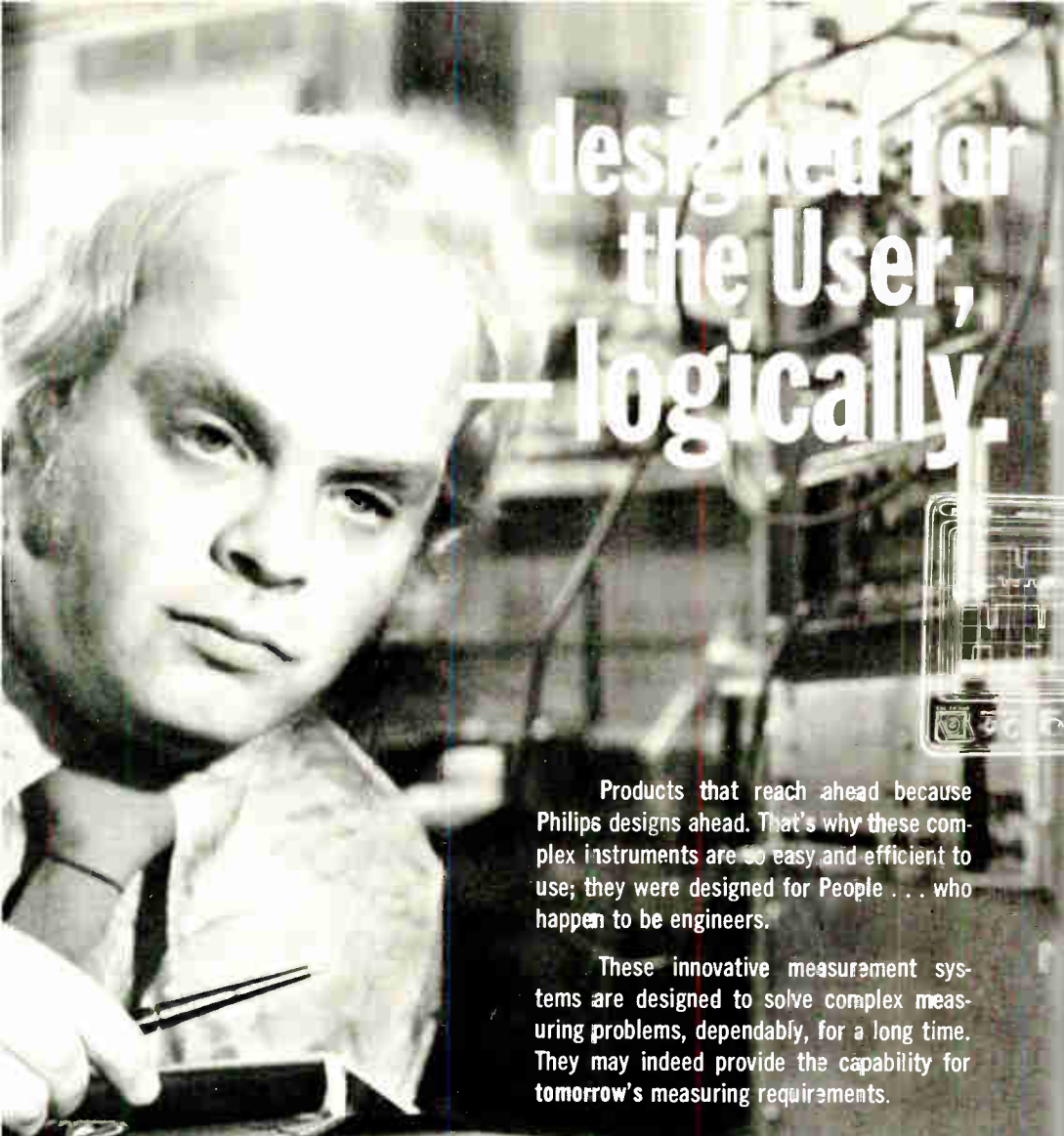

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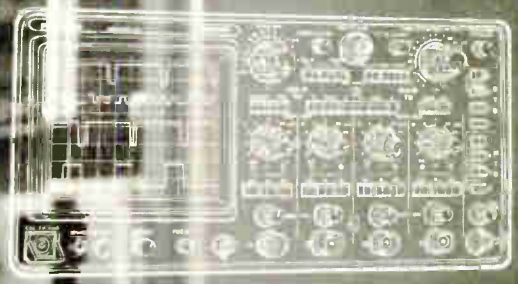

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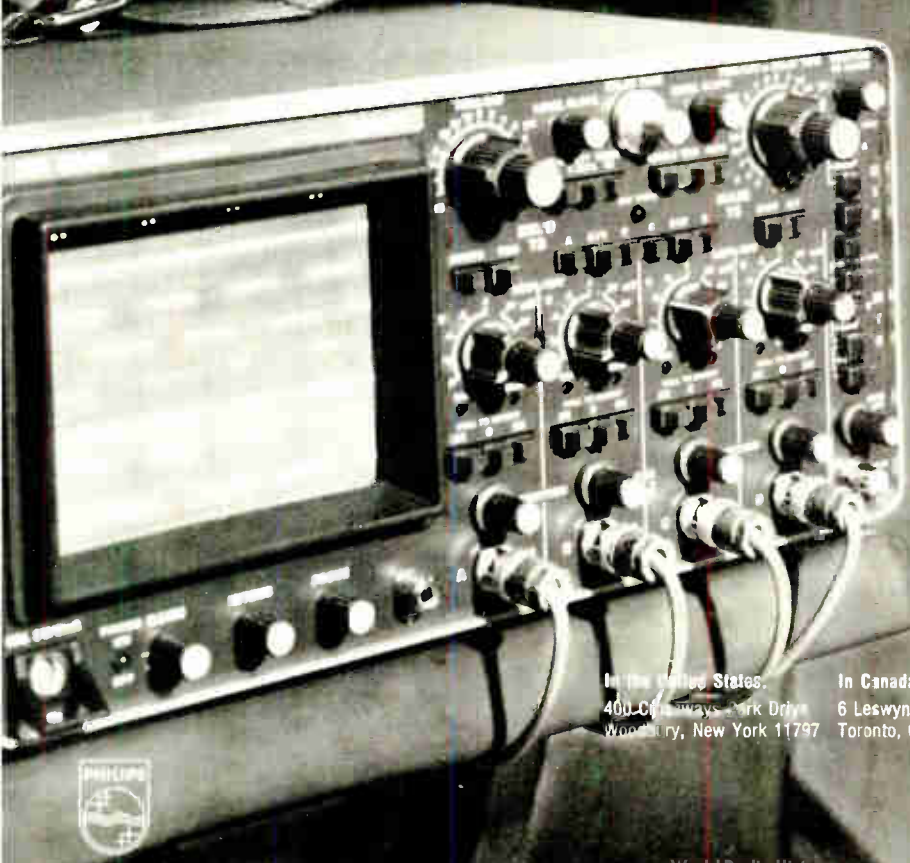

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Circle 195 for a demonstration

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Electronics review

date that the data was gathered."

In addition, says Reyes-Guerres, the commission should ensure the data is not presented in such a way that it can be "used as an incentive to recruit students." □

Consumer

Are video games imprinting TV tubes?

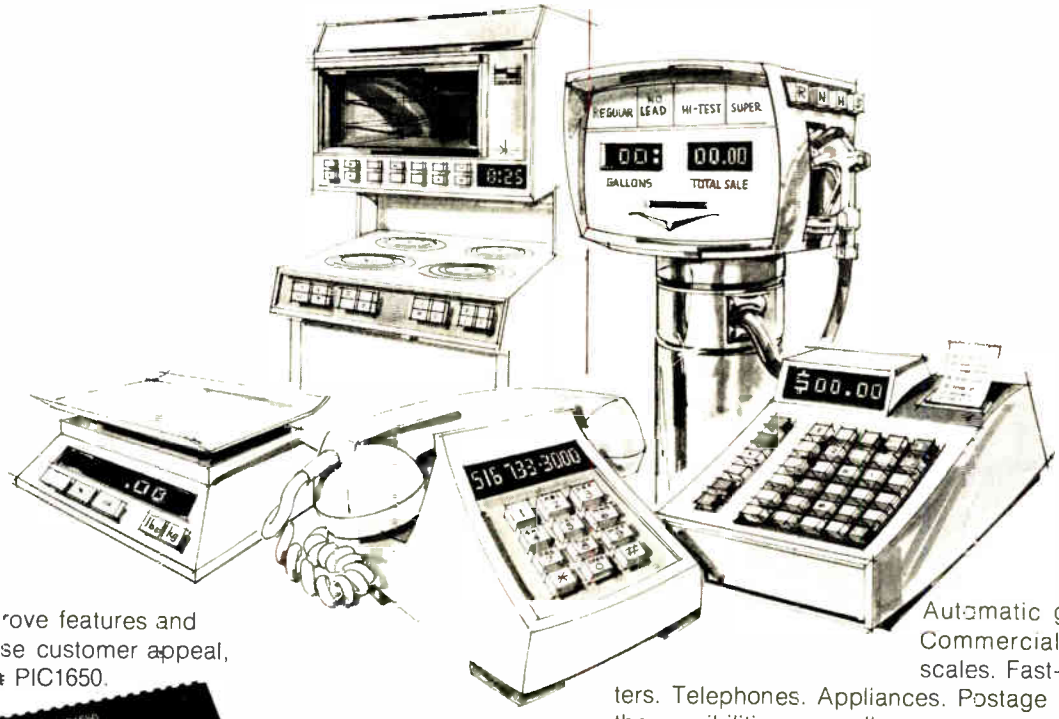
Video games may be leaving a lasting impression—if not on the players, at least on some television screens—so the staff of the Federal Trade Commission is investigating. Apparently, lines are imprinted on TV-tube faces when games are operated continuously for hours.

So far, the FTC has not gathered enough evidence to show just how troublesome the situation may be, says a commission official. Once enough data is accumulated, the FTC commissioners may vote to launch a formal investigation.

Magnavox Co., Fort Wayne, Ind., reports that it has had "a couple of complaints from dealers" who left Odyssey games turned on in display windows for some time, but "no complaints from consumers in four years." The company found permanent marks did show up after a 2,000-hour life test but when they became visible is unknown.

Committee agendas. Though outwardly unruffled by the action, the Electronic Industries Association plans to add discussion of the imprinting problem to the agendas of its Television Receiver and Picture Tube committees during the Consumer Electronics Show in Chicago this month. Jack Wayman, vice president of the EIA's Consumer Electronics Group, calls the matter "a bowl of jelly" too difficult to get a grip on. The worst that might happen, he adds, is that the FTC could require games makers to warn consumers of the possibility of imprinting and caution them not to leave the game turned on overnight, as well as to avoid high settings of intensity and brightness. □

Pick a PIC



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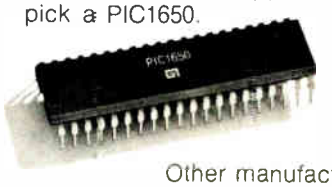

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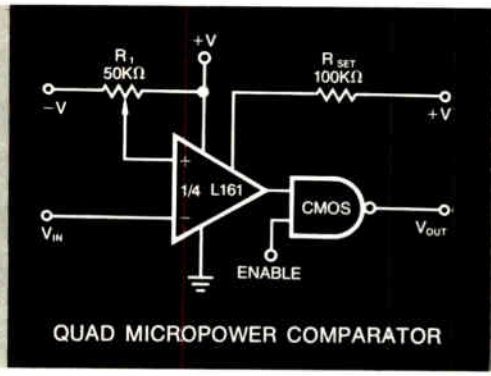
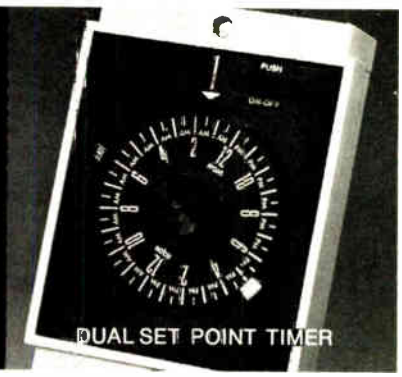
new ICs we've developed to and control design."





"These new products are good news if you've encountered problems with battery drain, CMOS interfacing, DVM costs or timing/counting control.

"Our new L161 Quad Micropower Comparator is ideal for use in aerospace sensors or battery powered products such as pocket pagers or smoke alarms. It reduces both power supply and component costs. And it solves the problem of sensing signals near ground and simplifies CMOS interfacing. The L161 is the industry's first programmable quad comparator, so you can use it at the optimum power and drive for your application. If you've been using op amp assemblies in comparator and oscillator applications, the L161 is the first monolithic replacement.

"We've also developed a new ± 3-1/3 digit CMOS A/D converter, the LD131. With just three capacitors and a single reference it can operate as a DVM with 0.1% accuracy. The LD131, like the recently introduced LD130 ± 3 digit DVM chip, eliminates dual tracking references and other expensive complications. Both devices enable you to use precise digital readouts in applications where it was previously unfeasible, such as digital thermometers. For less than the cost of an ordinary analog meter you get 10 to 20 times the accuracy and far higher resolution. The LD130 and LD131 are also ideal for applications such as scales, controls and microprocessor A/D interfaces.

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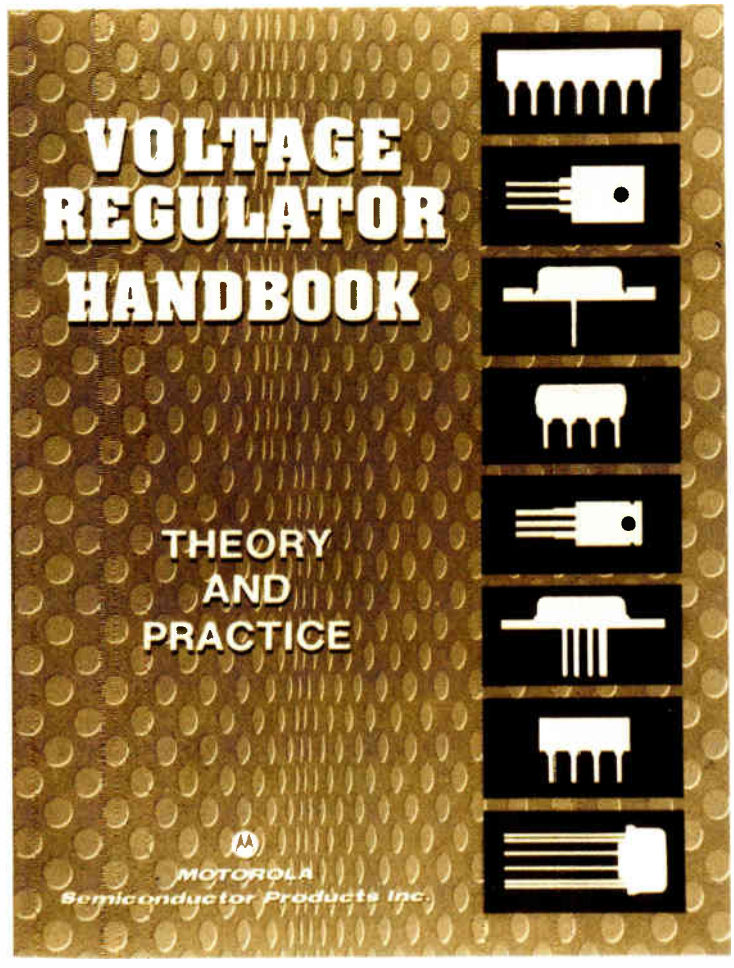

The Magic Book

It's as easy as 1, 2, 3. Motorola discloses basic regulatory theory along with circuit configuration and practical design examples. Also reveals series pass elements, heatsinking, construction and layout, input power supply design, reliability and trouble-shooting. In addition to complete Motorola regulator data sheets, it crystal-balls new regulator products. Selection guides and an industry cross-reference complete the act. All for the magically low price of just $2.50.

MOTOROLA

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	Positive								Negative			
	Maximum Current								Maximum Current			
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2	–		–		–		MC78L02C,AC		MC7902C		–	
3	–		–		–		–		–		MC79L05C,AC	
5	MC7805C		MC7705C		MC78M05C		MC78L05C,AC		MC7905C		–	
5.2	–		–		–		–		MC7905.2C		–	
6	MC7806C		MC7706C		MC78M06C		–		MC7906C		–	
8	MC7808C		MC7708C		MC78M08C		MC78L08C,AC		MC7908C		–	
12	MC7812C		MC7712C		MC78M12C		MC78L12C,AC		MC7912C		MC79L12C,AC	
15	MC7815C		MC7715C		MC78M15C		MC78L15C,AC		MC7915C		MC79L15C,AC	
18	MC7818C		MC7718C		MC78M18C		MC78L18C,AC		MC7918C		MC79L18C,AC	
20	–		MC7720C		MC78M20C		–		–		–	
24	MC7824C		MC7724C		MC78M24C		MC78L24C,AC		MC7924C		MC79L24C,AC	
Voltage Tol.	C = ±5%		C = ±5%		C = ±5%		C = ±10% AC = ±5%		C = ±5%		C = ±10% AC = ±5%	
Package	TO-3	TO-92	TO-220	TO-39	TO-220	TO-39	TO-92	TO-39	TO-220	TO-3	TO-92	TO-39

Out of the hat soon . . . LM117, a 3-terminal, positive, adjustable regulator for voltages from ±1.2 to 30 V, up to +1.5 A. Packaged in TO-3 and TO-220 it'll appear 1st quarter, '77.

The Magic Numbers

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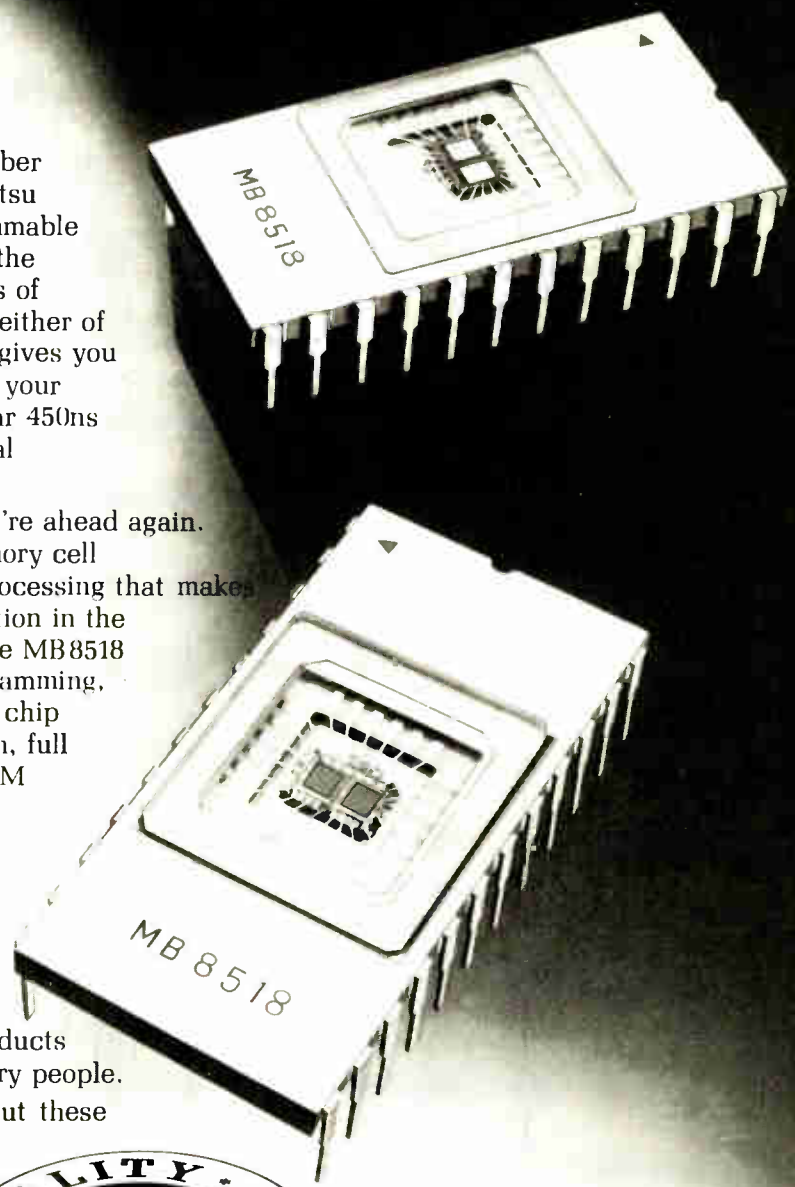

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Washington commentary

1977's Superbowl: AT&T vs the Federal Government

The future of America's telecommunications industry—and whether the American Telephone & Telegraph Co. will continue to control it—shapes up as 1977's most important Washington story for the electronics industries, more important perhaps than the issue of national defense.

The nomination of Harold Brown as Secretary of Defense in the Carter Administration, coupled to the nomination of Houston executive Charles Duncan Jr. to serve as Brown's deputy, strongly suggests that major alterations in the way the Pentagon does business will not be forthcoming this year at least. Brown, the 49-year-old physicist and former child prodigy, is an old Pentagon hand, having served as Lyndon Johnson's Secretary of the Air Force before becoming president of the California Institute of Technology in 1969.

The issue of telecommunications and AT&T, on the other hand, seems certain to produce significant controversy on Capitol Hill, in the Department of Justice, and, of course, the Federal Communications Commission.

Unlike the relative stability that Brown is expected to bring to the Pentagon at the start, the issue of telecommunications and AT&T is already a cauldron of controversy in Washington, with volatile new ingredients being tossed into the pot almost daily by the Congress, the Federal Communications Commission, and the Justice Department's Antitrust division. Shortly before Christmas, for example, Justice Department attorneys moved to speed up the action in its AT&T antitrust suit filed last year. In so doing, the Government's lawyers heightened the confrontation with AT&T by spelling out in some detail how and why it wants to break up the communications giant (see p. 38).

A Bell named Griffin

But that was last year. The question this year is just how vigorously a Carter Administration will pursue the antitrust suit in 1977 and beyond. The answer may lie with Griffin Bell, the 58-year-old Atlanta lawyer and Carter crony nominated to be Attorney General. Bell's nomination will likely be approved by the overwhelming Democratic majority in the Congress despite his controversial civil rights record during his service as a Federal judge. This troubles pro-competition lawyers in Washington—and some in the Justice Department as well—most of whom view Bell's overall judicial record as undistinguished at best.

However ploddingly the AT&T case evolves—and AT&T chairman John deButts has said he will see it through, not settling for a consent judgment as the company did 20 years ago—telecommunications issues will probably get their closest examination on Capitol Hill. With the reintroduction of the Consumer Communications Reform bid, the so-called "Bell bill" by which AT&T would have Congress guarantee its effective control of public communications, the Congress faces one of the most complex and controversial issues—legally and technologically—that has ever come before it. The man bearing much of the burden will be Rep. Lionel Van Deerlin, the California Democrat who chairs the House Interstate and foreign commerce subcommittee on communications [*Electronics*, Oct. 28, 1976, pp. 14, 35].

Van Deerlin's challenge

Van Deerlin, at least, is up to the challenge. Not only has he sent every newly elected House member a letter with a transcript of last session's preliminary hearings on the bill, but the chairman has more recently urged the FCC to describe how it is verifying AT&T's reported lobbying outlays to secure passage of the bill. AT&T has already acknowledged the expenditure of more than $2 million on the bill during six months of 1976.

The size of that figure distresses Van Deerlin, and so do reports that the Internal Revenue Service's inability to adequately audit AT&T tax returns between 1966 and 1975 has cost the Treasury nearly $3 billion in taxes. "A common thread running through these questions," Van Deerlin said in recent letters to the heads of the FCC and IRS, "is whether the Federal Government—specifically the FCC and the IRS—has sufficient resources to monitor AT&T's activities." The answer, of course, is no. FCC chairman Richard Wiley in effect said so last month in a response to Van Deerlin.

All this guarantees that significant changes in Federal telecommunications policy and regulation favoring competition are going to be pushed hard during 1977. If they come to pass, it will only be over AT&T's dead body. That spectacle seems unlikely right now, but then the year has just begun.

Ray Connolly

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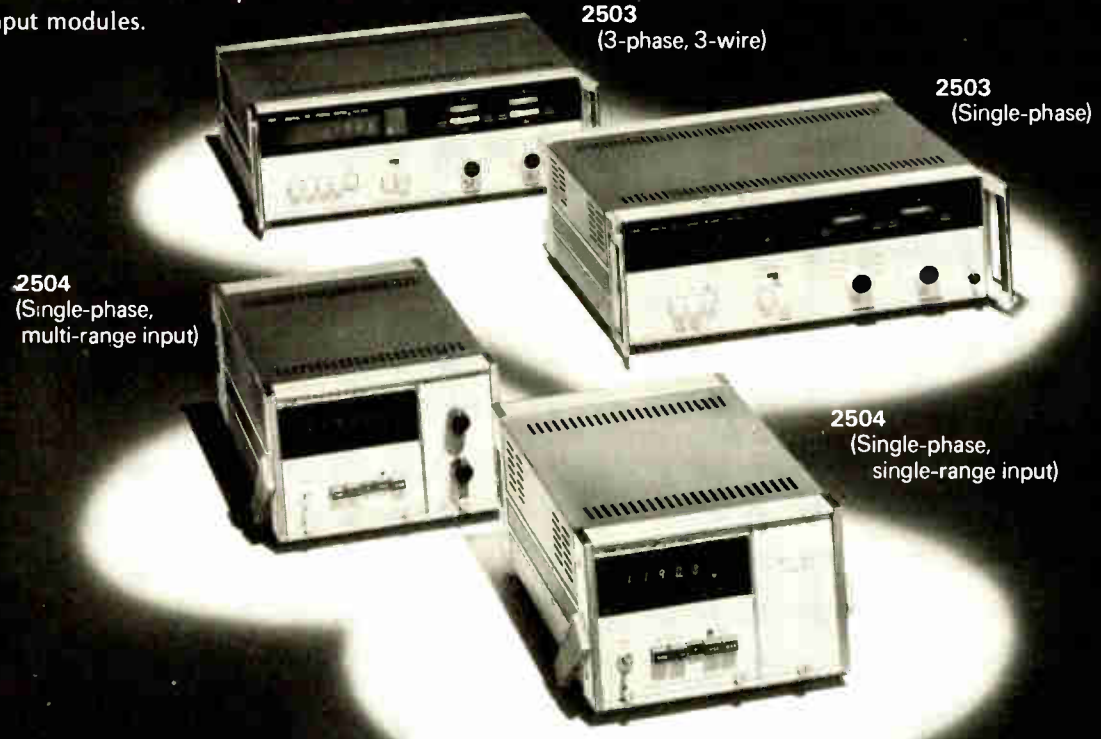
- Frequency Ranges: 40Hz to 1.2kHz (W)

Type 2504 Digital AC Meters

- Measuring Ranges: Single-range module; 150V, 5A (750W), or 100V, 5A (500W). Multi-range module; 100/150/300/600V, 2/5/10/20A (200W to 12kW), or 30/60/100/150/300V, 0.5/1/2/5/10A (15W to 3kW)
- Frequency Ranges: DC, 40Hz to 1.2kHz (W)

Patent Number: U.S. patent 3500109



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International newsletter

Space group pushes spending programs without formal OK

The 10-nation European Space Agency greeted the New Year without formal approval from its overseeing council for a little over half the $544 million it plans to spend this year. But agency officials are not too concerned. **They have standby financing for the first three months of the year for the Ariane launcher, the scientific program, and the general budget.** Budgets for ESA's other major programs—Spacelab, Meteosat, Orbiting Telecommunications Satellite (OTS), Aerosat, and Marots—have all been OK'd by their boards and do not require approval of the member-government council.

For 1977 spending, the Ariane launch vehicle—scheduled to start test launches in about 30 months—tops the list with 127 million units of account (one UA equals $1.09 this year). Second is Spacelab, ticketed for just over 100 million UA and slated for a late-1980 launch. All told, the agency's draft budget totals 499 million UA for 1977, up slightly from last year's 462 UA. **The biggest news is expected to be from the four satellites NASA will launch for ESA this year**—GEOS in April, OTS in June, Meteosat in September, and International Sun/Earth Explorer B, to be launched jointly with NASA's A version in October.

Japan chalks up record output of color-TV sets

By the end of November, Japan's 1976 production of color-television receivers had already topped the previous annual high. **In fact, a record 1,033,000 sets were made during November—1.4% more than the previous month and 25.3% more than a year earlier, government figures show.** Sales were even higher, with the excess coming from inventory. Production was boosted in November partially by a year-end sales drive, exports continued at a high level, and manufacturers compensated for fewer working days in December and January.

Of a total of 1,167,000 receivers sold, 492,105 were exported. The month's exports were 7.4% lower than in October because Christmas shipments had already peaked, but they were nearly double the figure for the previous November. Total 1976 production will far exceed the 8,757,000 sets produced in 1973, the previous best year. The total of 9,540,404 sets produced in the first 11 months is 43.7% higher than in 1975. Exports for this period were 4,677,459.

Tetrodes improve TV-picture quality

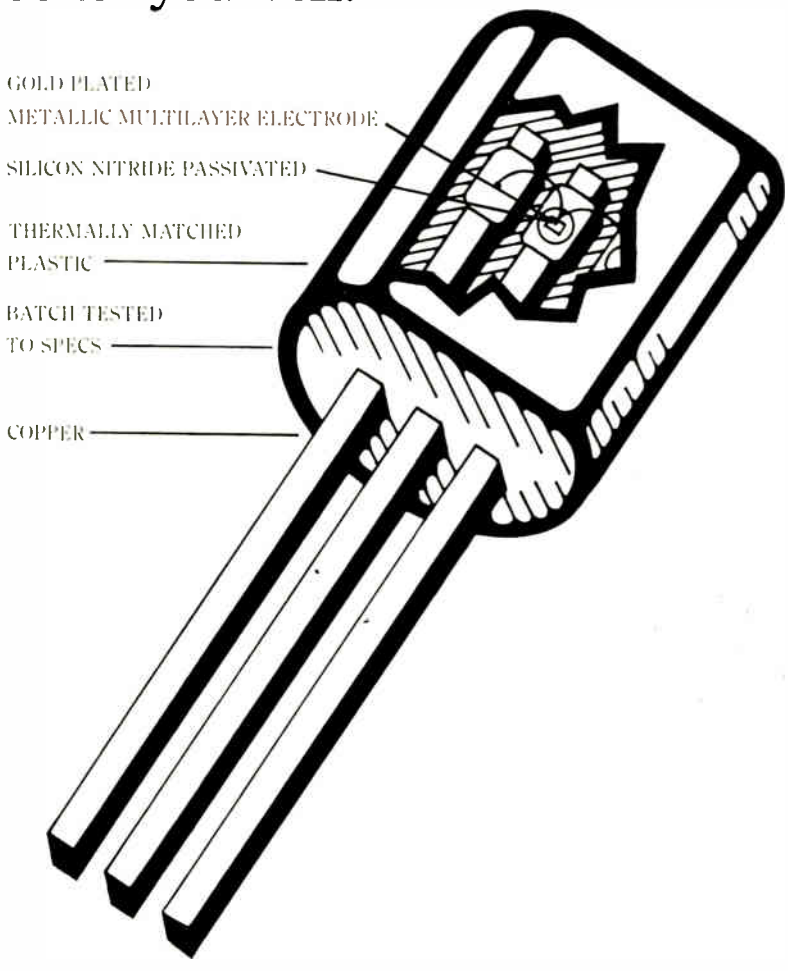
A pair of MOS tetrodes for television-receiver input stages considerably improves the quality of pictures produced from weak signals, claims the developer, West Germany's Siemens AG. **The devices, both ion-implanted n-channel types, provide much higher sensitivity and a wider dynamic range than the bipolar transistors they are to replace.** The BF960 has a gain of 18 decibels with a 4-dB noise figure at 800 megahertz, and the BF961 has a 20-dB gain with a 2-dB noise figure at 200 MHz.

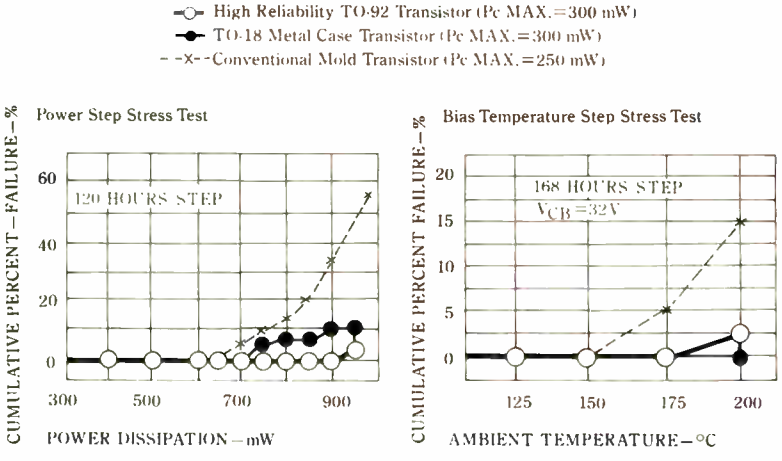
CGE aims to expand military-gear role

France's Compagnie Générale d'Electricité is expected to increase its activity in military electronics by gaining majority control of Sintra within the next three months. **CGE raised its holding in the military-electronics producer from 16.5% to 37.5% last June and is likely to expand Sintra's product line as soon as it wins complete control.** Sintra chalked up sales of $44 million last year, but has suspended its trading on the Paris stock market.

PLASTICS BETTER THAN HERMETICS?

See for yourself.





"Standard practice" can now change for the better—and cheaper. Up to now, industrial transistors have been specified in cans, to get reliability under heat and humidity. Consumer products have been able to tolerate the less expensive but less stable plastics. Now NEC has incorporated 5 technical advances that make these TO-92 plastics the equal of any hermetic metal case for most applications—and you get the lower price to boot!

1. GOLD-PLATED, MULTILAYER METALLIZATION. Because gold is electrically noncorrosive and inert to acids and alkalis. And moisture resistance and bonding strength are greatly improved over aluminum construction.

2. SILICON NITRIDE PASSIVATION Increases moisture resistance, while protecting against unreliability due to impurities. And, the operating characteristics improve, such as higher dc amplification factor and better noise figure.

3. A UNIQUE PLASTIC MATERIAL. Developed especially to match thermally the lead wires and other component parts. This minimizes or eliminates internal stress on the bonding wires.

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NEC

NEC America, Inc.

Thomson-CSF re-aims video-disk player at educational and industrial buyers

Thomson-CSF, which has spent $10 million since 1971 to develop its laser-based transparent-video-disk player, will begin test-marketing a version of its VDP to educational and industrial customers this year. However, the management, which has an exchange research-and-development agreement with Zenith in the U.S., still plans to tackle the consumer market—its original goal—in the early 1980s.

In 1978, the company plans to produce 1,000 VDPs, to be priced competitively with ¾-inch videotape recorders. It has built four prototypes and plans to produce 20 more this year. They are destined for large French companies, including automobile manufacturer Renault.

"The consumer market for VDPs will ultimately center around educational and instructional programing, rather than entertainment," predicts Claude Tinet, head of the VDP unit. "The best way to prepare for this market is by concentrating on industry as the stepping stone to the consumer."

Operation. Thomson's VDP uses flexible 12-inch disks with a 1.6-micrometer spiral pitch for 30 minutes of play. They come packaged in plastic protective cartridges that are inserted directly into the player. The 150-μm-thick disks, each with 45,000 frames, can operate at a variety of speeds, including three times the normal 25 images per second. That rate is achieved by spinning disks at 1,500 revolutions per minute for European television standards or 1,800 rpm for U.S. NTSC standards.

The system provides step-by-step slow motion and freeze framing, which is obtained by causing the pickup to move back one track at the end of each normal image scan. To make this feature easy to use, Thomson is now finishing a random-access search unit that will enable the record to locate specific frames.

The unit, which contains a microprocessor that will eventually be built into the VDP, finds the desired frame in 2 to 5 seconds after the frame's number is typed on a keyboard. Depending on its location on the disk, each frame is given a binary-code number that appears on the unit's control board and can also be superimposed on the image by a character generator.

Among other important modifications to prepare the VDP for industrial use, Thomson has rejected the dihedral plates it previously used to stabilize the disk [*Electronics*, May 30, 1974, p. 52] and now employs a flat frame stabilized by a metallic plate. This feature, says Tinet, reduces possible dust problems by increasing the gap between the laser and the disk.

Signals. The VDP includes a chroma signal with a 600-kilohertz swing centered on 3.3 megahertz, a luminance signal limited to 3 MHz and modulated over a swing from 7.1 to

Around the world

BPO to computerize mail-sorting gear

Like many postal services, the British Post Office is switching to more mechanization to sort out its logjam of letters. This year it will begin installing the first part of a second-generation automated letter-sorting system that it claims beats all others in reliability and low cost. Around midyear, the BPO also plans to award contracts to several suppliers for this phase of the network installation. Industry observers estimate that the second-step cost will equal the first part's $6.8 million.

If all of the many parts are completed in the early 1980s as expected, the BPO will have laid out about $76 million to industry for equipment in 63 second-generation centers around the country. These will join 17 first-generation facilities already installed. In the second-generation system, the BPO replaces the limited hardwired translators used for coding and sorting functions with a code-sort translator controlled by three Hewlett-Packard HP-2105A minicomputers having a MOS random-access memory of 8,192 17-bit words and 650-nanosecond cycle time. Five British suppliers will also win healthy contracts.

Cable loop cuts wiring needs for process control

A cable that handles signals on a cyclic timesharing basis greatly reduces the wiring requirements of microcomputer-based process-control system from Hokushin Electric Works. The 30-conductor cable can interconnect as many as 64 loops in any analog/digital mix, and changes can be made in the system simply by altering the software.

Availability of analog signals throughout the system makes it compatible with Hokushin's EK line of analog process-control instrumentation, which can be used for backup of critical loops. The system enables a factory already operating an analog system to expand it with digital controls.

Process control in the 900/TX system is handled by an LSI-11 microcomputer from Digital Equipment Corp. Use of the microcomputer-based system becomes economically feasible when control is needed for about 20 loops. The LSI-11, which Hokushin says provides greater throughput than competitive systems, normally controls 40 to 50 loops, depending on their individual demands. An operator's console includes another LSI-11 that controls the cathode-ray-tube display and other functions through an 8080A microprocessor that operates as a communications interface.

8.6 MHz, and two audio signals that are frequency-modulated. These signals are recorded on the disks as pits 0.6 micrometer wide and 0.15 μm deep. The size and spacing of the pits along the spiral track represent the signal conveyed to the screen by a photo-scan readout array under the disk. The array output is amplified to obtain a composite signal.

Thomson has also changed its method of servo control. Although a servo-driven mirror still keeps the light spot centered on the tracks, a moving-coil system now keeps the objective lens focused. The system automatically makes all focusing corrections that may be necessary from one disk to another in much the same way that a movie projector does. Error signals are obtained, like the video signal, from the light energy diffracted by the micropits onto the readout array. One error signal controls the radial tracking servo, and another controls the objective lens.

Thomson says many customers in industry will be attracted by its VDP's fast access time and easy replication of disks, which the company claims can be reproduced at a nominal fee compared to movies and Sony U-matic cassettes.

Still, the company is not abandoning the consumer market as an ultimate goal. "One of the reasons we are sticking to flexible disks," says Georges Broussaud, the Thomson engineer who spearheaded the movement into VDPs and is now studying their marketing potential, "is that they can be inserted in magazines and add a video supplement to publications that deal with sports, leisure, or current events. The cost of the software should not represent an obstacle to the profitability of such an operation some time in the future." □

West Germany

Siemens electronic control to inject insulin continually into diabetics

For years, millions of diabetics have longed for some alternative to their daily injections of insulin. That dream comes a giant step nearer reality with an instrument developed by Siemens AG. The electronically controlled Micro-Dosage System can continually inject insulin into the bloodstream through a catheter at an extremely minute rate—on the order of microliters per hour.

The result of a three-year development effort headed by Dr. Manfred Franetzki at the Siemens medical electronics facilities in Erlangen, the instrument has already been tried out on a dog and is scheduled for tests with diabetic patients in the near future, the company says. Participating in the project are Hoechst AG, a chemical and pharmaceuticals producer near Frankfurt, and a group of diabetes specialists at a Munich hospital.

Testing. Hoechst which has been conducting the animal tests, will continue them. The medical team at the Munich hospital is handling the basic research and will later test the system on humans. Before human trials, however, the government must approve the use of the highly concentrated insulin.

In its present form, the Micro-Dosage System consists of an electronic controller and the insulin dosage and storage device, DO2. The insulin dosage is selected through the book-size electronic controller, which controls the pump on the storage device according to the patient's needs. A liquid-crystal display shows the number of insulin units injected. The 120-gram DO-2, about the size and shape of a cigarette pack, is fitted with a miniaturized pump and powered by a mercury-oxide battery that lasts for at least two years.

Implantation. Future miniaturized storage devices, to be implanted, will contain a highly concentrated form of insulin to minimize the need for replenishment. With a concentration of, say, 1,000 insulin units per cubic centimeter and a diabetic's average daily need for 40 insulin units, a 10-cc storage device would hold enough for about nine months. After implantation, the device would be replenished by a hypodermic needle.

To meet these requirements, Hoechst must provide a solution that will remain chemically stable for long periods at body temperatures and under conditions of prolonged contact with the storage device. □

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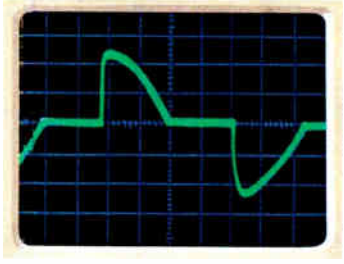

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Protection.

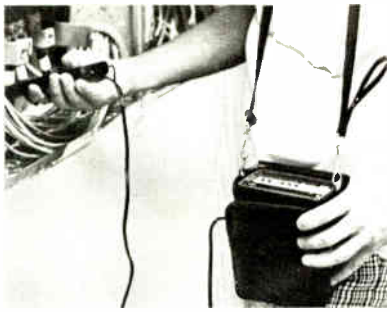
On the job, the 8030A has a predicted MTBF of 25,000 hours. The unit is designed to withstand overloads of 750V ac or 1100V dc, and transients as high as 6,000V. You can plug the ohms ranges into the ac line without damage. There's an easily replaceable protection fuse for the current ranges. And if you ever suspect the instrument has failed on any function, we've provided a self-test feature which will probably prove you wrong.

Diode test.

This unique function is for measurement of semiconductor junctions in-circuit. In diode test mode, the excitation voltage is high enough to turn junctions on. In the ohms mode, it isn't—allowing measurement of resistors paralleled by junctions.

Accessories.

The 8030A is compatible with Fluke's complete line of Universal DMM accessories which are designed with your convenience and safety in mind. (1) The brand new Universal Temperature Probe, Model 80T-150, measures temperature direct from −50°C to +150°C or from −58°F to +302°F with *any* DMM. (2) High ac currents found in motors, generators, and related applications up to 600A are accurately measured with the 80I-600 AC Clamp-on Current Transformer. (3) High frequency rf voltages can be measured with either the 81 RF (20 kHz to 250 MHz) or the 82 RF (20 kHz to 1 GHz) RF Probes. (4) For TV or other high voltage requirements, the 80K-40 Probe measures to 40 kV dc. (5) Most of these probes fit handily in the optional carrying case. (6) All 8030A DMMs include test leads at no charge.



Portability.

Carry the 8030A easily to the job. There's an extendable sunshade for outdoor work. The unit is available with either disposable or rechargeable battery packs. And the optional protective carrying case offers hands-free operation.

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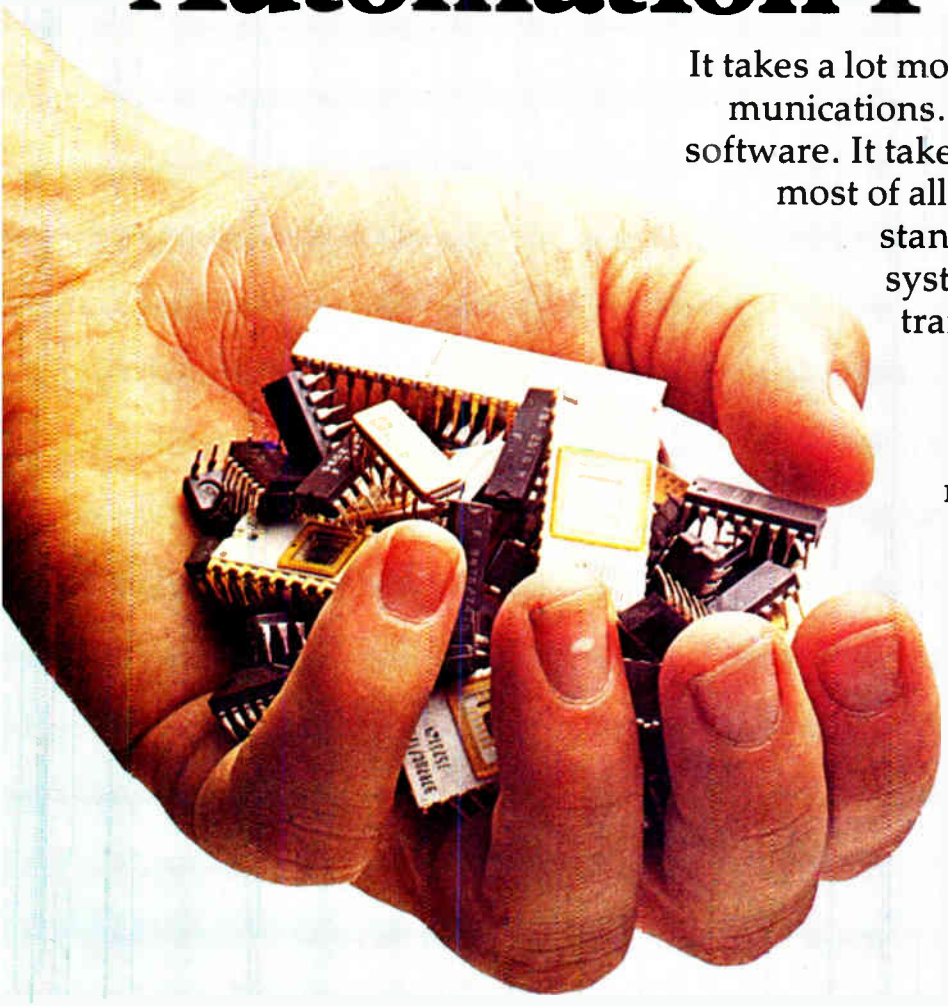

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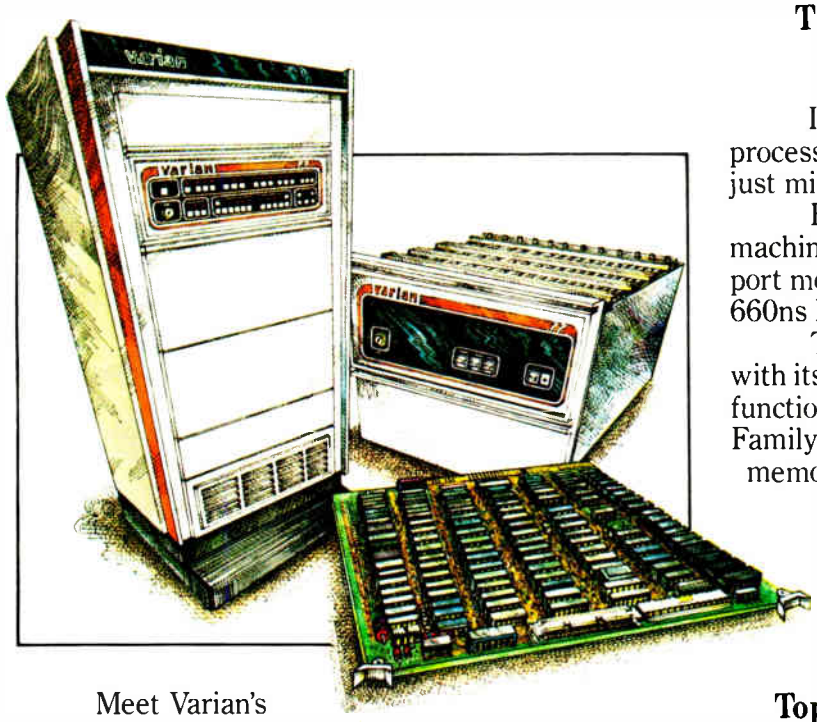

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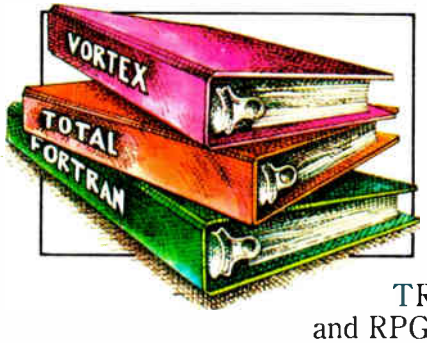

Usually found on only larger computers, TOTAL allows you to define and access your data base with powerful, high-level language processors like COBOL, FORTRAN IV Level G, and RPG-II. Opening the door to large libraries of already developed applications programs.

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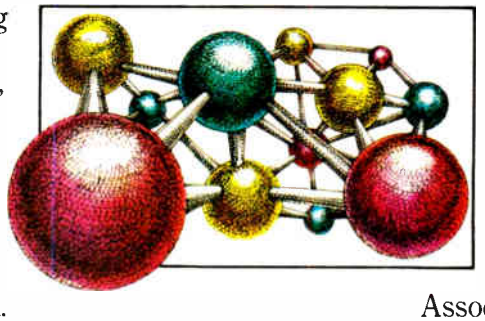

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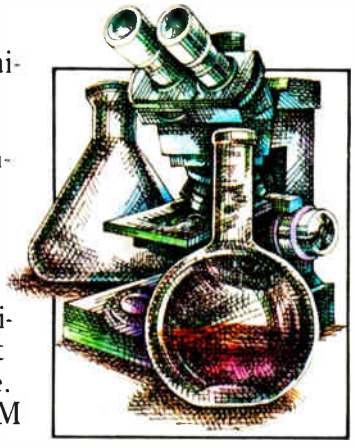

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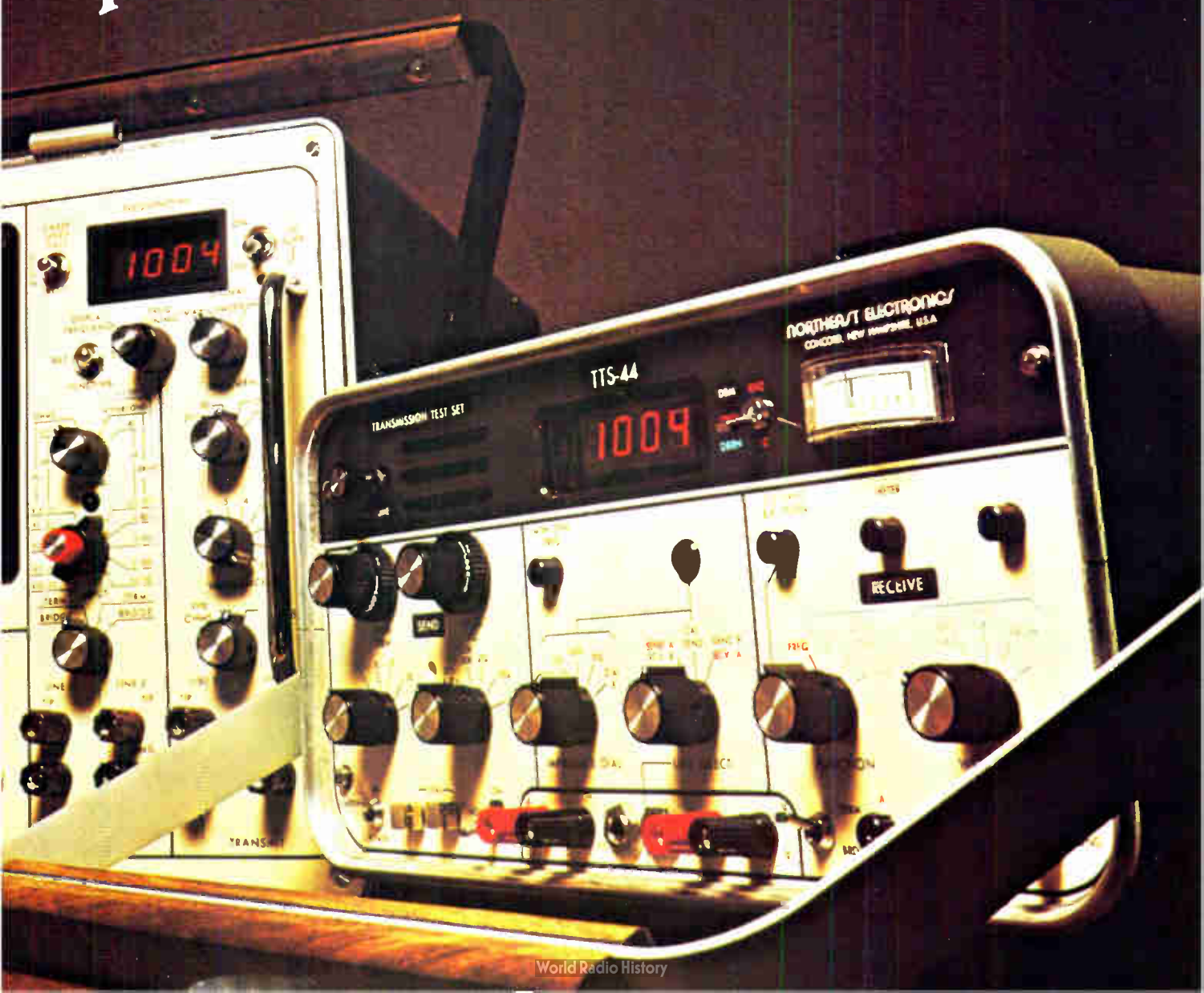

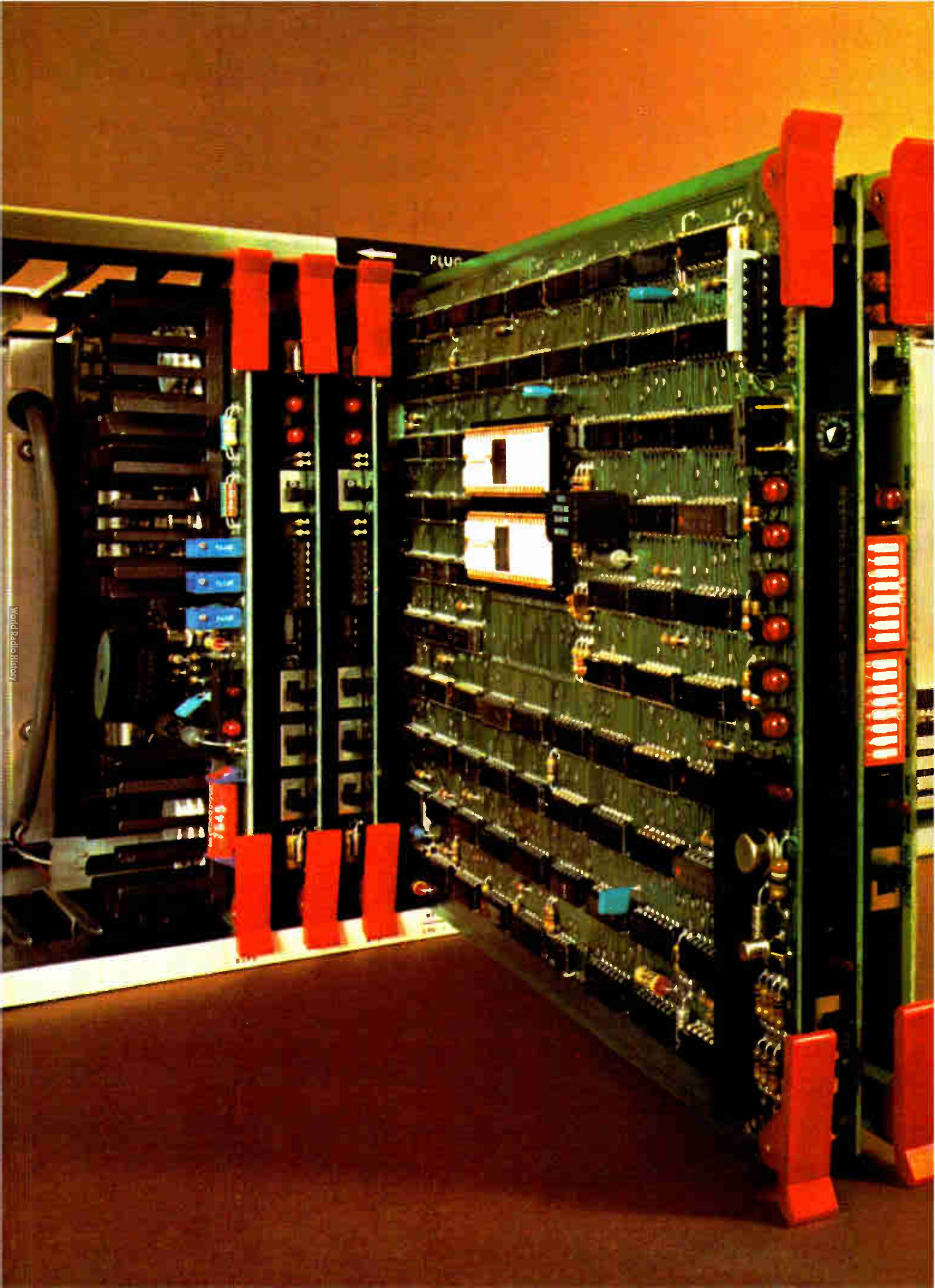

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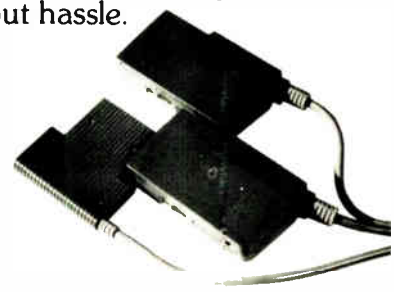

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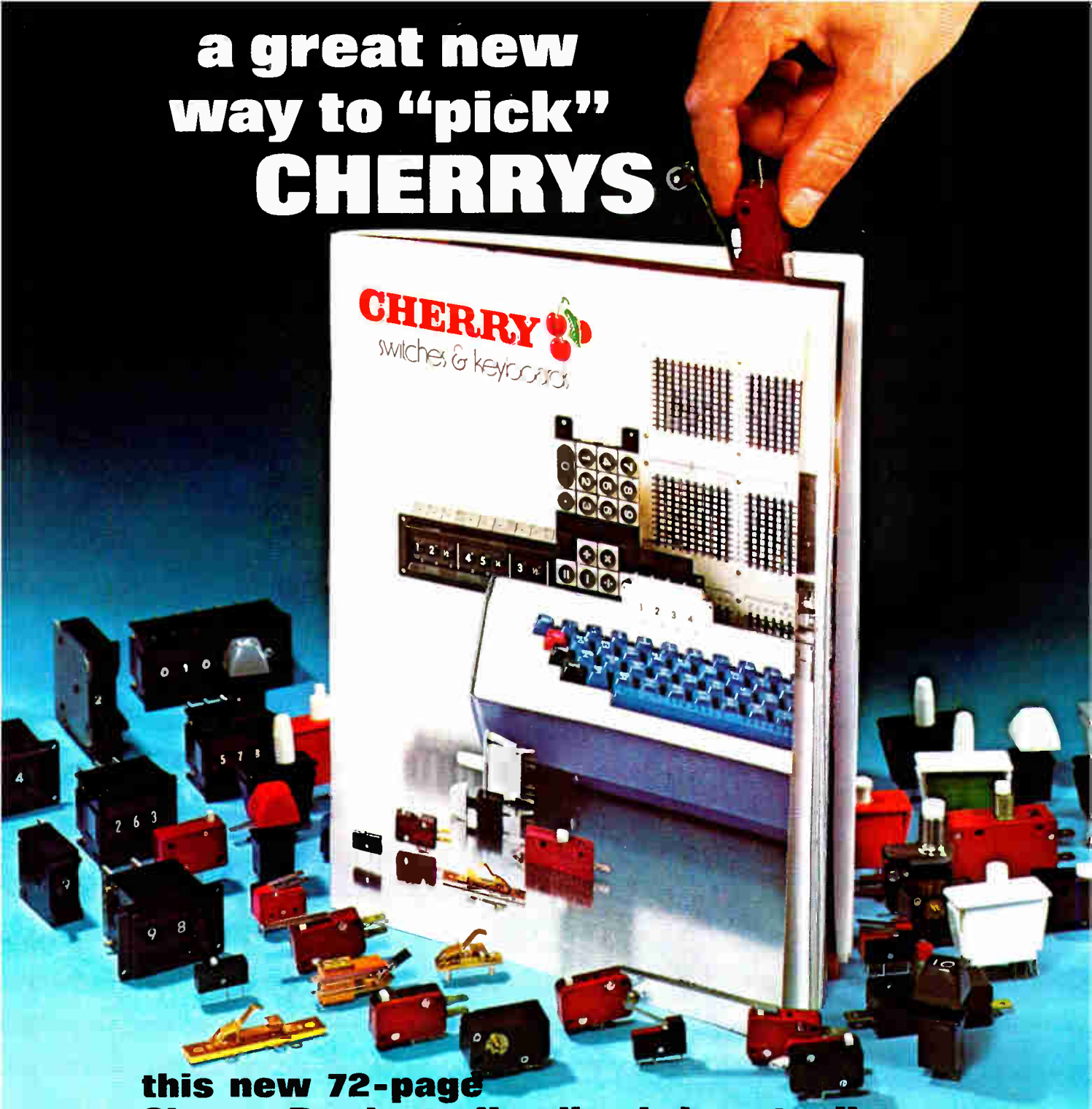

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Circle 66 on reader service card

Watch surge generates LCD shortage

But industry can't agree on long-term outlook for displays; estimates of 1977 sales range from 12 million to 21 million units

by Larry Waller, Los Angeles, bureau manager

In digital-watch displays, American taste is swinging toward liquid crystals and away from light-emitting diodes, particularly in the higher-priced models. This change raises even more questions for an industry that is sure of only one thing: it is growing. In fact, the only agreement among display suppliers is that LCDs are in very short supply [*Electronics*, Dec. 9, 1976, p. 25]. But informed industry insiders question the seriousness of this shortage, and they disagree about when it will end, how many LCD units will be produced, and who will build them.

Although definitive breakdowns on 1976 LCD production and sales are not available, many observers put the worldwide figure at 6 million to 8 million and 3 million to 4 million for the U.S. Of these, nearly 40% were captive production.

It is difficult to pin down the confusing 1977 LCD outlook. The leading U.S. manufacturer, Beckman Instruments' Helipot division, believes supplies will stay tight throughout the year, with each company pushing itself to the limit. Beckman places 1977 LCD production at 12-million-plus units. But this rate will not be reached until much later in the year. "Right now, industry can't supply more than a half million per month," observes Philip Strauss, marketing manager for the division.

Another independent, American Microsystems Inc., looks for the worldwide 1977 LCD market to top 21 million. But John Dunn, manager of LCD marketing, says that in the short run, "there is no way we can meet the expected doubling or tripling of demand without adding capacity, and that takes time." The company is expanding its facilities.

Reflected glory. Combination watch and stopwatch is from Hughes's module line.

Other firms, however, expect production to catch up much faster. Motorola Inc., which intends "to be a significant supplier to that marketplace," thinks the supply-demand gap will narrow rapidly. Martin Cooper, vice president and director of systems operations at Motorola's Communications group, estimates that, although "there may be temporary shortages, there will not be a shortage over the long haul—the whole year." He predicts that 15 million LCD watches will be sold in 1977, with LCD displays in the pipeline reaching 19 million.

At Optel Corp., Princeton, N.J., president Gerald Heller says that strong Christmas sales of LCD watches could cause a bigger immediate shortfall in supply. "The demand-to-supply ratio could be as much as 2:1," he says, adding that this shortage should be brief.

This leaves domestic U.S. LCD manufacturers straining for maximum output. Beckman, for example, is triple-shifting seven days a week in an expanded facility, and it is still not meeting demand. What's more, Tom Saldi, president of Solid State Scientific Inc.'s subsidiary, Integrated Display Systems Inc., says his Montgomeryville, Pa., plant is deluged with orders. The firm, which had to double its LCD capacity in 1976, will quadruple it this year.

The burning question now for module makers is where to find displays. Increasingly, reports are circulating that captive Japanese manufacturers, heretofore supporting only their own needs, are pursuing outside sales.

On this subject too, opinions differ. On one side, Thomas Hyltin, president of Micro Display Systems of Dallas, believes that Japanese production will help meet the shortfall in 1977. Yet William K. Weakland, general manager of Hughes Aircraft Co.'s Solid-State Products division, Newport Beach, Calif., does not expect the Japanese incursion to make any difference this year.

Optel's Heller, however, is sure that, as the shortage becomes more pronounced, "you can expect the Japanese and other offshore sources to make some encroachment on the U.S. market." Cooper of Motorola agrees, noting, "the Japanese represent a threat. They've clearly telegraphed that fact." Their pricing trend is ominous, he says, because it is based, not on today's costs, but on projected future costs.

One observer, in fact, says all these factors are converging to prevent a serious shortage. Murray Siegal, director of low-power circuits at Intersil Inc., Cupertino, Calif., which is out of the watch business but still supplies circuits, says 10 to

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15 smaller firms "will come out of the woodwork to fill the gap. In fact, it's already occurring. The Japanese, especially, are already making themselves felt."

What all the uncertainty boils down to for digital-watch builders is a bad headache in trying to plan production for the year. Not only does the present tight LCD supply cause delay of critical marketing decisions, but there's the looming question of quality.

Already burned by shoddy LED-display watches that scared off many customers, industry executives are wary of the same prospect in LCDs. Douglas Bosomworth, director of watch marketing at National Semiconductor, Corp., Santa Clara, Calif., fears, "if too many low-quality LCDs make it into watches because of competitive pressures, it will kill the market—again."

For this reason and because of the economic benefits, National has decided to produce its LCD displays in-house. "We're still in the early stages of planning," says Scott Brown, director of marketing for the Consumer Products division. "But we expect to have things up and running by mid-1977." Industry reports hold that other semiconductor firms in the watch business will follow suit.

The bottom-line puzzle, of course, is how many digital watches will sell worldwide in 1977 and what percentage of these in the U.S. will be LCDs. Here, projections start at 25 million total modules and peak at the 30-million-plus level. Beckman continues to believe that half the 25 million will have LCDs, while Hughes's Weakland holds to a one-third LCD content in a 30-million-unit market. He says the $2.50 to $3 LCD-module price, expected to remain at that level throughout the year, will keep it out of the growing mass market for watches less than $20.

While the ballooning 1977 production number for LCDs are taken as fact by many, Micro Display's Hyltin, who has been building these displays longer than most, advises skepticism. "It's an immature technology, with a big difference between talking and actually doing it," he warns. If all the LCD producers worldwide actually do what they say, "the world will be knee-deep in them," he says.

In looking at the year, AMI's Dunn judges that the bright future for LCD watches results from U.S. buyers getting into line with the worldwide trend. "In Asia, consumers prefer LCD watches four to one over LEDs, and in Europe the ratio is five to one." He expects the previous 3-to-1 edge enjoyed by LEDs in the U.S. to become a 50-50 split by the third quarter of this year. □

One solution: do it yourself

How does a major digital watch maker cope with burgeoning demand for liquid-crystal-display models when the displays themselves are in such short supply? One maker, Hughes Aircraft Co.'s Solid State Products division, in Newport Beach, Calif., is expanding its own production of LCDs.

General manager William M. Weakland says Hughes will build 1 million LCD watch modules in 1977, up from only 100,000 light-emitting-diode/LCD combinations in 1976. Display manufacturing already is in full swing at Newport Beach, Calif., headquarters, with another facility set to go on line in Taiwan by midyear.

While Weakland recognizes that "there is no question the permanent display will win out," he thinks the questions of cost and capacity will delay LCDs from equaling LEDs in units sold for three to four years. The big industry growth until then is still in below-$20 LEDs, where Hughes refuses to compete.

For 1977, Hughes is "changing and upgrading our product mix," around the "already sold-out" LCD line. Weakland has high hopes for an LCD chronograph and a LCD watch/calculator combination, both introduced in 1976. Total production should stay at the 2.5 million 1976 level, divided 60-40 in favor of LEDs. "To survive in this business," Weakland says, "you need a new, unique product every year, and the calculator is ours."

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Solid state

ISSCC program promises to dazzle

Devices to be described at Philadelphia meeting next month range from one-chip computer to 100-picosecond bipolar logic

by Laurence Altman, Solid State Editor

Nowhere will you see a more glittering display of new circuit technology than at this year's International Solid State Circuit Conference. Organizers of the Philadelphia conference, scheduled for Feb. 16 to 18, have once again skimmed the best of the semiconductor industry and come up with a conference that dazzles the imagination.

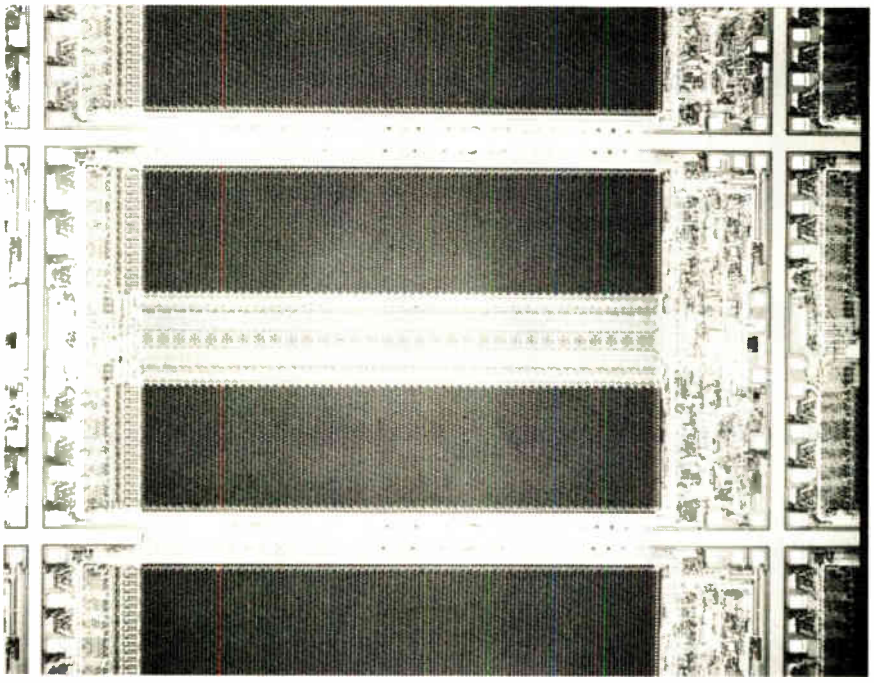
To take a quick look at six digital devices to be described, there will be:

- Intel's 8748 field-erasable-memory computer chip—an 8-bit, 5-volt controller/processor with an on-chip erasable programable ROM—that should blow open the byte-oriented low- and middle-priced microprocessor market.
- Mostek's new 16,384-bit dynamic RAM that has blinding speed as well as low power, thanks to an elegant two-level polysilicon construction process and a unique dynamic sense amplifier.
- Fairchild Semiconductor's single-chip central processing unit, which can perform Nova minicomputer instructions word for word (as it were). How is this one-chip Nova made? With injection logic, of course.
- A first look at Hewlett-Packard's heretofore secret sapphire LSI technology that the Palo Alto firm will be using for its next generation of minicomputer CPUs.
- The first good look at what everyone wants—a technology for making 5-V ultraviolet-erasable programable ROMs. American Microsystems Inc. does it with V-MOS, Intel Corp. does it with n-MOS, but either way it adds up to 8- and 16-kilobit user-erasable programable ROMs that turn out to be very dense and very fast.
- Finally, a real mind bender: Nippon Electric's 100-picosecond bipolar LSI logic—that is 0.1 nanosecond or 100 times faster than standard transistor-transistor logic. Nippon has built it into a 180-gate 8-bit arithmetic/logic unit that fits in a 1.6-mm^2 area, which is just a small portion of a full-sized chip.

And there's more. In the analog area, consider a charge-coupled analog-to-digital converter from General Electric; complementary-MOS converters; a 12-bit one-chip digital-to-analog converter from Precision Monolithics that is accurate, fast, and stable; the chip that National Semiconductor is building for Kodak's new instant cameras; and a slew of telecommunications circuits that combine analog with digital large-scale integration to implement large, low-cost telecommunications functions.

What makes the meeting doubly impressive is that these developments are not laboratory projects years away from seeing a user. Rather, they are the advanced state-of-the-art circuit designs that use reproducible manufacturing techniques and are heading for production today. In other words, they're real.

The erasable chip. Intel Corp. of Santa Clara, Calif., pulled a fast one on the rest of the industry by including an UV-erasable program-



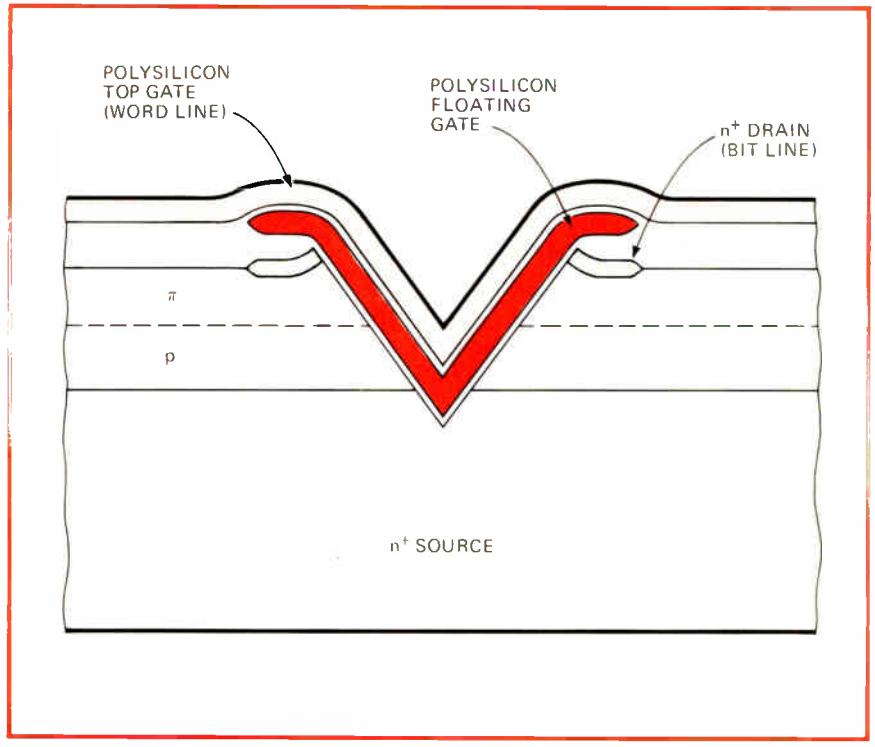
Big and fast. This Mostek 16,384-bit RAM is fast and dissipates low power because of a tight two-level polysilicon cell design and sense amps that use power only when sensing.

able read-only memory on its 8748 microcomputer chip. Designers David Stamm and David Budde will talk about it at the conference. By putting a 2708-like 8,192-bit EPROM on the single 5-v computer chip, which is part of a new MSC-48 minimum-chip microcomputer family, they have made sure that other suppliers will not be able to touch the product line for some time, since apparently Intel alone has the production techniques.

More. But the EPROM is only part of the story, as the paper will disclose. The chip combines a multiplexed-bus scheme with a very powerful 8-bit arithmetic/logic unit and a 64-by-9-bit random-access-memory array that can execute a very respectable set of program instructions including interrupts. Those capabilities put the one-chip controller/processor just below many multichip microprocessor families. It can stand alone as a low-cost controller, or it can be combined with other MSC-48 chips or 8080 peripheral chips to implement medium-performance data-processing jobs.

As for Mostek Corp.'s fast 16-k random-access memory, there are, of course, two 16-k RAMs already in production: Intel's two-level 2116 chip, which was disclosed at last year's ISSCC [*Electronics*, Feb. 19, 1976, p. 105], and Texas Instruments' single-level 4070 chip [*Electronics*, May 13, 1976, p. 81]. What makes the 4116 design from the Carrollton, Texas, firm so important is its speed-power specification: 150-ns access time at 462-milliwatt active and 20-mW standby power dissipation.

Mostek designers P.R. Schroeder and Robert Proebsting use a two-level polysilicon cell design to obtain the cell size—smaller than the 1 square mil that is the maximum needed for the high-density 16-k memory array. They also designed a unique dynamic sense amplifier, 64 on the chip, that reduces its power consumption by 20%. (Unlike static types, dynamic devices consume power only when they are on, which is a fraction of the time the chip is operating). Like other 16-k RAMs, the part will be supplied in the 16-pin multiplexed package that Mostek pioneered in 1973 for its 4,096-bit devices.



V for V-MOS. New MOS techniques are now being applied to erasable ROMs. This cross-section shows how AMI is applying its V-MOS process to a UV-erasable ROM cell.

Fairchild Semiconductor's 9400 16-bit Nova-compatible minicomputer processor chip does on its own what Nova designers need 100 or so Schottky TTL packages to do. Thanks for that achievement goes to Fairchild's injection-logic technology, which the Mountain View, Calif., firm calls I^3L circuit design. The process produces devices with low power (160 microwatts per gate), high speed (4 ns per gate), and extremely high packing density. The chip fits into a new slim 24-pin package that occupies only two thirds the pc-board area of standard packages.

Elegant. According to Fairchild designer Chuck Erickson, the chip contains some elegantly designed computer logic blocks. It is organized in two major segments: one for manipulating data, the other for manipulating program instructions. The data path includes four 16-bit accumulators as well as four 16-bit special registers and an ALU. The microcontrolled program unit is organized around a programed logic array with 19 inputs, 24 outputs, and 72 product terms.

As for 5-V EPROMs, there are several approaches, such as straight n-channel depletion loads, or buried-source or stacked-gate structures, which can be built with V-etch MOS processing. These and others will be discussed at a session on alterable ROMs.

Fred Jenne of American Microsystems Inc., for example, will discuss a V-MOS technique that his group has applied to an avalanche process. The method not only achieves the desired 5-V operation, but results in an EPROM cell only 0.3 mil square or about one third the size of 2708-types built with the n-MOS floating-gate process.

Jenne will also offer an advanced look at the way AMI is applying the V-MOS process to RAMs, with equally impressive speed, power and packing density. The cell is about half as big as today's split-gate 16-k cells (less than 0.5 mil^2), about twice as fast, and no more power-consuming. The ratio of cell capacitance to bus line capacitance is three times better than in split-gate designs, which means higher cell output signals, easier sense-amp detection, and faster, more reliable operation. □

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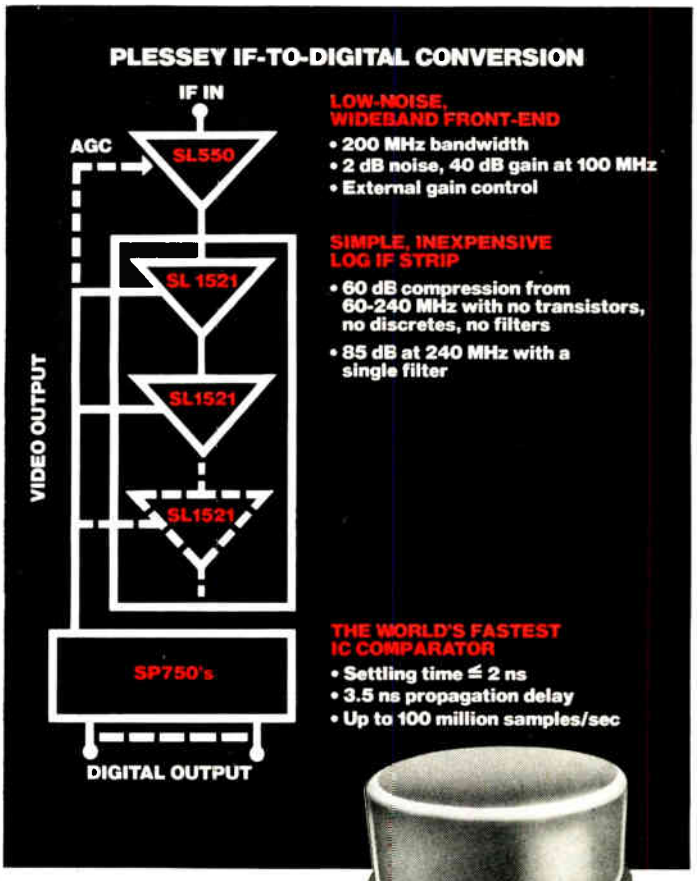

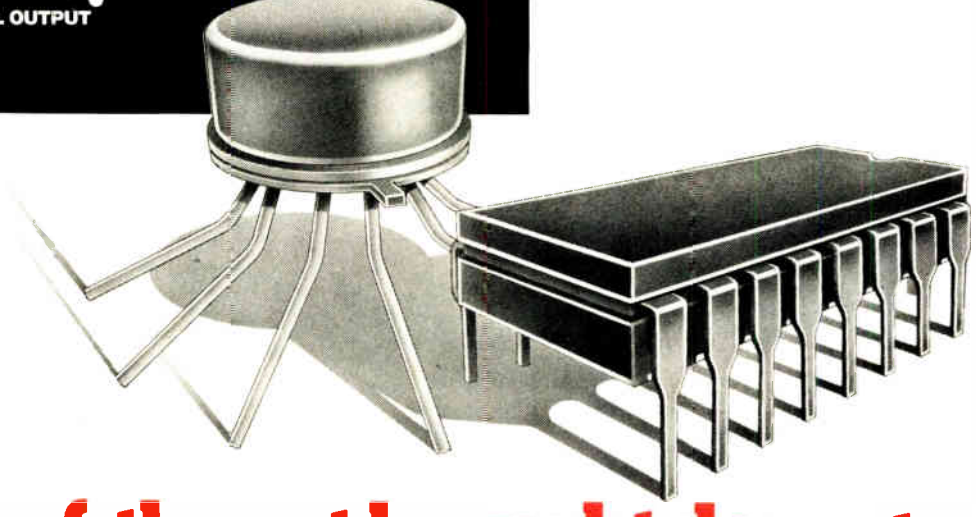

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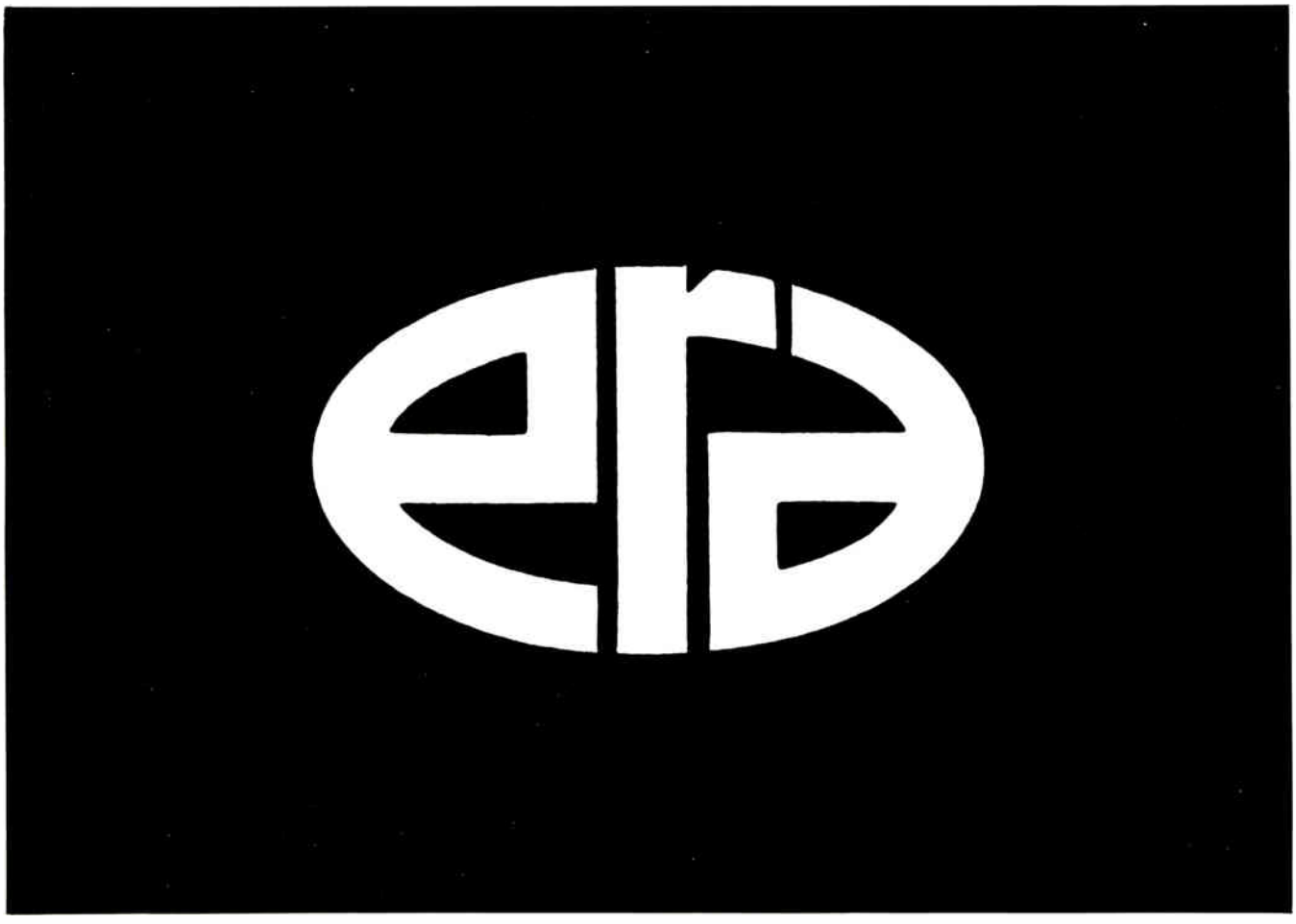

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Companies

Unitrode diversifies via acquisition

Purchase of 20% of Synertek broadens vista for firm long thought of as semiconductor maker for the military

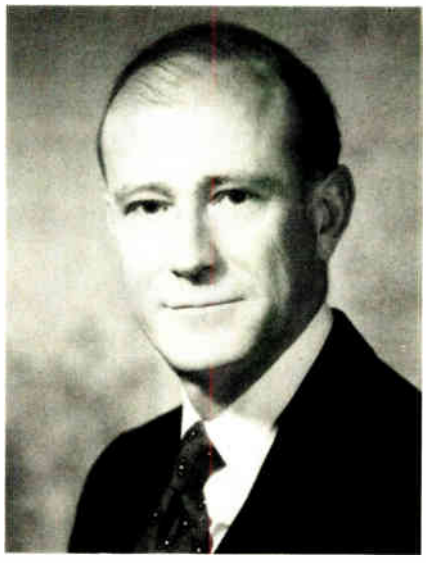
by Lawrence Curran, Boston bureau manager

"Dollar sales of integrated circuits in 1975 exceeded those of discrete semiconductors for the first time." With that remark, included in a recent report to shareholders, George M. Berman, president of Unitrode Corp. in Watertown, Mass., crystalizes the thinking behind his company's purchase of some 20% of Synertek Inc. stock.

This diversification through the $10 million Santa Clara, Calif., MOS LSI house is the most dramatic indication that Unitrode is expanding beyond the market with which the company has been traditionally associated—specialized semiconductors designed for high-performance defense and aerospace applications. Actually, Unitrode makes power semiconductors, including rectifiers, zeners, diodes, thyristors, transistors, rectifier assemblies, and hybrids.

The scholarly, pipe-puffing Berman bridles a bit at the suggestion that the 17-year-old company he heads has been mainly identified with the military market. Pointing to a list of products that use Unitrode components today in applications the company did not serve three to five years ago, Berman says that Unitrode is no newcomer to a business that is highly price-competitive. The list includes keyboard terminals, television sets, electronic organs, smoke detectors, telephone-switching systems, voting machines, and citizens' band radios.

Uses. The range of end uses could deflate the contention of one competitor that Unitrode "hasn't been in the mainstream of the semiconductor industry from a price standpoint," Berman says. He quickly singles out the 1971 acquisition of what is now Unitrode Computer Products Corp., Methuen, Mass., as strong evidence that the company knows how to make what he calls popularly priced products. "We've been doing a whale of a job in switching diodes, core-driver diodes, and plastic rectifiers."



Expansion. Unitrode president Berman is leading his Watertown, Mass., company into new price-competitive markets through acquisition and diversification.

Unitrode also owns Powercube Corp., the Waltham, Mass., manufacturer of switching power supplies that Berman says is running at a $3 million sales rate now. He is projecting growth to greater than $10 million in three to four years.

Back at Watertown, Berman cites the fact that the flagship plant has been supplying major computer manufacturers with plastic-packaged rectifiers, silicon-controlled rectifiers, and a transistor type or two since 1962.

On Wall Street, though, Unitrode is perceived by one analyst as a company "that historically found a specialized niche in semiconductors and hasn't been battling the giants." That is the view of Sal Accardo, vice president of Drexel, Burnham, Lambert. He adds that Unitrode's profit-margin history has been higher than the semiconductor industry norm "because of its specialty approach to life. But it's a new ball game with Synertek because they're subject to the same vagaries as other IC makers."

Bullish. The Synertek deal, though, makes Boston analyst Oakes Spalding bullish about Unitrode. Spalding, vice president of Adams, Harkness, and Hill, characterizes Synertek as "a very hot little company that was profitable during the recession and is very profitable now." He expects Unitrode to finish its current fiscal year with sales of about $31 million, up from $27.7 million in fiscal 1976, with earnings of 90 cents per share compared with 70 cents last year.

Berman is charting a compound annual growth rate of 20%, which would get Unitrode to $55 million in three to four years. He will continue to look for acquisition opportunities in the faster-growing parts of the semiconductor business.

But the company is not abandoning its historic base in the military market, and it would not be averse to acquiring a company in the less glamorous discrete business. And a new line of power switching transistors coming out soon will put Unitrode in competition with the likes of Motorola and RCA, which doesn't dismay Berman. □

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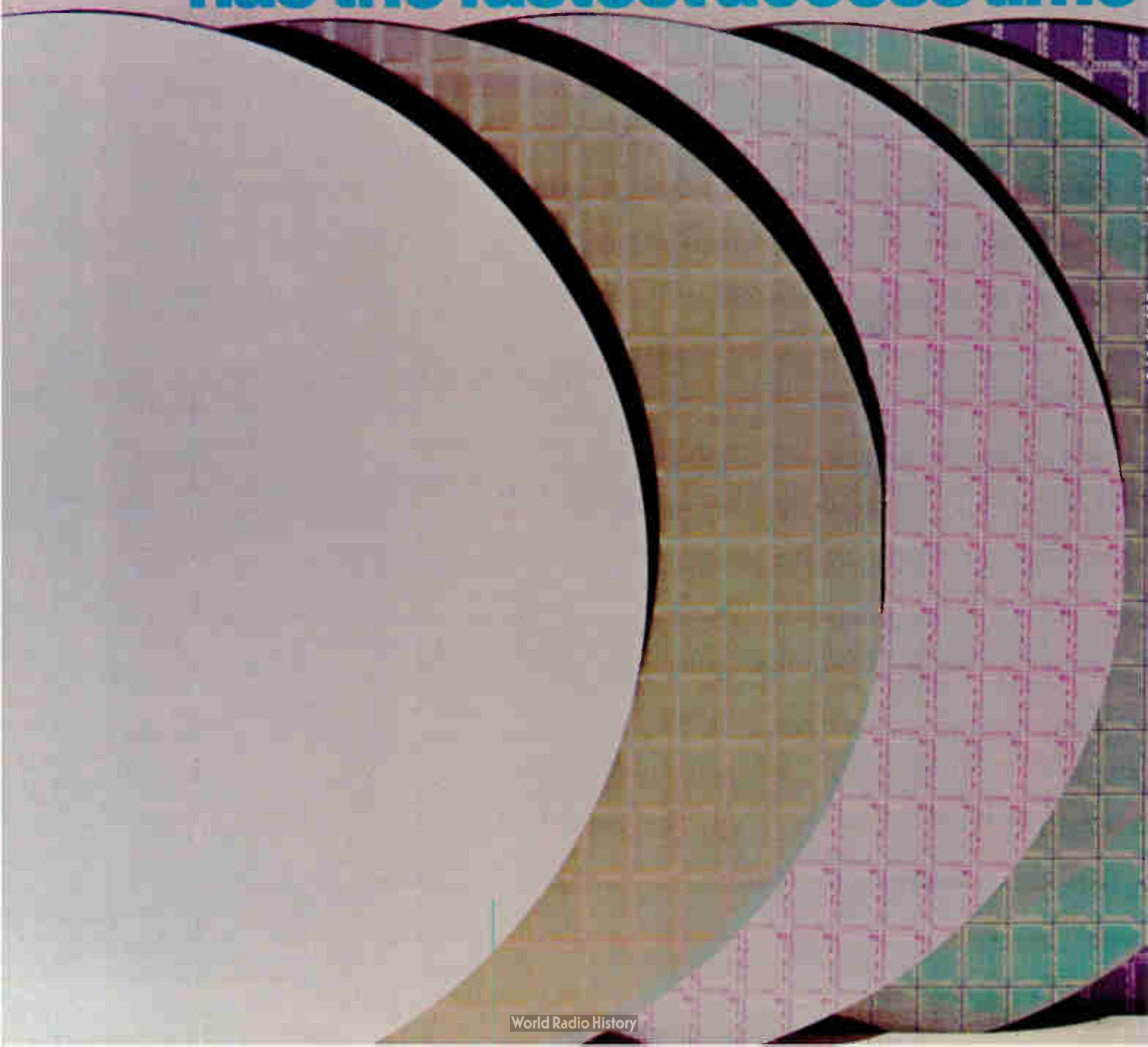

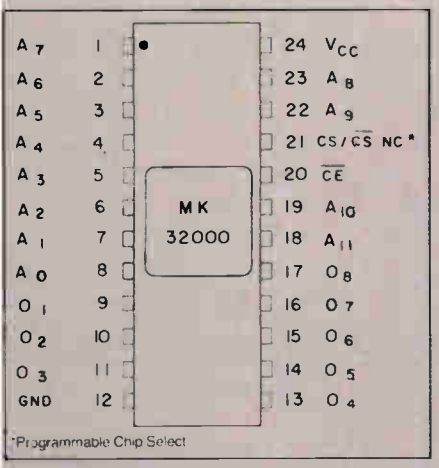

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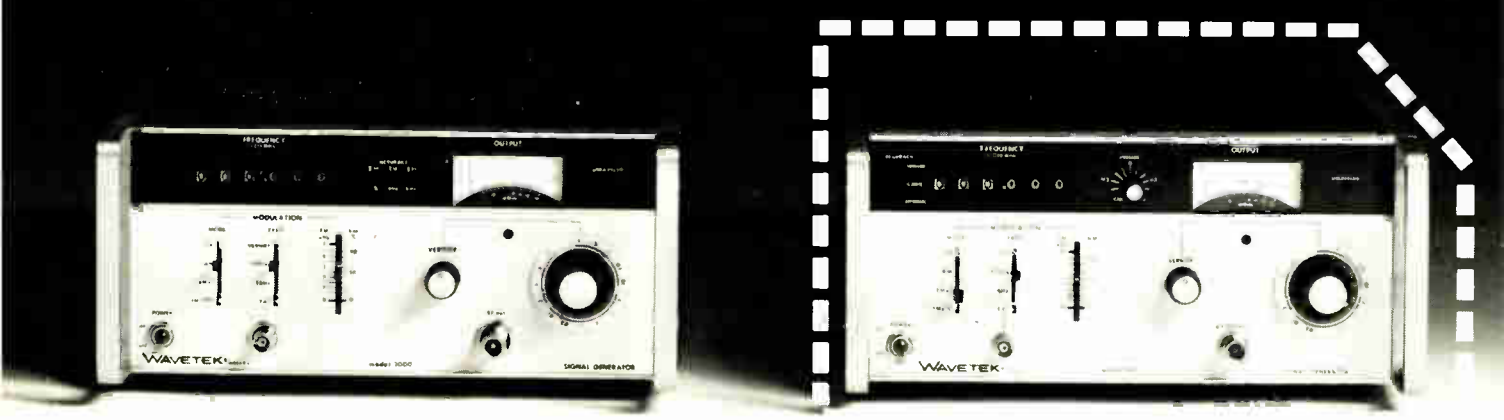

The Model 3000.

The New Model 3001.

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WORLD ELECTRONICS MARKETS

Worldwide forecast shows 12% growth for year ahead

☐ The world's electronics industries will step out smartly into 1977 to the faster tempo of an upturn in the marketplace. The brisk pace set in 1976 appears to have primed them for a year of continued strides forward, with only a missed beat or two to cause caution.

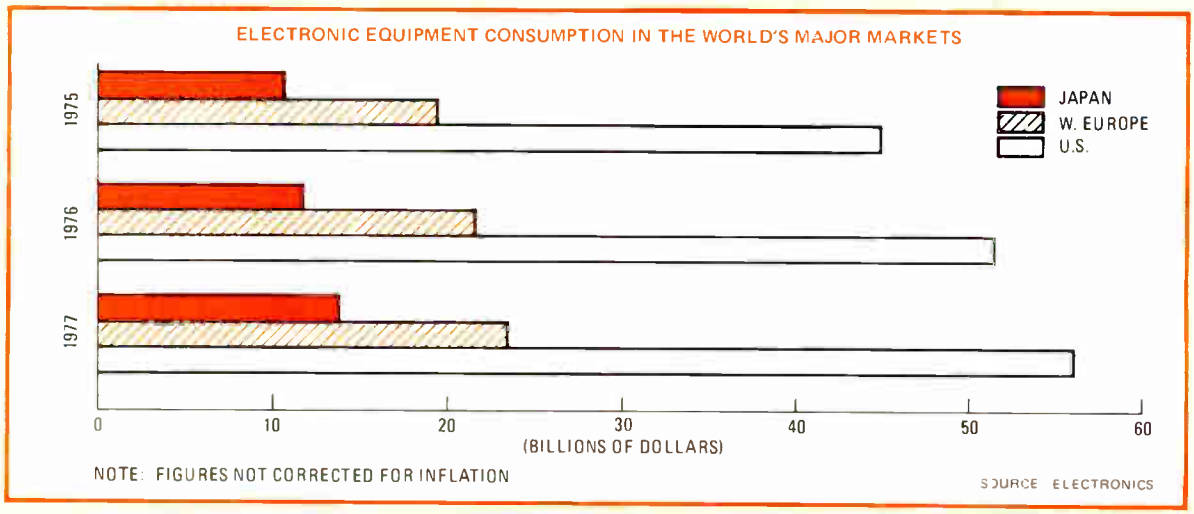
After all, the economies of the United States, Western Europe, and Japan have not yet fully recovered from the world recession, in part triggered by the oil crisis. While in general the electronics growth in 1977 promises to outpace the overall economies of these countries, inflation and rising oil prices could act as a drag for some.

Still, the outlook is for continued growth in most areas, with dollar buys of equipment rising an estimated 12% in the combined U.S., Western Europe, and Japan markets.

The electronics markets of the U.S., like its general economy, have been the first of the three to rebound from the slump of 1975. Sales of electronics equipment grew 12.4% to $50.58 billion in 1976 and should reach $56.35 billion this year, an 11.4% increase, according to the annual survey conducted by *Electronics*.

The survey of Western European countries indicates a gain of a little over 11% in 1977 to $23.68 billion for electronics equipment. The situation is spotty, however. Consumption in Great Britain, Italy, Scandinavia, and the Benelux countries is lurching along, while the market in West Germany continues to anchor Europe's growth.

As predicted, the Japanese electronics producers have exported their way out of the recession, and they should also do well at home. The *Elec-*



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tronics survey conducted in Japan shows a 17% rise in the dollar value of equipment purchased domestically, reaching $13.66 billion.

The estimated grand total of these three markets comes to $93.69 billion for 1977. However, it is important to note that these figures have not been corrected for inflation rates.

The use of electronics equipment in the industrialized nations had boomed in economies fueled by cheap oil. But when the oil-producing countries began raising the prices, they literally lowered the boom. Here, too, the ability of each country to absorb higher energy costs will continue to affect production, and demand.

On both counts, inflation and cost of energy, the U.S. seems in a better position than either Western Europe or Japan. Europe is trying to sustain growth while dependent on oil that costs five times what it did four years ago. Japan, which is the most dependent of all on imported oil, has responded by exporting the products of its technology, only to run into trouble over charges of unfair competition, actions on alleged dumping, and threats of quotas.

Each marketplace has key indicators to watch in the coming year for clues to how well the electronics industries are doing. In the U.S., one will be the highest dollar-value category: computers and peripherals. These products have become increasingly sensitive to economic cycles as their use has spread downward to small companies and outward to more applications.

Always sensitive to the economy, the volatile consumer market will be worth watching to see which of the new higher-priced products become hits—programable games, calculator watches, and video tape recorders.

In Europe, the factors to watch will be how well France, Italy, and other countries do in trying to match the market stability long enjoyed by West Germany. There are a few good signs. France's color-TV business, which has lagged behind Germany, is prospering. Italy and Spain are also recording big color-TV gains, though from a smaller base. Computers are unexpectedly hot in Italy and due for a shot in the arm in France.

As for Japan, the all-important consumer market should feel positive impact from the rapid growth of hi-fi components and the introduction of home video-tape recorders to offset the unchanged rate of growth in color television.

One trend to watch in all three major markets will be the impact of microprocessors, which could make 1977 a better-than-expected year. It is just the kind of technology-driven trend that has repeatedly provided the electronics industries with an upbeat outlook.

U.S. MARKETS

☐ For the U.S. electronics industries, business will move to a pretty lively rhythm in 1977. But just how lively will depend on a number of unknowns:

- How quickly the Carter Administration is able to stimulate the general economy.
- Whether any inflation that results from this stimulation will slow expansion investment and profits.
- How much the oil-producing nations pump up the cost of energy.
- How well the other industrial countries do at increasing the tempo of their own economies.

As predicted, 1976 was a recovery year. Total equipment consumption in the U.S. gained 12.4% to reach $50.58 billion, according to the annual survey of electronics manufacturers conducted by *Electronics*. This year, that figure should increase by 11.4% to $56.35 billion, the survey indicates. The unadjusted gross national product (which includes inflation of 5.1%) last year increased by 11% and is predicted to grow by 11% in 1977 (including inflation of 5.5%), the McGraw-Hill Economics department estimates.

The business theme is upbeat again in almost every product category: computers, consumer goods, communications equipment, industrial controls, and instruments. As a result, the prospects for most semiconductors and other components are also good.

Data-processing systems, peripherals, and office equipment, which turned around last year, have good prospects in 1977, particularly for the machines comprising distributed processing networks.

The products to watch in consumer electronics are color-TV sets in a market hit by low-priced imports, programable video games just getting off the mark, liquid-crystal-display watches coming up fast on light-emitting-diode types, and microwave ovens.

For industrial electronics, microprocessor-based process controls will be the hot products. In addition, the market for test equipment used with microprocessors should set a fast pace in the instruments sector.

Semiconductors and passive components stand to benefit from the overall gain in electronics equipment. The microprocessor market is expanding at both ends, down into cheap single-chip controllers and up into complete data-processing systems.

Networks are spreading fast

Cheered by a turnaround year that shoved U.S market dollars a solid 12% upward, the data-processing industry is pushing happily ahead into a good and in some segments excellent 1977. Compared with 1976, overall growth should be 14% to $20.9 billion. But the U.S. customers for minicomputers, intelligent terminals, and disk-storage units in particular could spend as much as 25% more than they spent last year because of the boom in small business systems and distributed-processing networks.

Distributed processing is the key market in the years ahead. Though it is still difficult to define, one fact is becoming clear: the fear that distributed-processing networks would replace large central computers appears ill-founded. Mainframe manufacturers continue to expand the performance of top-of-the-line systems to serve centralized networks better, even though they cannot expect the market to expand more than 5%.

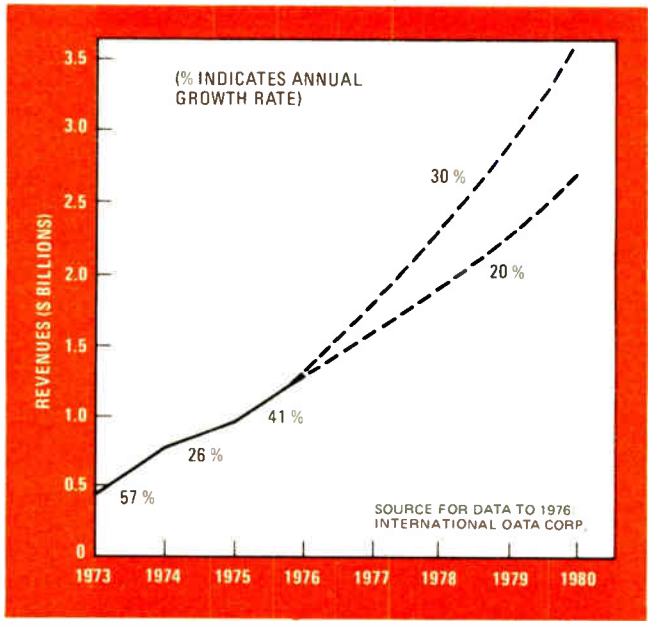
Last year, for instance, International Business Machines Corp. increased the performance of the high-end system/370 models 158 and 168, countering competition from Itel Corp. and Amdahl Corp., two manufacturers of plug-compatible processors. Last year, indeed, as IBM went, so went the industry, at least in the case of two other major trends: the installation of more distributed-processing systems, and more use of minicomputer systems tied into mainframes.

IBM added software for equipment that shares in the systems network architecture, the company's blueprint for future distributed-processing systems. It also entered the minicomputer business with the Series/1, apparently mainly with the aim of reaching those end users who have been adding remote minicomputers to their centralized installations.

At minicomputer manufacturers, meanwhile, sales of both high- and low-end products are growing rapidly, and only middle-of-the-line sales, traditionally aimed at laboratory and scientific applications, are lagging somewhat. High-end buys could grow by close to 30%, while consumption of the low-end, one-board computers will explode before year-end. Percentage growth rates mean little here, since the units are just now moving into production, but total dollar sales for 1977 could exceed $330 million.

Terminals, peripherals jumping ahead

The spread of distributed processing is evident in the strength of the intelligent-terminal market. It will grow somewhere between 30% and 35%, hitting close to $500 million, whereas purchases of simple CRT terminals will grow only about 18%, to about $224 million. In part, the intelligent terminal is bringing in much new business, but in part it is gaining at the expense of the key-to-disk data-entry system, the market in which will fall off by about 30% to $42 million.



Minicomputers' merry future. Revenues from U.S. minicomputer customers may total $3 billion in 1980. Upper edge of spreading band represents annual growth of 30% (perhaps conservative in an industry that has already hit 40% and 50% growth rates).

As for specialized terminals, such as retail point-of-sale and electronic funds-transfer systems, 1977 looks good. With a healthy sales record topped off by a good Christmas season, retailers will be in a mood to spend for new equipment. POS systems can expect to ring up about $643 million in the U.S. in 1977, up 25% from 1976. In the EFT area, a source of delay is state legislatures, deliberating over bills that would allow off-premises banking equipment. Now, fewer than 20 states allow such equipment in various configuration, but upwards of 10 more could approve it during the next year. Still, consumption of automated teller machines and cash dispensers will increase by 35% in 1977, and 1978 could be an even bigger year.

In peripherals, the use of floppy-disk drives will grow substantially during 1977, as these small, 250- and 500-kilobyte storage devices show up in more small computing systems as well as in word-processing systems. Look for about 40% growth, to $55 million.

As for large disk-pack storage systems—now in the 400-megabyte range—their cost per megabyte has declined by an order of magnitude since their introduction in the early 1960s. However, dollar gains in large-system buys will be only about 3%, even though unit buys may show around a 15% increase. In the 10-to-50-megabyte minicomputer disk-cartridge area, however, market dollars could improve by 25% to 30% during 1977, keeping pace with the growth in minicomputer systems.

A bright year, with shadows

All the forms of entertainment people once left their homes to enjoy, they now seem very willing to bring into the home—movies on video tape, arcade games and a touch of Las Vegas gambling in programable games, even the fast-food service of microwave ovens. All of which will help keep the consumer electronics industry quite happy next year, while coping with some of its usual difficulties. The figures from the *Electronics* survey peg 1977's growth at 14.3% to $8.61 billion, following a 14.7% gain to $7.54 billion in 1976.

Despite this bright picture for U.S. consumption, there are difficulties in store for American producers. In television, it is the sharp rise in Japanese imports, which hit record-breaking proportions last year. In video games, it is the shortage of large-scale-integrated circuits for games. In addition, manufacturers will experience delays in getting type approvals from the Federal Communications Commission required to put video games on the market.

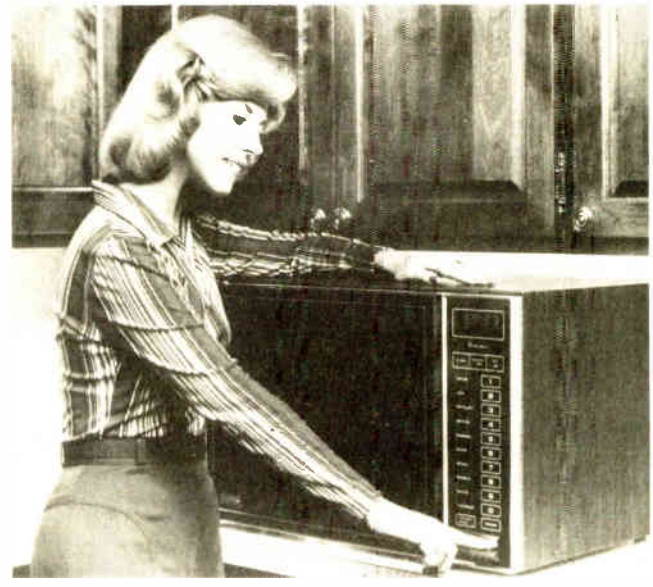
For digital watches, the problem is and has been falling prices. Last year digital-watch makers were also plagued by high returns, in some cases as many as 40% being returned by retailers, so that this year they are concerned with whether these quality problems have turned off consumers. Audio companies are also being hurt by imports and serious profit declines. As for calculators, it is the familiar story of over-inventory at the low end and rapidly falling prices for what have been profitable scientific and programable machines.

But as always the irrepressible consumer electronics companies are looking ahead for "this year's big product." This time, depending of course on the general state of the economy under the new Carter Administration, consumers could start going for high-ticket items—unlike the calculator and watch businesses, which seemed determined to hit the lowest possible prices. One high-ticket item that is already moving is the microwave oven. But sales could also start moving in video-tape recorders from Japan, projection television, and if the time seems right, even video-disk players. However, it probably will be 1978 before these high-priced items really begin to catch on. Meanwhile, high-end, programable video games and microprocessor-based recreation-room products are eliciting favorable initial reactions.

Television: good news and bad

First the good news—color TV, the monetary foundation of the industry, should log in $2.58 billion when all the U.S. market figures are in for 1976, a solid 16% increase over the previous recession year. This coming year, color is expected to hit $2.75 billion, according to figures reported in the *Electronics* survey.

Although color-TV manufacturers expected to sell from 7.8 million to 8.7 million units to dealers last year, the actual figure will be more like 7.6 million to 7.8 million. In 1977 something like 8.5 million units should be sold.



Successful recipe. Microwave ranges, such as this Litton model 420, are cooking up a storm. Japan led the U.S. in 1974 but lost the dollar value advantage in 1975. This year, U.S. sales should reach $900 million, compared to $313 million in Japan.

The bad news, of course, is the staggering increase of Japanese imports of color-TV receivers. In the first half these imports grabbed some 30% of the U.S. market. In the third quarter, while U.S. makers were easing off production, the Japanese captured almost 60% of the total U.S. TV sales—more than 40% of color, nearly 80% of black and white.

Digital watches are still in American hands, though low-priced imports from the Far East are becoming a factor. Total units expected to be sold this year range from 20 million to 22 million. Although prices for the low-end models have been coming down, the most promising growth area will be in the higher-priced models. There will be more liquid-crystal-display watches sold, also more calculator watches with LEDs.

Microwave ovens, a market that was once slipping into the control of imports, has turned sharply in favor of American-made ranges. Litton Microwave Cooking Products, Minneapolis, Minn., estimates that 1,490,000 U.S.-made ranges were sold last year and expects that another 2,075,000 will be moved this year. By 1978, the company predicts, microwave ovens and ranges will surpass conventional ranges in dollar sales.

Last year's star attraction, video games, will actually just hit stride this year, with demand still exceeding supply. Estimates of sales in 1976 are between two million and three million units. Up to six million units could be sold this year at a total value of $230 million.

All signals are 'go'

After a whopping 24% increase in 1976, the communications sector should jump another 12% this year, reaching $4.11 billion. The boom in citizens' band radio should continue, despite the glitch caused by this month's switchover to 40 channels. In fact, the industry expects to sell some 12 million CB sets each year until 1981. The land-mobile industry is growing at 10% to 15% a year and is heading for a $1 billion market by 1980.

The telephone industry, although marked by continual regulatory uncertainty, is still growing at a rate of 10% a year. Looking beyond 1977, small earth stations that capitalize on increasing satellite capacity have a bright future. And, for the first time, there is a serious market for fiber-optic communications systems (see graph).

Record sales for CB

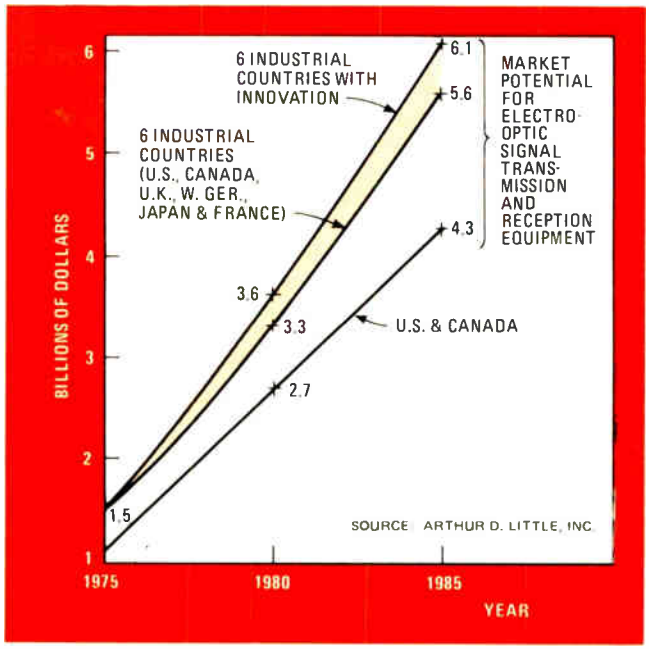
Even with last year's sales slump caused by the Federal Communications Commission's announcement of channel expansion, factory sales soared. They reached a record high of $900 million, the *Electronics* survey discloses. The FCC reports it received about five million license applications last year. Figuring 2½ sets per application, the commission estimates more than 12 million new transceivers went on the air in 1976.

Amateur radio has benefited from the new interest in personal communications and from the crowded conditions and undisciplined users on many CB channels. The American Radio Relay League, the leading organization of amateur radio operators, says its membership hovered around 134,000 for years, but has been jumping an average of 1,500 new members a month since last January. If this increase continues, sales of ham gear, now worth less than $20 million a year, may take off.

The telephone industry has been marked by increasing competition in recent years, and the American Telephone and Telegraph Company Inc. went all out last year to keep its network to itself. The firm began promoting the Consumer Communications Reform Bill, which proposes elimination of nearly all competition, putting all interconnected devices under jurisdiction of state agencies (which tend to favor Bell over rival equipment suppliers), and assuring AT & T of the major share of the potentially lucrative telecommunications market. Because Congress is considering a complete overhaul of the Communications Act of 1934, the "Bell Bill," as its opponents call it, is likely to become submerged in the legislative process.

Increasingly popular in private automatic branch exchanges is equipment with management controls through built-in features such as automatic least-cost routing and toll accounting. Stored program control worked for the PABX, and it appears that 1977 will see a repeat story in key telephone systems (the basic desk phone with extra buttons for optional features.)

Non-Bell firms supplied 15% to 20% of the PABXs and key telephone systems installed in 1976. Their market share should increase in the next few years, but the extent will depend on the outcome of the interconnect jurisdiction issue, the fate of the Bell Bill, and the pricing structure of competing systems from AT & T.



Upward trend. If potential users push investment in fiber-optic technology and if governments respond with favorable regulations, the market for fiber-optic digital signalling equipment could reach $3.6 billion by 1980 and climb to $6.1 billion by 1985

Most modem makers expect powerful competition from AT & T this year, at least in the low-speed market. They point to the recent Bell introduction of two modems and a direct-connect teleprinter. The anticipated boost in capital spending this year should return the overall modem growth rate to at least 20%, with 30% for high-speed-equipment makers.

For the next two years, the chief market for satellite earth terminals will be overseas. But U.S. sales should jump when Satellite Business Systems and AT & T expand their systems. SBS foresees a need for some 7,500 end-user earth stations by 1985. Reportedly it plans an investment of more than $185 million for earth-station components and spare parts.

Although developing slowly, the market for fiber-optic communications systems promises to boom. But it depends on how quickly the telephone, automobile, and computer industries adopt fiber optics.

The telecommunications industry is the largest potential customer for optical-fiber cable. Since Western Electric Co. is gearing up to meet much of that need, independent suppliers can only hope to pick up between 10% and 40% of Bell's business.

A capital year ahead

Jubilant over a 16% increase in the U.S. market in 1976, the industrial-electronics sector is greeting 1977 with optimism. Grounds for its hopes are twofold—an expected rise in capital goods expenditures and the multifaceted appeal of microprocessor-based systems. The few detectable notes of reservation reflect uncertainty over incentives under the Carter Administration for capital goods spending, to which the industrial-electronics market is closely tied. *Electronics* projects that $1.71 billion worth of industrial electronic equipment will be bought for use in the U.S. this year, up 13% from 1976's $1.51 billion.

To spotlight three of the largest segments, numerical-control manufacturers anticipate a mixed first quarter of 1977, following similar behavior in the previous quarter, but look for normal growth throughout the rest of the coming year, for a boost of 18% to a total market of $76.8 million. Manufacturers of process-control computer systems, after a good 1976, expect U.S. customers to buy even more vigorously in 1977, for a total of $239.7 million, and they look forward to continuing healthy growth, as environmental standards get tougher to meet and energy costs continue to rise. The use of pollution-control and -monitoring equipment, too, should grow, expanding consumption by about 7% to $190.2 million.

Equipment buys planned

In fact, the growing need to monitor and control pollution accounted for 60% of the overall increase in all plant and equipment expenditures in 1976—a significant percentage, in view of the fact that pollution control does not contribute directly to productivity. That percentage will probably be repeated this year, when manufacturers plan to raise capital spending in real terms about 8%, according to a McGraw-Hill fall survey of 17 major manufacturing industries. This increase represents the industrial sector's attempt to catch up with the rest of the economy, which has been expanding while expenditures for the production of durable equipment remained essentially flat, in terms of constant dollars, for the last five quarters.

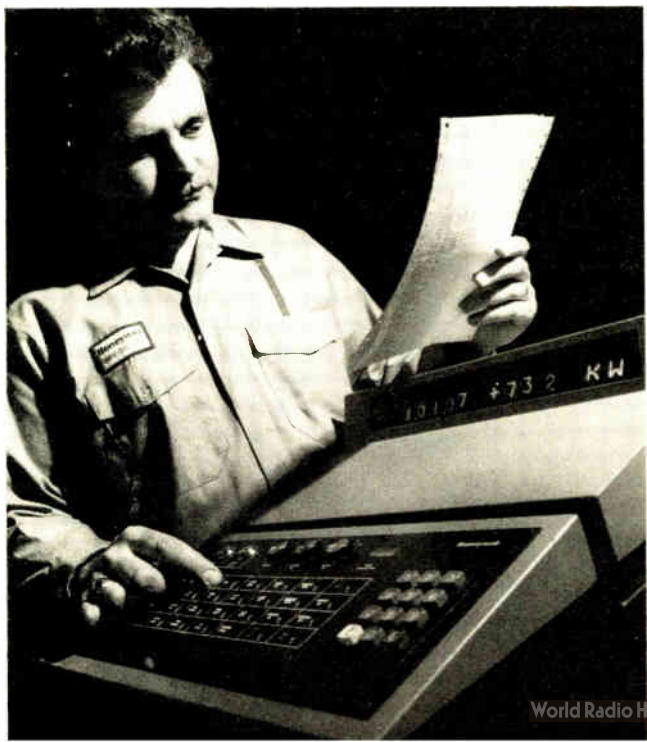
For the coming year, every one of the 10 durable-goods manufacturers plans increases, led by the automobile industry's huge 61% raise in investment to $4.15 billion, aerospace's 18% increase to $1.38 billion, and the steel industry's 18% growth. For 1978, increases are also seen, but to a lesser degree and not in all areas.

There's no stopping the microprocessor

The pressure to prevent waste, increase productivity, and decrease energy consumption, all of which can be aided by tighter process control, is promoting the growth of microprocessor-based systems. Especially as device prices spiral downward, the trend toward distributed control will gain strength, and more and more plants will have processes run by local microprocessor controls that are tied to a central console.

Aside from quickening the shift away from analog controllers—although analog sales are expected to expand slightly over the next five years—microprocessors are taking over in other less revolutionary ways. They are helping in the phasing out of open-loop numerical controls for machine tools, product lines that both Superior Electric Co. and Sperry are dropping. They are invading computer numerical control, too, but at a slower rate. Here, their slow displacement of hardwired digital circuits is primarily due to the relatively small shipment rate of CNC systems as compared to, say, computer peripherals: more time must elapse before the number of units shipped amortizes design expenses. A secondary factor discouraging rapid redesign is the relatively small cost of electronics in relation to the total machine-tool price.

A more glowing future awaits the microprocessor and computers generally in energy management. As utility bills continue to rise, industrial users are turning to computer control of energy to minimize demand charges through selective load shedding. The installation of such systems can yield 10% reductions in electricity bills, so that they pay for themselves in a matter of 12 to 18 months. IBM, for one, goes so far as to guarantee such savings, and Honeywell, Allen Bradley and others also offer similar systems. It is therefore not surprising that the power-demand control market will increase 13%.



Electric billcutter. Computer-controlled energy-management systems to cut use by selective load shedding are growing fast. Yielding reductions in power-demand charges of up to 10%, these systems can amortize their $100,000-and-up price tags in 12 months.

Measuring up to change

As new instrumentation lines are developed to test products of increasing complexity and as the oldest models are superseded by designs with greater capabilities, the market will gain 10.6%—1% more than last year—to a total of $1.84 million, according to *Electronics'* survey.

Microprocessors continue to proliferate in numbers and applications, so the increase in sales of instruments to support them will far exceed the industry average. The market for automatic test equipment should outpace the norm as equipment manufacturers increasingly shift to automation to increase production and cut labor costs. Instruments to test growing product lines such as citizens' band radios and other communications gear will also increase their market share. In particular, sales of frequency counters should boom (see table), and new products abound.

Unlike the fluctuations experienced in commercial instrumentation sales, the medical electronics market will continue to grow, even though the predicted increase of 14% to a total of $1.44 billion is slower than the historic 15% or more per year. The reason is the recently instituted regulations of hospital spending by Federal and state planning boards.

The pace will be set by tomographic X-ray and ultrasonic scanners, each expected to increase sales by 31%. The values of computerized X-ray equipment will be $230 million, and ultrasonic gear will go to $64 million.

Microprocessors generate macro growth

The fastest-growing instrumentation lines are logic and microprocessor analyzers. The latter, designed specifically for troubleshooting circuits built around microprocessors, did not even exist as a class last year. However, more than a dozen firms will compete to fulfill substantial demand in 1977. These instruments are effective for troubleshooting in the field, as well as for testing in the laboratory and on the production line.

Logic analyzers—both timing and state monitors—are finding new markets and also competing for the oscilloscope market. Thus far, these instruments have been most useful in the laboratory for testing prototype microprocessor systems, but some are being used in the field to repair high-speed computers. Logic analyzers have been used sparingly for production-line testing because they are difficult to set up, and automatic test systems can do that job more efficiently. However, production-line use can be expected to increase as designers devise better ways to program expected responses.

Logic-state analyzers, which display the binary signal on a line at the system's clock transition, are more suitable for production-line checks than logic-timing analyzers. State analysis compares actual readings and expected results, lending itself to automation since this task can be handled by a computer, calculator, or microprocessor. But the logic-timing analyzer provides more information than is necessary in the factory, and its results can be difficult to interpret.

WORLDWIDE SALES OF FREQUENCY COUNTERS
(MILLIONS OF DOLLARS)

	1975	1976	1977	1978	1979	1980	Compound Annual Growth Rate 1975–1980
Low cost	$ 9	$11	$13	$14	$15	$18	14.9%
Single function	10	11	12	13	14	15	8.5%
Universal	46	50	56	60	63	70	8.8%
Bench	(23)	(24)	(27)	(29)	(30)	(32)	(6.8%)
System	(23)	(26)	(29)	(31)	(33)	(38)	(10.6%)
Microwave	25	29	33	35	36	40	9.9%
Dedicated	(16)	(19)	(23)	(25)	(27)	(31)	(14.1%)
Plug-in	(9)	(10)	(10)	(10)	(9)	(9)	(-0-)
TOTAL	$90	$101	$114	$122	$128	$143	9.7%

SOURCE: PRIME DATA

Oscilloscope functions change

Ironically, the need for oscilloscopes to display analyzer outputs will stimulate the demand for them, even as the scopes begin to be impacted by the gradual shift to logic analyzers for testing digital circuits. Total oscilloscope sales this year should increase to $287.5 million—11% higher than in 1976.

Low prices, together with expanded functions brought about by large-scale integration, are building new markets for frequency meters. Most of these units are limited to relatively low frequencies and measure only a single parameter. However, as prices drop below $150, these counters will be increasingly used for such tasks as testing citizens' band radios.

Complex universal counters account for the largest segment of the $50 million counter market. Single-function versions are being gradually replaced by universal types, which take advantage of microprocessors and large-scale integration in general to add functions with increasing prices.

The market for signal sources will grow, even as designers increase the overlap in capabilities of synthesizers, function generators, and oscillators. The capabilities of synthesizers, in particular, are increasing faster than those of other signal sources.

Synthesizers have become competitive with simpler oscillators and signal generators. The continued decline in synthesizer prices will erode sales of both test oscillators and, where programability is required, signal generators, too.

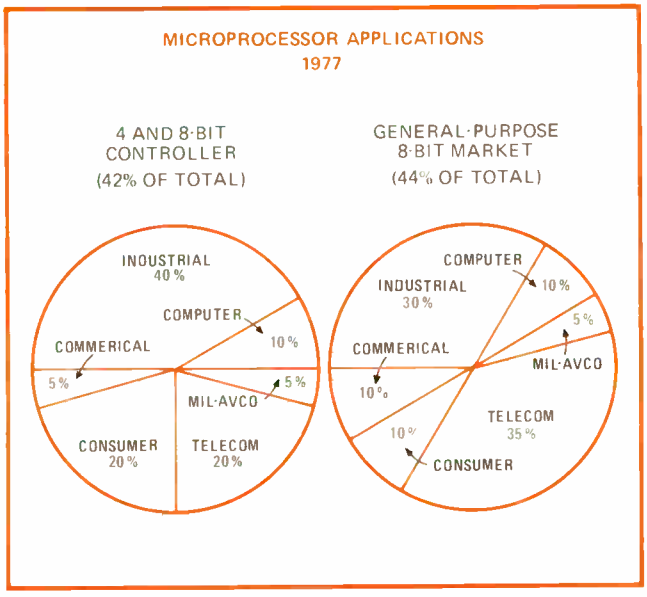
Outlook sunny and no showers

Semiconductors danced their way back into the sun in 1976, thankfully quitting the long dark tunnel of 1975, and their dancing days are sure to last at least through another year.

After a bookings lull that sent shivers through semiconductor company boardrooms last summer, U.S. consumption resumed its earlier upward climb, as heavy year-end orders began rolling in. Purchases reached an historic $2.63 billion, an increase of 29% over 1975. Barring a general turndown in the economy, they will remain strong through 1977, albeit at a lower rate, climbing to $3.2 billion or about 22% above last year.

Integrated circuits, which earned over $1.5 billion or about 56% of the total U.S. semiconductor market, continue to dominate new markets, at the expense of discretes. In large-scale integration alone—memory, microprocessor families, dedicated consumer and industrial control chips—consumption almost doubled last year, accounting for about one third of IC usage. Moreover, hardwired digital logic (transistor-transistor logic, Schottky, emitter-coupled logic, and complementary-metal-oxide-semiconductor) as well as linear products and hybrid ICs enjoyed a strong comeback from their poor performance in 1975, almost matching the pace of the LSI sector.

The best performers in the IC market continue to be memory products, most notably the 4,096-bit random-access memories that now dominate computer mainframe and peripheral designs. Their popularity shows no sign of waning, with 35 million units expected to sell for an average of $4.25 each to make a total domestic market this year of around $150 million. What is changing is the product mix: the 22-pin packages are retreating before the higher-speed 16-pin types.



This year, the big 16,384-bit chips will enter volume production. Manufacturers shipped a mere 50,000 of them in 1976 (about $2 million worth shared by Intel, Mostek and TI). But between 2 million and 5 million units are expected to reach U.S. customers in 1977, who will pay $25 million to $40 million for them, and twice that many units will move in 1978. Average selling price will range from about $25 in the beginning of this year to below $10 by 1978, when the industry should achieve an annual output of 10 million units.

As for read-only memories, a third of the units sold were field-programable ROMs, types that are popular in small microprocessor-based systems. The big surprise, though, is the ultraviolet-erasable PROM. Demand for it is booming, especially the 8-bit 2708-type, because it is large enough to accommodate most sizes of program. This market, at the moment being supplied almost entirely by Intel Corp., exceeded $30 million last year, and should exceed $40 million by the end of 1977.

Microprocessors make big waves

The microprocessor is expanding in every direction, whether as a $5 single-chip controller or in a $5,000 data-processing system using 400 LSI packages. In the process, it is stamping on the growth potential of hardwired logic. A short-term exception is Schottky transistor-transistor logic, which will last in high-performance systems until ousted by Schottky LSI 4-bit processor slices.

Buys of microprocessor and microprocessor-related chips, including on-chip memory but excluding standard memory, almost doubled last year, going from $71 million to $108 million. They may reach $200 million this year. When standard ROMs and RAMs are added in, microprocessor systems will account for over $300 million worth of digital ICs this year.

The chart on this page analyses the 1977 market in terms of the two principal processor types. The low cost and small component count of controllers make them most suitable for consumer products and also as replacement for electromechanical timers in industrial equipment, while the byte-oriented families will find heaviest service in industrial processors and smart terminals.

Linears are lively

In linear ICs, data-acquisition products are growing the fastest. This year, consumption should rise from $25.6 million to $33.5 million, a gain of approximately 31%. Hybrid and modular data-acquisition products should also do well, to the tune of $60.5 million, up 21% from $50 million.

The big growth area in discrete semiconductors is power transistors, which should reach $234.4 million this year, up around 25% from last year's $187.5 million market. The surge is mainly in switching transistors for switching-regulated power supplies.

COMPONENTS

Back on the growth track

Having fought their way out of a market abyss, components should get firmly back on the path of real growth this year. In fact, consumption in 1977 could hit $5,307.6 million, a growth of 7.5% over 1976 and nearly a 6% rise over the best year ever, 1974.

Setting the pace for a successful New Year was the brisk business activity of the last quarter of 1976. The market grew 11% to $4,935.3 million, making it a very good year compared to the grim 1975, if not quite as good as expected.

Two small clouds ahead for this year are the possibilities of somewhat extended delivery times and shortages of high-demand products before the year is out. The problem started when the consumer market softened around midyear and almost came to a standstill during the third to fourth quarters, accounting for the poorer-than-projected showing of 1976. Because of this slowdown, many components manufacturers cancelled their plans for capital expansion.

Dollar figures for 1976 are high, but that is deceptive. Prices for many components, particularly those using precious metals, are up. As the table shows, although $440.8 million worth of resistors were used in the U.S. in 1976, a gain of nearly 15% over 1975, units growth was barely over 9%. In 1977, the situation should worsen. Despite a 7% increase to $473.2 million, the number of units should rise by merely 1%.

Capacitors are suffering similarly. Total dollars paid for those used in the U.S. increased by slightly over 13% to $593.4 million in 1976, but total units declined by around 1%. For 1977, capacitor consumption should be $621.6 million, a growth of close to 5% over 1976, yet the number of units should be down again—by 2%.

The picture does not change for relays. The past year saw an 11% increase in relay consumption to $432.4 million, but that figure bought only 7% more units than in 1975. For 1977, units consumption should be up by slightly more than 6% over the 1976 level, while consumption dollars should rise to $475.2 million, a gain of about 10% over 1976.

U.S. SELECTED COMPONENT MARKET GROWTH

Components market segment		1975	1976	1977
resistors	U.S. market	$384.8	$440.8	$473.2
	dollars growth	–	14.5%	7.3%
	average price	$0.062	$0.065	$0.069
	units growth	–	9.3%	1.1%
capacitors	U.S. market	$523.4	$593.4	$621.6
	dollars growth	–	13.4%	4.7%
	average price	$0.112	$0.128	$0.137
	units growth	–	−0.8%	−2.1%
relays	U.S. market	$389.3	$432.4	$475.2
	dollars growth	–	11.1%	10%
	average price	$5.587	$5.798	$5.995
	units growth	–	7.0%	6.3%

SOURCE: GNOSTIC CONCEPTS, INC., MENLO PARK, CALIF.

FEDERAL

Marking time

Unless the incoming Carter Administration significantly rearranges the budget priorities of the outgoing Ford Administration—an unlikely prospect in the short term—there will be little substantial change in the Federal outlays for electronics in 1977. The $16.6 billion presently projected reflects a 6.25% gain on the year just ended, but the increase will barely offset inflation.

As usual, nearly 90% of Federal spending on electronics will be absorbed by the military markets. Of that almost $15 billion, procurement will account for just under half. A 12% increase in military research and development funds will boost that category to nearly $5 billion, provided both the new White House team and the 95th Congress accept what the Pentagon insists are critical requirements. An 8% gain in outlays for ships and conversions begins the effort to strengthen the U.S. Navy's fleet between now and 1980 in order to counter growing Soviet naval activity. But this program, too, is beset with problems, notably ship cost overruns.

As for nonmilitary spending, transportation in the coming year is pegged at $405 million, an inflation-offsetting gain of no more than 6.6%. Much of that increase will come in Federal Aviation Administration development programs for air-traffic control and for warning systems monitoring such dangers as ground-level wind shear around major airports. FAA procurement, on the other hand, will remain essentially flat.

The Government markets for health-care and education electronics are expected to stay more or less put at $387 million. More than 72% of that figure—$280 million plus—will go on health-care electronics. The Solar and Laser-fusion Research effort, sponsored by the Energy Research and Development Administration, continues to hold out hope for the development of new power-generating systems with extensive new monitoring systems. In 1977 ERDA will be allotted $73 million.

U.S. MARKETS FORECAST 1977

Market estimates represent industry-wide consumption (at the factory level) of goods shipped by U.S. and foreign manufacturers for the U.S. market. Some product categories have been added, deleted, or redefined. Therefore, these totals are not directly comparable to those of previous years.

(millions of dollars)	1975	1976	1977	1980
FEDERAL ELECTRONICS, TOTAL	**14,406**	**15,659**	**16,638**	**19,250**
Defense, total	**12,860**	**14,049**	**14,963**	**17,373**
Procurement, total	6,166	6,783	7,051	8,608
Communications and intelligence	1,101	1,185	1,205	1,463
Aircraft, related ground equipment	1,735	1,810	1,890	2,294
Missiles and space systems	2,147	2,265	2,310	2,820
Mobile and ordnance	370	403	436	567
Ship and conversions	813	1,120	1,210	1,464
Research, development, test and engineering	3,943	4,416	4,945	5,538
Operations and maintenance	2,751	2,850	2,967	3,227
NASA, total	**784**	**795**	**810**	**850**
Transportation, total	**372**	**380**	**405**	**520**
FAA procurement	227	235	240	295
FAA research and development	85	89	100	115
Highway and transit systems	60	56	65	110
Health, Education, and Welfare, total	**365**	**375**	**387**	**415**
Education systems	110	105	107	120
Health-care electronics	255	270	280	295
Energy R&D Administration, total	**25**	**60**	**73**	**92**

(millions of dollars)	1975	1976	1977	1980
SEMICONDUCTORS, TOTAL	**2,037.0**	**2,628.3**	**3,218.8**	**4,687**
Discrete Semiconductors	**675.8**	**790.1**	**906.5**	**1,029**
Diodes	207.4	240.5	277.1	316
Signal	29.2	35.0	38.5	40
Rectifier, total	90.5	105.0	126.0	150
Arrays	15.6	18.7	19.6	20
Zener, total	38.7	45.0	53.1	60
Voltage regulator	29.9	35.0	40.9	45
Reference	8.8	10.0	12.2	15
Special purpose, total	33.4	36.8	39.9	46
Microwave, total	24.2	26.6	29.3	35
Varactor (less than 1GHz)	7.2	8.5	9.0	10
Tunnel	2.0	1.7	1.6	1
Transistors, total	373.0	438.5	504.5	575
Bipolar, total	331.1	388.5	448.0	505
Small signal (less than 1W)	106.7	128.0	130.6	120
Power (1 W or more)	161.6	187.5	234.4	300
Duals and arrays	19.3	23.0	25.0	20
Rf and microwave	43.5	50.0	58.0	65
Field effect, total	41.9	50.0	56.5	70
Junction, total	31.7	38.0	42.7	50
MOS, total	10.2	12.0	13.8	20
Thyristors, total	76.8	89.1	99.8	110
Protection devices, including varistors	18.6	22.0	25.1	28
Integrated circuits, total	**1,086.2**	**1,512.7**	**1,927.3**	**3,106**
Standard logic families, total	422.1	581.0	728.2	922
DTL	36.8	35.1	33.7	29
TTL	260.0	349.0	410	435
Schottky TTL, total	33.5	60.0	90.5	165
Standard	27.0	35.0	43.0	60
Low power	6.5	25.0	47.5	105
ECL	31.8	33.8	51.0	68
C-MOS	60.0	103.1	143.0	225
Microprocessor families, total	70.9	108.2	188.2	438
CPUs, total	24.9	38.5	63.9	166
MOS, total	23.1	35.6	58.9	150
4-bit	13.7	16.6	22.8	26
8-bit	5.8	13.0	25.0	70
16-bit	1.6	3.0	7.6	50
1-chip controllers	2.0	3.0	3.5	4
Bipolar, total	1.8	2.9	5.0	16
Bit slice	1.8	2.5	4.0	8
Full CPU	---	0.4	1.0	8
ROMs	14.5	16.7	32.0	80
RAMs	8.0	15.0	30.5	79
I/O interface chips	10.0	21.0	39.3	80
Peripheral chips	13.5	17.0	22.5	33
Memories, total	337.4	449.9	552.7	978
Random access, total	201.1	283.5	351.4	653.0
Dynamic, total	133.6	185.7	223.3	339
p-MOS	49.6	32.0	16.8	10
n-MOS, total	84.0	153.5	202.5	318
Bipolar	0	0.2	4.0	11
Static, total	67.5	97.8	128.1	214.0
Bipolar	38.5	42.5	50.0	100.0
n-MOS	25.0	48.3	67.5	93.0
C-MOS	4.0	7.0	10.6	21.0

COMPONENTS

(millions of dollars)	1975	1976	1977	1980
COMPONENTS, TOTAL	**4,442.7**	**4,935.3**	**5,307.6**	**5,975**
Capacitors, total	**523.4**	**593.4**	**621.6**	**786**
Paper	59.6	66.0	68.0	75
Film	73.6	85.0	90.5	109
Electrolytic	195.3	222.5	232.0	305
Aluminum	86.0	107.5	110.0	140
Tantalum	109.3	115.0	122.0	165
Mica	22.0	23.0	26.2	25
Glass and vitreous enamel	4.6	4.9	5.0	4
Ceramic, except chips	131.0	144.6	150.0	200
Variable	13.1	16.0	16.0	19
Chip	13.2	20.0	22.0	36
Other	11.0	11.4	11.9	13
Connectors, total	**525.2**	**598.1**	**655.9**	**793**
Coaxial, total	60.0	67.5	71.0	82
Standard size	45.0	47.0	49.5	60
Miniature	15.0	20.5	21.5	22
Cylindrical, total	140.6	148.6	156.3	181
Standard	35.3	35.8	35.0	31
Miniature	65.3	65.5	68.0	80
Subminiature	40.0	47.3	53.3	70
Rack and panel	117.5	137.2	152.3	199
Fused	14.5	15.0	16.0	18
Printed-circuit	88.2	111.1	127.3	137
Card-insertion	54.6	72.3	83.0	78
Two-piece, metal-to-metal	33.6	38.8	44.3	59
Special-purpose	66.8	75.4	79.0	97
Device sockets and socket panels	37.6	43.3	54.0	79
Electron tubes, total	**992.4**	**1,045.6**	**1,113.4**	**1,093**
Receiving	155.0	135.0	125.0	70
Power and special-purpose, total	341.4	348.6	364.4	370
High-vacuum	63.3	61.6	60.5	56
Gas and vapor	16.6	15.6	15.5	12
Klystrons	38.0	39.0	37.0	33
Magnetrons	41.0	42.5	46.0	51
TWTs, including backward-wave	83.5	89.5	103.0	112
Light-sensing	12.5	13.3	14.1	16
Image-sensing, including TV camera and image-intensifier	33.0	34.0	34.5	36
Storage	15.5	15.6	15.5	15
Cathode-ray, except TV	29.0	29.0	29.5	32
Other	9.0	8.5	8.8	7
TV picture, black-and-white	36.0	32.0	29.0	18
TV picture, color	460.0	530.0	595.0	635
Filters, networks, and crystals, total	**182.3**	**197.5**	**201.0**	**217**
Passive electric-wave filters	38.5	39.2	39.8	42
Crystal filters	31.6	34.6	34.3	40
RFI and EMI filters	40.0	42.0	43.0	46
Active filters	3.9	5.0	6.4	12
RC networks	8.1	10.0	11.0	14

(millions of dollars)	1975	1976	1977	1980
Delay lines	12.0	11.5	10.2	7
Quartz crystals, mounts, and ovens	48.2	55.2	56.3	56
Magnetic, total	**330.5**	**344.0**	**356.9**	**383**
Computer memory cores	30.0	28.0	27.5	18
Transformers, chokes, except TV	228.5	242.5	256.4	293
Laminated	147.8	156.7	165.4	187
Toroidal	49.7	52.6	55.8	65
Pulse transformers	31.0	33.2	35.2	41
TV components	54.0	56.5	57.0	58
RF coils	18.0	17.0	16.0	14
Microwave hardware, total	**76.5**	**81.7**	**83.7**	**105**
Mixers	10.1	11.0	11.0	13
Detectors	3.3	4.3	4.5	7
Passive components, total	30.5	31.5	32.5	39
Waveguide	8.0	8.5	8.5	11
Coaxial and stripline	22.5	23.0	24.0	28
Switches, total	8.4	9.1	9.1	12
Waveguide	2.6	2.9	2.8	4
Coaxial and stripline	5.8	6.2	6.3	8
Ferrite devices, total	20.5	21.6	22.1	28
Isolators	6.1	6.6	6.6	8
Circulators	10.3	10.5	11.0	14
YIG devices	4.1	4.5	4.5	6
Power limiters	3.7	4.2	4.5	6
Printed circuits, total	**292.4**	**341.0**	**378.0**	**441**
Single-layer	34.1	49.5	52.0	59
Two-layer	168.0	178.0	190.0	205
Multilayer	71.2	89.0	105.0	125
Flexible	19.1	24.5	31.0	52
Readout devices, total	**107.1**	**135.0**	**162.2**	**198**
Discrete, total	39.8	50.5	62.7	57
Gas-discharge	3.0	2.8	2.5	2
Incandescent	12.3	18.0	20.2	22
Fluorescent	1.5	1.7	2.0	3
Light-emitting-diode	23.0	28.0	38.0	30
Multidigit, total	67.3	84.5	99.5	141
Gas-discharge	24.0	27.5	28.5	37
Incandescent	2.0	2.5	3.0	4
Fluorescent	2.0	2.5	3.0	5
Electroluminescent	3.0	3.5	4.0	5
Light-emitting-diode	26.0	35.0	40.0	50
Liquid-crystal	4.3	6.5	13.0	27
Plasma panel	6.0	7.0	8.0	13
Relays, total	**389.3**	**432.4**	**475.2**	**551**
General-purpose	80.3	87.5	96.5	115
Telephone-type	21.0	24.5	26.3	34
Crystal-can	32.0	38.0	42.0	46

(millions of dollars)	1975	1976	1977	1980
High-sensitivity	20.0	22.6	25.1	33
RF	70.0	75.0	83.0	85
Reed	20.3	29.8	33.5	42
Stepping and impulse	6.5	5.5	5.0	3
Time-delay	17.8	19.0	22.9	28
Solid-state	12.3	15.0	19.0	26
Other	109.1	115.5	121.9	139
Resistors, total	**384.8**	**440.8**	**473.2**	**526**
Fixed, total	163.9	189.6	197.2	198
Composition	47.8	55.8	54.0	46
Deposited carbon	15.8	23.8	25.7	30
Metal film	50.0	59.7	67.0	72
Wirewound	50.3	50.3	50.5	50
Variable, total	138.9	157.4	167.7	179
Potentiometers, wirewound	24.6	26.0	25.4	26
Potentiometers, non-wirewound	58.3	68.4	75.5	84
Trimmers, wirewound	19.0	19.6	20.3	17
Trimmers, non-wirewound	37.0	43.4	46.5	52
Other	20.0	21.2	22.4	26
Thermistors	25.0	27.0	30.0	40
Resistive networks, total	37.0	45.6	55.9	83
Thin-film	3.2	3.5	3.6	8
Thick-film	30.8	39.0	48.6	70
Other	3.0	3.1	3.7	5
Switches, total	**240.5**	**267.7**	**300.0**	**342**
Small-movement snap-action	53.0	55.0	57.0	61
Lighted	47.0	48.5	60.7	78
Push-button	20.0	24.0	26.0	30
Toggle	14.0	16.0	17.0	20
Side	13.0	15.0	17.5	20
Rotary	31.0	33.2	34.8	37
Coaxial	10.5	10.5	10.0	8
Thumbwheel	13.5	17.0	19.0	21
Keyboard, single-key	6.0	6.0	7.0	10
Keyboard, assemblies	27.5	36.0	43.0	44
Solid-state, including Hall-effect	5.0	6.5	8.0	13
Transducers, total	**94.3**	**102.1**	**109.5**	**129**
Pressure	32.0	38.5	42.0	50
Temperature	8.0	9.0	10.0	13
Motion, linear	21.5	20.6	21.5	24
Torque	19.0	19.5	20.0	22
Other	13.8	14.5	16.0	20
Wire & cable, total	**304.0**	**356.0**	**377.0**	**411**
Coaxial cable	45.0	54.0	60.0	74
Flat cable	100.0	120.0	129.0	130
Hook-up wire	70.0	85.0	92.0	100
Multiconductor, shielded	54.0	62.0	61.0	67
Multiconductor, unshielded	35.0	35.0	35.0	40

Read-only, total	101.8	128.1	158.8	257.0
Mask type, total	41.2	44.8	53.7	79.0
Bipolar	9.5	10.5	12.0	16.0
MOS	31.7	34.3	41.7	63.0
Programable type, total	32.1	44.3	53.6	79.0
Alterable type, total	28.5	39.0	51.5	100.0
Ultraviolet	25.0	32.0	41.5	65.0
Electrical (EAROM)	3.5	7.0	10.0	35.0
CCDs	3.0	4.0	9.5	40.0
Shift registers	31.5	34.3	33.0	28.0
Linear ICs, total	219.3	302.3	355.5	625
Analog switches	9.1	12.2	13.4	25
Operational Amplifiers	49.0	67.7	77.8	100
Comparators	7.2	9.7	11.3	25
Voltage regulators	27.1	35.2	40.5	75
Timers	16.6	22.1	24.8	50
Data acquisition, total	15.9	25.6	33.5	75
D-a converters	8.2	11.3	15.0	30
A-d converters	4.1	7.3	9.7	25
Multiplexers	1.8	3.5	4.4	10
Sample-and-holds	1.8	3.5	4.4	10
Interface, total	36.9	49.8	59.8	110
Communications, total	18.6	25.5	30.1	45
Entertainment, total	38.9	54.5	64.3	120
Consumer product ICs, total	36.5	71.3	102.7	143
Calculator chips, total	3.7	1.5	0.7	---
Watch chips	9.7	26.3	47.3	64
Games chips	7.9	27.5	34.7	45
Other, including cameras, toys, organs	15.2	16.0	20.0	35
Optoelectronic devices, total	**76.0**	**87.3**	**103.9**	**149**
Photovoltaic (solar) cells	6.8	8.0	8.5	10
Photoconductive cells	3.3	4.2	6.0	8
Light-emitting diodes	23.5	26.0	30.0	45
Photodiodes, including arrays	5.5	5.2	5.0	8
Phototransistors, including arrays	12.0	13.0	13.9	17
Couplers and isolators	19.5	24.5	33.5	52
Silicon targets	5.4	6.4	7.0	9
Multicomponent and hybrid, total	**199.0**	**238.2**	**281.1**	**403**
Operational amplifiers	15.2	18.3	21.0	25
Instrumentation amplifiers	4.2	5.0	5.7	8
Isolation amplifiers	1.4	2.0	2.5	6
Data acquisition devices, total	41.4	50.0	60.5	85
D-a converters	17.3	20.8	24.5	30
A-d converters	16.0	19.2	23.8	35
Multiplexers	3.7	4.5	5.2	7
Sample-and-holds	2.9	3.5	4.0	8
Other	1.5	2.0	3.0	5
Functional circuits	8.0	10.0	11.0	13
Signal sources, incl. oscillators	0.8	1.0	1.0	1
Modular voltage/current sources	12.0	15.0	17.7	25
Miscellaneous custom functions	107.0	126.9	149.9	225
Other	9.0	10.0	11.8	15

INDUSTRIAL AND COMMERCIAL MARKETS

(millions of dollars)	1975	1976	1977	1980
INDUSTRIAL AND COMMERCIAL, TOTAL	**24,045.8**	**27,433.3**	**31,166.1**	**42,294**
Test, measuring, and analytical instruments, total	**1,522.0**	**1,667.9**	**1,844.4**	**2,253**
Non-microwave equipment, total	**1,035.6**	**1,143.8**	**1,274.5**	**1,571**
Spectrum analyzers	44.3	49.6	56.4	75
Frequency synthesizers	27.0	30.2	34.3	42
Function generators	13.0	17.5	19.5	24
Signal generators	32.0	33.0	35.0	42
Sweep generators	9.4	10.2	11.5	14
Pulse generators	13.0	13.5	14.0	19
Oscillators	12.5	12.6	12.5	12
Waveform analyzers, distortion meters	36.5	39.5	41.3	48
Counters, time and frequency	45.6	48.4	50.8	59
Panel meters, total	87.2	94.4	104.0	135
Analog	70.0	75.0	82.0	105
Digital	17.2	19.4	22.0	30
Noise measuring	3.5	3.9	4.3	6
Temperature measuring	14.0	15.5	18.5	23
Analog voltmeters, ammeters, multimeters	16.3	16.3	15.3	15
Digital multimeters, total	63.2	66.0	72.4	81
3½ digit and below	23.4	26.0	29.8	36
4½ digit and above	39.8	40.0	42.6	45
Power meters	9.0	9.9	10.8	14
Calibrators and standards, active and passive	11.5	13.0	14.3	17
Oscilloscopes, total	229.5	257.9	287.5	384
Non-plug-in	132.0	150.0	170.0	235
Plug-in main frame only	62.5	68.8	74.9	95
Accessories and plug-ins	35.0	39.1	42.6	54
Recording instruments, total	158.0	169.4	195.0	216
Magnetic-tape	67.5	72.5	88.0	92
Strip chart	69.0	72.3	80.0	90
X-Y	21.5	24.6	27.0	34
Automatic test, total	127.0	142.0	158.5	181
IC testers	65.0	73.0	78.5	85
Component testers	10.5	11.0	9.5	6
Pc-board testers, total	51.5	58.0	70.5	90
Bare board	7.5	9.0	10.5	14
Digital	27.0	30.0	35.0	43
Analog	17.0	19.0	25.0	33
Manual test, total	26.8	31.9	39.9	59
IC testers	6.0	7.2	8.6	13
Component testers	12.5	13.0	14.0	17
Logic analyzers	7.3	10.5	16.0	27
Logic probes	1.0	1.2	1.3	2
Amplifiers, total	50.5	62.6	71.4	95
Lab type	9.8	11.0	12.1	15
Signal conditioners	40.7	51.6	59.3	80
Phase-measuring	5.8	6.5	7.3	10
Microwave equipment, total	**120.4**	**131.5**	**147.2**	**186**
Phase-measuring	13.0	14.0	15.3	20
Impedance-measuring, total	11.6	13.0	16.4	20
Slotted lines	0.5	0.6	0.6	1
Network analyzers	8.0	9.0	11.5	13
Vector voltmeters	1.5	1.6	1.8	2
Bridges	0.4	0.5	1.0	2
Time-domain reflectometry	1.2	1.3	1.5	2
Power-measuring	6.9	7.4	8.1	10
Computerized automatic measuring	8.2	9.0	10.5	15
Spectrum analyzers	18.0	18.0	20.0	25
Wavemeters	0.7	0.8	0.8	1
Frequency counters	13.0	14.0	16.0	20
Noise-measuring	2.5	2.8	3.0	4
Signal generators	12.5	14.0	15.0	18
Sweep generators	20.0	22.0	24.5	32
Modulators	1.0	1.2	1.2	1
Field-intensity meters and test receivers	4.5	5.5	5.5	7
Antenna-pattern measuring	4.5	4.8	4.9	5
Oscillators	4.0	5.0	6.0	8
Analytical instruments, total	**366.0**	**392.6**	**422.7**	**496**
Chromatographs, total	58.0	64.0	70.5	84
Gas	40.0	44.0	47.5	50
Liquid	18.0	20.0	23.0	34
Spectrophotometers, total	82.6	87.0	94.0	108
Infrared	19.0	21.0	23.0	26
Ultraviolet-visible	37.6	39.0	43.0	50
Atomic absorption	26.0	27.0	28.0	32
Mass spectrometers	27.0	29.5	32.0	38
Nuclear magnetic-resonance spectrometers	20.0	22.0	24.0	26
Electron microscopes	19.0	20.5	22.5	25
pH meters and ion-selective electrodes	24.7	26.7	28.0	35
Spectrofluometers	12.0	13.0	14.0	16
Spectropolarimeters	1.9	2.0	2.0	2
Thermal analyzers, total	8.8	9.5	10.5	13
Differential	4.1	4.5	4.9	6
Thermogravimetric	1.5	1.5	1.7	2
Differential-scanning calorimetric	3.2	3.5	3.9	5
X-ray analysis	39.0	41.0	44.0	56
Other	73.0	77.4	81.2	93

(millions of dollars)	1975	1976	1977	1980
Data processing systems, peripherals, and office equipment, total	**16,342.7**	**18,330.6**	**20,914.5**	**28,534**
System shipments, total	5,530.0	5,950.0	6,748.0	9,045
Portable Computers	80.0	100.0	138.0	290
Small (less than $100,000)	1,650	1,850.0	2,109.0	3,500
Medium (up to $1 million)	1,500.0	1,800.0	2,191.0	2,530
Large (greater than $1 million)	2,300.0	2,200.0	2,310.0	2,725
Micros and minis, total	345.0	546.7	900.0	1,792
OEM microcomputers	35.0	112.7	336.0	900
OEM minicomputers	310.0	434.0	564.0	892
Memory systems, total	380.7	402.5	454.8	610
Add-on systems	270.0	265.0	283.0	370
Core	145.0	115.0	108.0	95
Semiconductor	125.0	150.0	175.0	275
OEM systems	110.7	137.5	171.8	240
Data storage devices, total	1,805.0	2,029.0	2,050.0	2,670
Rigid disk drives	1,175.0	1,436.0	1,490.0	2,095
Flexible disk drives	25.0	38.0	55.0	75
Magnetic drums	70.0	65.0	60.0	55
Reel-type magnetic tape drives	500.0	450.0	400.0	400
Cassette/cartridge magnetic tape drives	35.0	40.0	45.0	45
Input/output peripherals, total	1,663.0	1,914.4	2,185.2	2,990
Card read/punch	240.0	238.0	225.0	240
Line printers	815.0	937.0	1,077.8	1,562
Serial printers	250.0	325.0	400.0	450
Non-impact printers	85.0	97.8	112.0	162
Computer output microfilm	125.0	160.0	204.8	376
Optical character readers	48.0	57.6	69.1	110
Magnetic ink character readers	38.0	35.0	30.0	20
Electromechanical plotters	35.0	36.0	37.0	40
Paper tape devices	27.0	28.0	29.5	30
Key entry, total	301.0	233.0	199.0	147
Key punch/verify	110.0	90.0	70.0	25
Key-to-tape	5.0	3.0	2.0	2
Key to disk	108.0	60.0	42.0	20
Keyboard-to-cassette/cartridge	78.0	80.0	85.0	100
Data terminals, total	913.0	1,033.5	1,199.0	1,897
Keyboard printers	111.0	105.0	96.0	30
CRT	162.0	190.0	224.0	348
Intelligent	290.0	377.0	490.0	931
Interactive graphic	70.0	72.0	90.0	130
Audio-response	10.0	9.5	9.0	8
Remote-batch	270.0	280.0	290.0	450
Source data-collection equipment, total	834.0	1,226.5	1,572.0	2,586
Point-of-sale systems, total	429.0	512.0	643.2	1,127
Electronic cash registers/terminals	380.0	450.0	567.0	992
Credit-authorization terminals	32.0	42.0	51.2	85
Electronic scales	17.0	20.0	25.0	50
Banking systems, total	70.0	85.0	104.5	210
Automated terminals, cash dispensers	35.0	45.0	60.8	115
Teller terminals	35.0	40.0	43.7	95
Industrial systems, total	75.0	79.5	84.3	99
Ticketing and stock quote	200.0	450.0	600.0	950
Other specialized terminal	60.0	100.0	140.0	200
Office equipment, total	4,571	4,995	5,606.8	6,797
Desk-top calculators, total	540.0	570.0	589.2	663
Programmable	180.0	195.0	210.6	273
Non-programmable	360.0	375.0	378.6	390
Word-processing	500.0	550.0	800.0	1,100
Dictation	156.0	185.0	217.0	289
Copying	1,500.0	1,600.0	1,744.0	2,000
Facsimile	90.0	98.0	105.0	120
Electronic typesetting	185.0	192.0	201.6	225
Accounting/bookkeeping	1,000.0	1,100.0	1,200.0	1,500
Printing/duplication	600.0	700.0	750.0	900
Automotive electronics, total	**294.0**	**363.5**	**440.3**	**847**
Voltage regulators	40.0	30.0	25.0	10
Emission-control systems	40.0	54.4	73.9	186
Electronic ignition systems	5.0	11.0	13.0	15
Fuel-injection systems	60.0	81.6	110.9	205
Safety systems, total	46.0	50.0	69.5	231
Anti-skid controls (truck and car)	33.0	40.0	58.8	142
Air-bag sensors and controls	6.0	4.0	5.0	80
Seat-belt interlocks	5.0	3.0	1.5	---
Radar collision-avoidance systems	2.0	3.0	4.2	9
Spark advance systems	3.0	6.5	10.0	20
Automatic test systems	100.0	130.0	138.0	180

(millions of dollars)	1975	1976	1977	1980
Communications equipment, total	**2,973.3**	**3,684.8**	**4,111.0**	**5,401**
Radio, total	1,297.0	1,780.4	1,977.4	2,621
Aviation mobile, including ground support	57.0	63.0	69.3	80
Marine mobile (ship and shore stations)	40.0	44.0	48.4	63
Land mobile (mobile and base stations)	610.0	671.0	738.0	1,010
Microwave relay, including cable systems	25.0	31.0	39.0	45
Satellite earth stations	50.0	55.0	64.9	100
Amateur	15.0	16.4	17.8	23
Citizens' band	500.0	900.0	1,000.0	1,300
Navigation systems	148.0	152.0	157.2	177
Station, total	172.3	176.4	180.7	185
A-m and fm	46.0	48.8	51.7	53
TV, excluding CATV	126.3	127.6	129.0	132
Telemetry (industrial only)	28.0	31.6	35.7	49
Switching systems (central office and PABX)	280.0	315.0	370.0	460
Voice terminals (autodialers, autorecorders, etc.)	8.6	12.4	17.2	38
Paging systems	33.0	40.0	43.4	54
Intercoms	138.0	142.0	146.3	159
Laser communications systems	8.8	9.7	10.8	14
Nonbroadcast TV, total	115.6	128.3	138.5	173
CATV, total	73.8	82.7	89.5	114
Studio and head-end	6.3	8.4	8.6	10
Distribution	24.0	27.7	29.3	35
Transmission lines and fittings	27.5	25.0	25.3	26
Converters	16.0	21.6	26.3	43
CCTV, total	41.8	45.6	49.0	59
Cameras	26.7	30.0	33.0	39
Monitors	7.2	7.3	7.5	10
Auxiliary	7.9	8.3	8.5	10
Video recording units (nonconsumer)	20.0	21.2	22.4	27
Data communications, total	724.0	875.8	1011.4	1,444
Modems	105.0	150.0	181.5	295
Remote concentrators	125.0	163.8	203.1	308
Message-switching systems	152.0	183.9	217.0	332
Front-end processors	282.0	307.3	331.9	408
Multiplexers	60.0	70.8	77.9	101
Industrial electronic equipment, total	**1,291.6**	**1,508.4**	**1,714.9**	**2,323**
Motor controls (speed, torque),	110.0	118.8	126.3	152
Numerical controls, total	57.7	65.0	76.8	90
Hard-wired	40.0	40.0	38.0	22
Direct	1.4	1.7	3.8	8
Computerized	16.3	23.3	35.0	60
Inspection systems, total	33.5	36.8	40.2	51
Ultrasonic	11.0	11.8	12.6	15
X-ray	18.0	19.8	21.8	28
Infrared	3.3	3.8	4.2	6
Ultraviolet	1.2	1.4	1.6	2
Thickness gages and controls, total	71.3	80.0	89.7	121
Photoelectric	52.3	58.5	65.9	90
Radiation-based	19.0	21.5	23.8	31
Factory data-acquisition systems, total	300.0	398.0	476.1	744
Continuous process	100.0	150.0	176.0	255
Discrete process	200.0	248.0	300.1	489
Process controllers	51.3	57.1	64.3	75
Process recorders and indicators	47.7	47.2	47.4	57
Sequence controllers, total	44.7	56.5	64.8	91
Programable	29.5	38.5	46.3	69
Hard-wired	15.2	18.0	18.5	22
Ultrasonic cleaning	8.5	9.5	10.5	12
Pollution monitoring, total	166.0	178.0	190.2	227
Air	94.0	104.0	111.3	134
Water	72.0	74.0	78.9	93
Induction and dielectric heating and sealing	29.5	39.5	40.0	48
Welding controls	15.3	18.3	21.6	33
Process-control computer systems, total	181.1	202.3	239.7	286
Digital	139.5	154.0	185.0	223
Analog	41.6	48.3	54.7	63
Power-demand control	175.0	201.4	227.3	336
Power supplies, total	**390.0**	**455.8**	**515.3**	**751**
Encapsulated	12.0	14.3	16.3	22
Modular	180.0	220.0	255.0	390
Open-frame and card	85.0	98.0	110.0	168
Lab and bench	27.0	29.5	33.0	45
Programable and system	16.0	19.0	21.0	29
Industrial heavy-duty	70.0	75.0	80.0	97

(millions of dollars)	1975	1976	1977	1980
Medical equipment, total	**1,092.5**	**1,268.3**	**1,442.6**	**1,810**
Diagnostic, total	609.1	741.3	871.4	1,070
Tomographic X-ray	100.0	175.0	230.0	300
Other X-ray	300.0	325.0	370.0	450
Electroencephalographs	10.3	11.7	12.8	16
Electrocardiographs	24.5	28.0	34.0	40
Ultrasonic scanners	32.0	49.0	64.0	80
Automated blood analyzers	80.3	83.5	86.8	97
Scintillation cameras and counters	48.6	54.6	58.0	67
Audiometers	13.4	14.5	15.8	20
Patient-monitoring systems	115.0	130.0	145.0	190
Prosthetic, total	264.8	280.5	296.7	383
Hearing aids	114.3	124.8	132.2	156
Pacemakers	147.5	152.0	160.0	220
Motorized limbs	3.0	3.7	4.5	7
Therapeutic, total	72.1	79.1	86.4	105
X-ray	40.0	43.5	46.5	51
Diathermy, shortwave and microwave	7.0	7.8	8.6	11
Ultrasonic generators	9.4	10.2	11.1	14
Defibrillators	15.7	17.6	20.2	29
Surgical support, total	31.5	37.4	43.1	62
Blood-flow meters	7.0	8.0	8.8	11
Blood-pressure monitors	12.0	14.0	16.1	23
Current generators	7.0	8.4	10.1	16
Biomedical lasers	5.5	7.0	8.1	12
Nuclear instruments and equipment, total	**45.0**	**48.4**	**51.7**	**62**
Spectrometers	11.5	12.5	12.0	13
Reactor controls	14.5	17.0	19.2	26
Radiation-detection and monitoring, total	19.0	18.9	20.5	23
Detectors, including ion equipment	9.0	9.0	10.0	11
Monitors, portable and fixed	5.0	5.9	7.0	9
Personal dosimeters	5.0	4.0	3.5	3
Lasers and equipment, total	**48.7**	**55.6**	**61.9**	**82**
Gas lasers	16.0	19.2	22.1	32
Semiconductor lasers	2.9	3.6	4.2	6
Other (ruby, neodymium-doped, etc.)	19.0	20.3	21.3	24
Laser power supplies	7.8	8.7	9.6	12
Modulators	3.0	3.8	4.7	8

CONSUMER ELECTRONICS

(millions of dollars)	1975	1976	1977	1980
CONSUMER ELECTRONICS, TOTAL*	**6,573.0**	**7,539.3**	**8,614.3**	**11,292**
Television receivers, total	**2,635.8**	**3,002.8**	**3,185.0**	**3,636**
Black-and-white	415.0	426.4	431.8	425
Color	2,220.8	2,576.4	2,753.2	3,211
Consumer audio equipment, total	**2,303.0**	**2,446.5**	**2,578.0**	**3,089**
Radios, total	755.0	808.0	859.4	1,016
Table, clock, and portable radios	455.0	483.0	511.6	596
A-m only	135.0	143.1	151.7	179
A-m/fm	320.0	339.9	359.9	417
Automobile radios	300.0	325.0	347.8	420
Phonographs and radio-phonographs	274.6	293.0	297.6	305
Portable	147.6	150.0	150.6	152
Console	127.0	143.0	147.0	153
Tape recorders and players	730.9	743.0	759.0	887
Automobile players	200.0	188.0	165.0	210
Cassette and cartridge player/recorders	164.3	180.0	198.0	238
Reel-to-reel players/recorders	49.0	50.0	45.0	32
Tape player/radio combination	317.6	325.0	351.0	407
Hi-fi audio components	542.6	602.5	662.0	881
Stereo	480.0	507.5	541.3	688
Four-channel equipment	62.5	95.0	120.7	193
Other consumer electronics products, total	**1,634.2**	**2,090.0**	**2,851.3**	**4,567**
Antennas, TV, and radio	43.6	46.2	50.0	56
Home video players/recorders	35.0	50.0	85.0	200
Video projectors	4.0	6.5	12.0	80
Electronic organs, other instruments	240.0	280.0	322.0	400
Intrusion alarms, fire monitor	150.0	154.5	160.7	186
Electronic assembly kits	63.1	70.0	75.0	98
Microwave ovens	405.5	600.0	900.0	1,835
Telephone-answering devices	9.0	11.0	13.0	16
Home video games	40.0	125.0	230.0	500
Calculators, hand-held, total	482.0	401.0	417.0	434
Four- or-five-function	292.0	284.0	293.0	290
Slide rule and financial, nonprogramable	172.0	81.0	71.0	80
Programable	18.0	36.0	53.0	64
Electronic watches	142.0	320.0	550.0	700
Digital clocks	20.0	25.8	36.6	62

*Includes domestic made equipment, off-shore products sold under U.S. labels and domestic and foreign-label imports

EUROPE MARKETS

☐ As the chorus launches into "Oh What a Beautiful Morning," the orchestra suddenly switches to "Who Knows Where or When." For the most part, that's what businessmen in Western Europe have been hearing.

It is clear that 1977 shapes up as a pivotal year for the electronics manufacturers in Western Europe. They are going to find out if the recession that stalled business around the world in 1975 has really reached its end.

A year ago, it looked as if the worst were over. By early summer the growth rates for the economies of West Germany, France, Italy, and even Great Britain had many observers convinced that a solid upturn had set in. After the summer simmered down, economists realized that consumer spending had caused the rise, not the capital investment that is essential for a long-lasting upturn in the business cycle. Down went the projections for growth during 1976 and 1977, and up went the apprehension levels of businessmen.

Nor, at the moment, are there particularly great expectations for the year ahead. To be sure, the crucial West German economy still is running strong, with growth of around 5% likely for the year ahead and with inflation under control. Chances for growth are next to nothing, though, in inflation-ridden Great Britain and Italy. France's new prime minister, Raymond Barre, seems almost sure to go way under his avowed target of 4.8% growth this year; inflation in France is already at double-digit levels so the balky economy can't be pushed too hard. The Benelux countries and Scandinavia will do better, although not as well as Germany.

Overall, then, the outlook is very patchy. If Germany continues strong, the growth for Western Europe as a whole could run a little higher than last year's 3.5%. In any case, it looks as if the region is settling into an era of slow growth—slow compared to the late 1960s and early 1970s, at any rate.

Explanations for the change of pace aren't hard to come by. The lusty growth came when Western Europeans were outfitting themselves with the trappings of highly industrialized economies—automobiles, refrigerators, entertainment electronics, and the like. What's more, the big build-up was fueled mainly by cheap oil. Not only have crude oil prices quintupled over the past four years, but the garages, kitchens, and living rooms are mostly filled. Western Europe, in short, has become a sort of vast replacement market burdened with production facilities designed to run on sorely missed low-priced energy.

Luckily, the electronics industries of Western Europe still seem set to outpace the overall growth. *Electronics* surveyed equipment markets in 11 countries during the fall and came up with a consensus forecast of $23.86 billion for the year ahead. That works out to an 11.4% gain over the estimated $21.41 billion for 1976. Of course, all these market figures are in current prices and look better than they would if discounted for inflation.

Although the electronics industries do not mirror the economies of Western Europe, intimations of the new growth pattern do turn up in the market charts. The consumer electronic sector, for example, does not figure to grow as much this year as it did in 1976, when it showed up well against 1975's recession. Also, saturation is slowing the color-television boom. Sectors like industrial electronics and test and measurement gear, which depend on private investment, will be laggards.

It is not hard to explain why communications turns up in the chart as the fastest-growing equipment sector. France has launched a massive program to better the phone network, for one thing. For another, there's heavy use of communications gear in the weapons that Western Europeans are exporting to the Middle East to help pay their oil bills.

This year, as always, the overall figures encompass a considerable spread of market sizes and performances. Norway, with an oil boom lifting its economy, ranks first in forecasted growth with a solid 20% spurt. At the bottom of the list comes neighboring Sweden. There, the color-TV market has peaked, and the drop for that category pulls the country's equipment totals slightly below the 1976 level.

As usual, West Germany towers over her neighbors in market size. The equipment markets there total $8.15 billion for 1977. Then come France at $5.22 billion and the United Kingdom at $2.87 billion. The Benelux countries total $1.96 billion, while Italy comes to $1.66 billion. Spain and Sweden are close together, with $1.11 billion and $1.02 billion respectively, while Switzerland has $0.71 billion and Denmark and Norway come in last with just under half a billion each.

CONSUMER

Entertainment market to lose bounce

For radio and television-set makers, it's hard to think of a more worrisome combination than saturation compounded with austerity. Yet splotches of saturation are starting to turn up on the market maps of Western Europe, particularly in West Germany and in Scandinavia. At the same time, austerity is the order of the day in France, the United Kingdom, and Italy.

As a result, the entertainment-electronics business doesn't figure to show as much bounce this year as it did in 1976, when consumers started coming back into dealers' showrooms after a year of recession wariness. *Electronics*' annual survey puts the market at $7.121 billion, up from $6.7 billion last year. The growth of slightly better than 6% will be down appreciably from the 1976 rise of just less than 9%.

Sales of the market mainstay, color-TV sets, surged some 14% last year to reach $3.258 billion. They should show a more modest 9% rise to $3.566 billion in 1977.

The picture varies

Like a spinning color wheel that's come to rest, the consumer sector's overall hue turns out to be a blend of considerably different segments. In the massive West German market, for example, color-set sales should hit 2.5 million units this year and then edge up to a peak of something like 2.75 million units by 1980. "The culmination point in terms of first-set sales has been reached," asserts Johanna von Ronai-Horvath, who heads market research activities at Schaub-Lorenz, an International Telephone and Telegraph company. She estimates that 15% of this year's German sales will be replacements.

French set makers, who saw color-set sales burgeon in West Germany and in the UK during the early 1970s, logged a 25% gain to push past the 1-million-set mark. This year, a 15% gain is in sight.

In Great Britain, the color-TV market reached a very spiky peak four years ago. It has been holding up reasonably well considering the shocking state of the country's economy. Sales last year ran a bit above 1.6 million sets, but prospects for 1977 draw divided views.

Some set makers say sales will edge up slightly, but Alan D. Hall, marketing director, ITT Semiconductors, thinks they are too bullish. John F. Cryer, manager of linear integrated circuits for RCA Corp.'s solid-state operation in Europe, expects that the UK market will be flat, but notes that business Europe-wide should be reasonably good. Conversely, Robert N. Blair, Fairchild Semiconductor's general manager for Northern Europe, reckons that consumer business looks fairly strong. So does Mike Alderson, the UK marketing manager for Motorola Semiconductor Products Inc.—"depending on the government not doing anything silly."

The outlook for color-TV is equally drab in Scandinavia, where the market will start tailing off in 1977,

Healthy color. A strong West German market for color-TV sets will keep workers, such as these quality control checkers at Grundig's production plant in Nürnberg, busy in 1977. For Europe as whole, color TV should account for more than $3.5 billion in sales.

according to a respected Swedish electronics-market researcher. The Benelux countries, also, look like slow growers for the years ahead.

The growth in Italy and Spain, where color broadcasting was late in starting, was truly explosive last year. Set sales should boom again this year in both countries.

Although the Italian broadcasting organization still does not have an official government go-ahead to broadcast color, it airs a heavy program of color every night. That's enough to send Italian consumers, whose lire are worth a little less almost every day, flocking to the market. Color-TV sales practically doubled last year to reach some 420,000 units. The 1977 prospect is a near 50% gain to better than 600,000 units.

In Spain, the percentages are equally spectacular and should carry the market this year to well above 300,000 sets. "Color-TV has become even more fashionable than cars, which have maintenance costs," says Jose Maria Gorria, a marketing executive at Philips Iberia.

But these bright spots on the color-TV wheel will take on a less gaudy hue as the years spin on. Set makers in the mature markets in Western Europe will be trying to adjust to the slower cadence of replacement markets. The bellwether German producers hope that sets with built-in video games will get some buyers into the replacement market earlier.

No one is counting on much help in the next two or three years from high-priced hardware like video-tape recorders and video-disk players. "We are just at the beginnings of a consumer era," says Jo Jongeneel, a senior planning executive at Philips.

COMPUTERS

All countries continue steady growth

Computer makers in Western Europe, by and large, have set their corporate throttles to cruise at growth rates considerably below the 15% they considered their due through the early 1970's. On *Electronics*' markets chart,

deliveries of computers and related hardware add up to $7.29 billion for 1976, a handy 13% gain over the 1975 figure. For the year ahead, the forecast is for $8.20 billion. Although that works out to a lower growth rate, it nonetheless signals a strong year for electronic data-processing firms.

Stronger for some, than for others, of course. The dominant West German market should move up nearly 12%, all told. The climb will be steeper for the minicomputers and the large mainframes than for the categories in between, figures Bernhard Marten, an EDP marketing man at Siemens.

For larger systems, many customers held off ordering until well into 1976, says Jochen Rössner, a marketing specialist at Sperry Univac. The market picked up during the fall, and "there are now a lot of serious sales discussion taking place," he reports.

"Doing particularly well will be terminals," says Rolf Prey, an official at Nixdorf Computer AG, a German heavyweight in terminals, office computers, and disk storage systems. The market for point-of-sale systems should start to swell, now that retailers, wholesalers, and commodity producers have agreed on a common article code—a prerequisite for widespread adoption of POS.

French data-processing markets will show growth approaching 13%, rising from $1.67 billion to $1.88 billion in 1977. Although Prime Minister Raymond Barre has an austerity plan going, it won't crimp the Government's plans to hype the computer business, particularly for the "French" computer outfits—CII-Honeywell-Bull and SEMS, which teams up the minicomputer efforts of Thomson-CSF and La Télémechanique.

Chairman Jean-Pierre Brule this fall announced that CII-Honeywell-Bull is working toward a unified line of computers for the mid-1980s. By the time government subsidies for the newly merged computer company end in 1980, the firm expects to be rock-solid. "We will be a formidable competitor with IBM in French computer sales," Brule avers. "We expect to outdistance them in computer deliveries within the next five years." It will be a considerable achievement, indeed, if he does pull it off successfully.

Surprisingly, the Italian computer market looks as though it will bounce up 14.5% to reach $527 million. Part of this gain has to be discounted for the price hikes that inevitably follow inflation in the cost-of-living indexes. But a good part also comes from a lowering of the "entry level" that started when IBM introduced its System/32 two years ago. Before then, first-time buyers were mostly companies with at least 100 employes. Now the figure has dropped to 40 employees.

Check out. Point-of-sale systems, such as this one from Nixdorf Computer AG, are catching on fairly quickly in some European countries. In fact, sales of POS equipment will nearly double from the $68.9 million posted in 1975 to $137.2 million this year.

COMMUNICATIONS

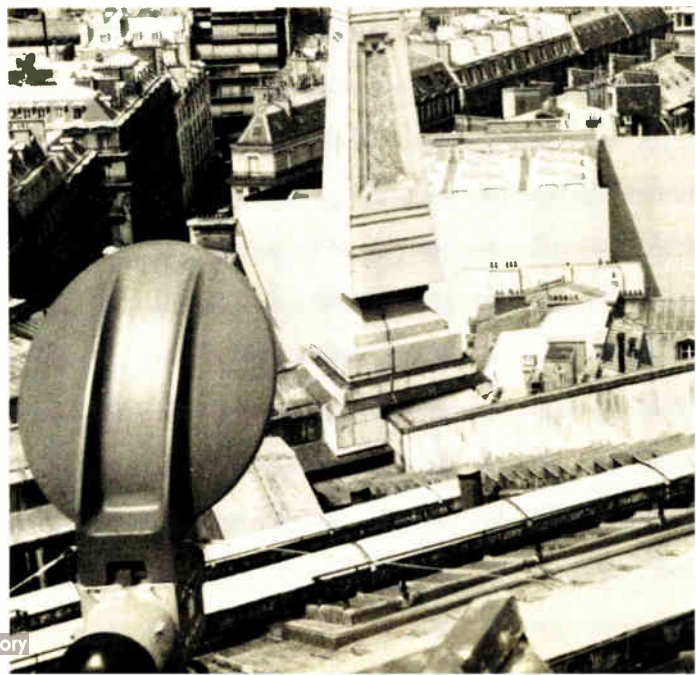
Phone prospects vary from cheerful to gloomy

Mystery-novel addicts know the postman always rings twice. That's not the case with the post-office and telecommunications administrations of Western Europe. Each is starting to ring in its own fashion, particularly when it comes to spending for improvements in telephone networks.

When that spending is totaled, it turns the communications sector into the fastest-growing major market segment in Europe. *Electronics*' consensus survey spots it at $4.94 billion, up a very good 14% over the $4.33 billion in 1976. But it's a mistake to think that the strong overall growth means good business for telecommunications makers from the chilly shores of the North Sea all the way down to the sunny Mediterranean.

Ringing loudest and clearest at the moment is the French post office and telecommunications ministry (PTT). It is beginning massive programs to add eight million phone lines to its network by 1980. That will be more than were put into service in the century from 1875 to 1975.

A whopping $4.9 billion has been earmarked in the



PTT's 1977 budget for the program. The bulk of the money is destined for laying lines, but there's plenty of fallout for telecommunications-gear makers—some $370 million for carrier equipment and nearly a quarter of a billion dollars for semielectronic switching equipment. More good news is that there are smaller but significant outlays for equipment like microwave relays and paging equipment.

Thomson-CSF, the largest electronics group in France, will score heavily in telephone markets for the first time next year. The group got itself solidly into the business this year when it convinced the government to pressure ITT into selling its controlling holding in le Matérial Téléphonique (LMT). As part of the same deal, the French subsidiary of L M Ericsson (SFE) went under the wing of Thomson-CSF.

Crash effort launched

For its crash effort, the PTT last year ordered more than one million lines of conventional switchgear and 290,000 lines of new-look hardware. Space-division systems—90,000 lines worth—will come from LMT, SFE, and Constructions Générales de Constructions Téléphoniques, an ITT outfit. Time-division switching, on which the post office is counting for the long run, chiefly means CGE's CIT-Alcatel, although Thomson-CSF will be a force later on.

In West Germany, telecommunications-gear producers don't hear much tinkling from the Bundespost. The agency, which accounts for nearly two thirds of the country's communications business, shaved its outlays for cables and equipment to something like $1.9 billion in 1975, below the 1974 level.

Last year, the figures were down again, and it's the same sad story this year. Thus the German carrier-equipment and public-switching categories look like they will be dead flat for next year at $229 million and $62 million, respectively.

Viewpoint. Microwave transmission links are sprouting up all over France, as the post and telecommunications ministry pushes telephone modernization and television programming. These portable antennas for TV program relays are sitting atop the Paris Opera.

There was a slight rise in sales of telephone equipment to private buyers and to export customers, but not enough to keep the country's 30-odd producers working at anywhere near capacity. And there's no short-term succor in sight.

The much-touted electronics switching systems won't become a factor before 1978 or so, "maybe not even until the early eighties," says one industry observer. "Neither does EDS provide much of a push," says another.

Those initials stand for stored-program-controlled data switching hardware that will eventually be installed in eighteen cities to form the hub of an integrated teletype and data network. The Bundespost has announced plans to spend more than half a billion dollars on this program by 1980.

Even harder hit have been the equipment makers in Great Britain. The British Post Office launched a major program to modernize its network by phasing out its ancient step-by-step switches and phasing in semielectronic TX-2 and TX-4 exchanges several years ago. But it has announced a massive $370 million cutback that reduces exchange orders by one third over the next three years.

Exchange makers gloomy

Electromechanical exchanges will suffer most. But the cutback will hit newer exchange types as well—enough so that one semiconductor supplier terms the market outlook for his customers that makes exchanges as "a bit unhappy."

By and large, there's not much exuberance among telecommunications equipment producers in the smaller countries of Western Europe, either. Restraint is the byword for spending for 1977. However, the year will see a start on the Nordic data transmission network, for which the Danes, Finns, Norwegians, and Swedes plan to spend some $215 million.

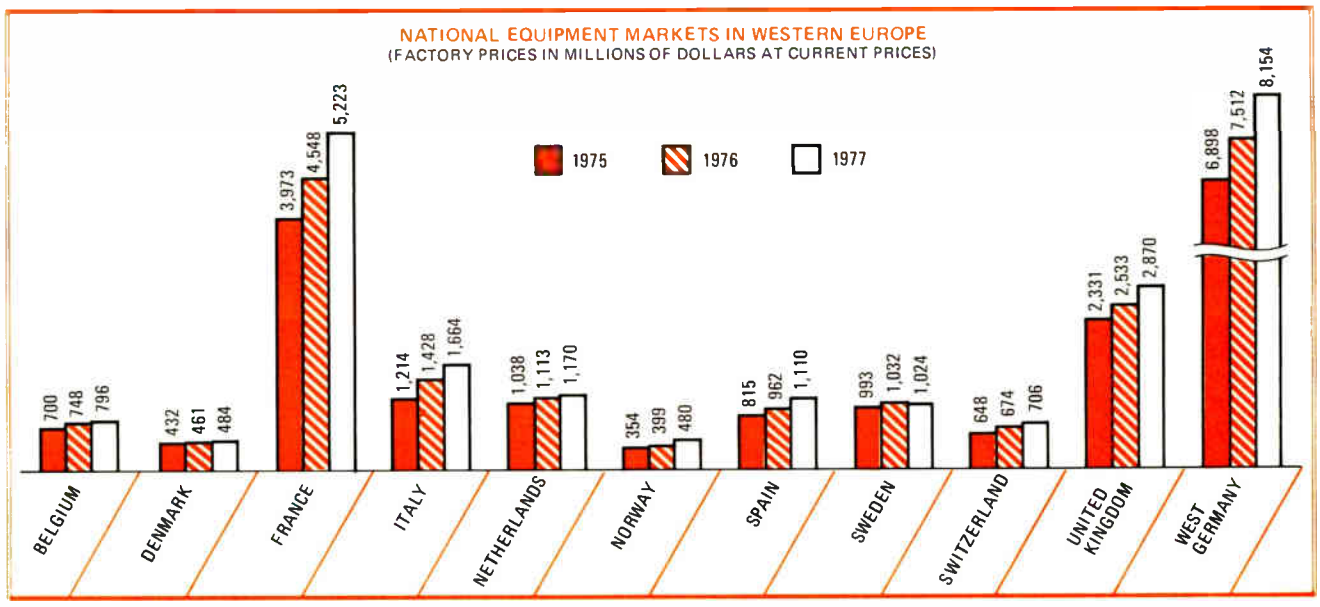
Holland is a special case because Philips' Telecommunicatie Industrie is based there. Philips has an unchanging home market, like most of its neighbors. But the company is negotiating with Saudi Arabia for a massive long-term telecommunications contract involving billions of dollars, outsiders estimate. In fact, "if we get that contract, our immediate problems will be solved," says Jan Meijers, administrative director for the company.

DEFENSE

Wary arms suppliers hope exports hold up

There's no clear line of demarcation between producers of defense electronics and of telecommunications equipment in Western Europe. Quite often, they are just different divisions of the same company or different companies in the same group. So military sales swell the telecommunications categories in *Electronics*' survey.

Defense budgets are hardly changing in real terms,



and more of the outlays are going for higher pay and better military living conditions. Nonetheless, the categories that reflect electronics procurement are showing growth.

For navigation, radar, and radio communications, the survey records markets totalling $1.91 billion this year, which are up from an estimated $1.68 billion for 1976. This slight growth stems mainly from hardware integrated into a plane, a ship, or a missile battery that is destined for export. France and Great Britain, and to a lesser extent Italy, Holland, and Sweden, are doing a handsome business in armaments—everything from submarines to airplanes.

The export order books are still at high levels at most military-electronics producers. But some concern is emerging about how long they will continue to flourish. "We'll be watching very closely to see if our order intake in 1977 keeps up with deliveries," says Edouard Guigonis, senior vice president at Thomson-CSF. The company does more than half its business in professional electronics such as measurement and test systems with overseas customers.

In the United Kingdom, an order-book index worked up by a tracker of professional-electronics markets shows a 15 point drop over the past year for military end markets.

The F-16 deal

Late this year or early next year, a favored few avionics producers in Belgium, Denmark, the Netherlands and Norway will start picking up the surprisingly thin fallout from the offset arrangements with General Dynamics in the so-called arms deal of the century. In that agreement, the four nations signed up to buy 348 F-16 fighters from the U.S. firm.

Some $325 million of offset is for electronics and electromechanical gear, not including radar. About $50 million of avionics business has been nailed down by Danish firms, roughly half of what they expect to eventually get. In Norway, the government-run firm Kongsberg Vapenfabric has landed a contract that includes the inertial navigation system. But Belgium and the Netherlands are still trying to sort out who will get what in the fire-control-radar orders.

COMPONENTS

Parts makers see second good year in a row

Western European components suppliers generally felt reasonably certain they would bounce back during 1976 after their disastrous 1975—and they were right. Components markets in the 11 countries covered by *Electronics'* survey rose 13.2% over 1975.

This year's forecast is a climb from $5.66 billion to $6.37 billion. Equipment makers built up their recession-depleted parts inventories early in 1976, putting a bulge in last year's sales curves that will not turn up in 1977.

Actually, views are divided about the rate of expansion for components markets. In West Germany, for example, Gert Lorenz, head of the Philips subsidiary Valve GmbH, figures total components output in the country will go up 5%. Much more optimistic, Alfred Prommer, vice president for components sales at Siemens, puts the expansion at 13%.

Although everyone agree that semiconductors will outgain—but not outdo—passives in sales this year, the extent is something else. "We see moderate growth, but not the light at the end of the tunnel," says Francois Dufaux, European marketing manager for Texas Instruments Inc. "Book-to-bill ratios will stay stable at about 1.2 through mid-1977," insists Piero Martinotti, the European marketing manager for Motorola Semiconductor. He pegs this year's gain at better than 20%.

The consensus forecast comes between these two views, with an 18.5% rise to $1.67 billion. Microprocessors will go from $19.3 million in 1976 to $40.5 million.

JAPAN MARKETS

☐ The quakes rocking Japan's economy have subsided, and the island nation's manufacturers are generally optimistic about the future. The gradual, unspectacular recovery will continue, especially in the electronics industries. In the fiscal year ending in March, the gross national product will rise about 13% including inflation, about the same as last year.

The electronics industries generally will be good performers, with domestic sales growing faster than the GNP. Total domestic sales of electronics equipment increased 11% over calendar 1975 to almost $11.7 billion, the *Electronics* survey discloses. They should gain 17% to over $13.7 billion this year (see table).

The electronics growth will not equal the 25% to 45% upward thrusts common before the world recession. Companies have settled for slower growth with a few hot products or markets carrying the slow runners.

The consumer-electronics business will continue to seesaw. Domestic sales of color-television sets were flat, as household saturation reached almost 95%. Yet exports were particularly good throughout 1976. So most Japanese TV makers enter 1977 at a high rate of production. Audio producers, on the other hand, expect a good year both at home and abroad, especially for stereo components.

Components companies, led by semiconductor firms, rode the crest of the consumer-products export boom, especially in citizens' band sets. On the home front, the semiconductor houses are geared up for what promises to be solid growth in digital large-scale integration for both memory and logic devices.

This optimism of semiconductor producers is fueled by the outlook among Japanese computer manufacturers. Having survived the more open competition created by liberalization of the domestic market, the computer firms are looking forward to using their growing home base as a springboard into exports.

Meanwhile, suppliers of communications equipment to the Nippon Telegraph and Telephone Public Corp. spent anxious months waiting for a lift in spending. The rate of expansion, slowed over the last two years, probably will resume this year, because the government is helping the phone company catch up on postponed projects, such as electronic exchanges.

Industrial control has been the sick man of Japanese electronics, with the slowest recovery. Even though most electronics firms were returning to relatively good health last year, the other major industries were not as spry. As a result, process controls, the largest segment of the industrial electronics market at $652.7 million last year, will barely regain its pre-oil-crisis peak.

IMPROVED ELECTRONICS DEMAND

	Estimated domestic consumption (millions of dollars)		
	1975	1976	1977
Consumer	4,444.2	4,730.6	5,446.6
Computers	3,119.4	3,673.7	4,336.6
Communications	1,442.0	1,567.4	1,867.5
Industrial, test, auto, medical equipment	1,403.6	1,580.5	1,878.4
Power supplies	87.9	119.3	132.5
Total	10,497.1	11,671.5	13,661.6
Components and tubes	2,468.8	3,200.9	3,532.0
Semiconductors	1,266.7	1,666.5	1,955.6
Total	3,735.5	4,867.4	5,487.6

Note: Yen value computed at 286 yen = $1. Figures are based on a survey of manufacturers supplying the Japanese domestic market and are not adjusted for inflation. Source: *Electronics* 1977 Market Report

CONSUMER

Stereos, exports buoy flagging television market

The consumer electronics market picked up speed again in 1976 and promises to jump 15% to almost $5.5 billion this year. At home, the action will center around the new market for the home video-tape recorder/player. Overseas, the focus is on the explosive growth of television-set exports to the United States and the investigations signaling an American effort to halt further Japanese expansion.

While exports were flying high last year, domestic color-TV sales rose only about half a million units to about 6 million. They probably won't go much over 6.2 million this year. Sales were split almost evenly between second sets and replacements, but replacements should be slightly ahead this year.

The domestic color-TV market is virtually saturated, so the first year of home-VTR sales has arrived none too soon. But there's a hitch. Four noncompatible systems offering different features and prices have been introduced [*Electronics*, Oct. 14, p. 68].

Sony Corp. was first with its one-hour Betamax, retailing for $1,000. This fall, Victor Co. of Japan (JVC) brought out its two-hour VHS system at $890. In between came Sanyo and Toshiba with a joint-effort called V-Cord II, which at $1,150 and $1,220 is the

VTR competition. Japanese video-tape-recorder companies are locked in a struggle to gain leadership in setting the standard for home units. Sony's SL-7100 Betamax (above), at a new low price, has heated up the battle, but JVC has picked up more supporters.

highest priced of the competitors. The lowest priced home VTR, with a retail tag of $730, has been the VX-2000 from Matsushita Electric Industrial Co.

Recently Hitachi Electric, Sharp Corp., and Mitsubishi Electric tipped the balance toward JVC by signing agreements to sell its version under their labels. Because Victor is part of the vast Matsushita family, it is fairly certain that Matsushita will offer the VHS as well, although the company has avoided any formal announcement of its intentions.

Thanks to its head start, Sony expects to fight it out for a share of the market. Soon after JVC's announcement, Sony came out with a slightly simpler Betamax, priced at $800.

Meanwhile, the Ministry of International Trade and Industry has called upon the makers to develop a standard VTR, lest the competing systems confuse dealers and consumers. It would appear that Victor has the edge by mutual acceptance among the noncommitted TV manufacturers. On the other hand, Sony has thrived in the past by going its own way.

Three banzais for audio

Very rapidly, the stereophonic-sound market in Japan is gaining on domestic color-TV sales, which were $1.67 billion in 1976. The high-end audio total came to $1.12 billion—about $248 million for tape decks, about $100 million for high-priced phonographs, and $772.4 million for high-fidelity components. With about 50% saturation, the audio market will grow at a higher rate than color TV in 1977. Both systems and discrete components should grow by 20% this year.

Other key products in Japan's domestic consumer sector for 1977 include:

- Microwave ovens. After one of their periodic sales pauses last year, electronic ranges should perk up again in 1977, growing by about 10%.
- Radios. The old standby keeps rolling along, with most growth in the extensive lines of radio/tape recorder combinations. Total combo sales this year should be about $359 million.
- Electronic watches. Total 1976 production was well ahead of 1975, but the average selling price dropped by about $10. Sales of analog and digital electronic watches should exceed $205 million this year, *Electronics* predicts.
- Calculators. Total earnings from personal calculators last year plunged almost 25% and are predicted to fall by at least 6% again. Underscoring the effects of oversupply at home and abroad was the October bankruptcy of Systek Corp., Japan's leading private-brand exporter.

COMPONENTS

ICs, discretes register smaller but healthy gains

The country's semiconductor suppliers, including American firms, have few complaints about last year and not much to gripe about for 1977. Total integrated-circuit consumption, showing gains in every category, jumped over 47% to $816.5 million in 1976 and should spurt another 19% to $970.9 million this year. Discrete semiconductors gained over 24% to $698.2 million last year and should grow by 15% to $800.7 million this year.

On the digital-IC scene, major producers Nippon Electric Corp., Fujitsu, Hitachi, Toshiba, and Mitsubishi are putting finishing touches on their 16,384-bit dynamic memories that undoubtedly will be compatible with U.S. designs. Per-bit prices comparable to 4,096-bit devices may be quoted as early as this spring, although some firms do not see this crossover until the spring of 1978.

Eight-bit designs are coming on strong in the microcomputer market. Estimates of the market share of the 8080A type range up to 90%, and Toshiba has indicated it will join local suppliers NEC, Mitsubishi, and Oki Electric. Motorola, however, says it has seen a dramatic rise in sales of its 6800 microprocessor recently. Domestic 6800 suppliers Hitachi and Fujitsu have just started deliveries as well. Toshiba has recently introduced a single-chip microcomputer that should open a market for simplified control devices ranging from computer input/output units to consumer products.

Companies are also rounding out memory lines. In 8,192-bit types, Fujitsu has programable read-only memories and masked ROMs compatible with Intel's. Nippon Electric has an avalanche electrically alterable ROM that has more pins than Intel's and is compatible with Intel's programable ROMs and its own and Intel's masked ROMs. Hitachi has recently announced development of a 32,768-bit masked ROM.

Toshiba is selling a 1,024-bit nonvolatile random-access memory that is finding favor as a core replacement in small systems and as an EAROM. Mitsubishi, which has a 4-kilobit metal-nitride-oxide-semiconductor EAROM, is also putting the finishing touches on a 4-k integrated-injection-logic RAM.

Booming export markets in color-TV sets, calculators, and CB radios actually created a shortage of some semiconductors, ICs and discretes alike, through the summer. In fact, American companies that usually

concentrate on exporting ICs reported they were getting orders for discretes because Japanese manufacturers could not fill the demand.

But sudden slumps, first in calculators and then in CB transceivers, cooled off this demand. This year, the increased IC content in CB and TV sets will mean resumption of growth, although not at 1976 peaks. In TV sets, electronic tuning with digital controls is coming on the scene. For CBS radios, phase-locked-loop circuits will be used in new 40-channel products.

Some new technologies promise to lay the groundwork for future market surges. Vertical field-effect transistors are being developed with kilowatt outputs up to ultrasonic frequencies and tens of watts at microwave frequencies. The same technology is being extended to thyristor-like devices. Oki Electric has developed bipolar programable wired-OR, wired-AND logic arrays.

Passives go up and down

The passive components business in Japan has bounced like a yo-yo for the past few years and may be in for more of the same. Recovery from the early 1975 rock bottom was rapid, and, until the summer of 1976, orders exceeded sales. Some companies increased personnel and investment, while others felt that the boom was transient.

The problem is that, when other electronics sectors start sneezing, the components sector catches cold. The drop in demand for CB transceivers and calculators hurt, although it may pick up somewhat this year. Sales of TV sets are also expected to remain flat this year. So components suitable only for a single application, such as 40-position switches and quartz crystals for CB sets, have been hit hardest. With other components, manufacturers have been able to realign to some extent and more nearly balance demand and supply.

Yet the overall result has been sharp ups and downs. With business expectations up this year, components companies could again overexpand and follow a quick rise with a fast fall.

COMPUTERS

Domestic firms slug it out with U.S. invaders

The Japanese computer industry is alive and well, which this year is news. A year ago, the six domestically owned computer mainframe companies were bracing for almost complete liberalization of the domestic market. They feared that International Business Machines Corp. and other U.S. firms would take over larger market shares.

For various reasons, the Japanese makers (guided by the Ministry of International Trade and Industry into three separate joint ventures) not only survived, but prospered [*Electronics*, Nov. 25, p. 84]. Domestic data-processing and office-equipment sales rose by some 18% to $3.67 billion and should gain another 18% to $4.34 billion this year, according to the *Electronics* survey.

These are relatively modest gains, however, compared with those of four and five years ago. That fact is a partial explanation for the Japanese firms' retention of their estimated 56% share of the domestic market. Another factor was that the joint ventures of Fujitsu Ltd. and Hitachi Ltd., Nippon Electric Corp. and Toshiba Ltd., and Mitsubishi Electric and Oki Electric were ready with systems competitive with the IBM System 370. In addition, IBM did not have the production capacity and software support to take over the Japanese domestic market. At any rate, the firm has repeatedly emphasized that it has no such intentions.

Although the total data processing market is moving up slowly, there are certain hot spots such as data entry equipment, up 35% last year and expected to jump another 21% this year. After a slow start, point-of-sale equipment, which includes electronic cash registers and bank cash dispensers, has started to move and should grow by almost 39% in 1977.

According to Takachiho-Burroughs Co., there now are 7,000 cash dispensers installed or on order in Japan. Recently, the telephone company set up a new operation to handle cash dispensers from 54 participating banks to numerous terminals in stores, supermarkets, airports, and the like. It promises to be a good source of sales.

The next new market, just taking shape in Japan, will be word-processing systems. Handling correspondence in this way can be difficult in Japan because of the complexity of mechanizing the written language.

COMMUNICATIONS

Phone company's troubles take their toll

The course of capital spending at the Nippon Telegraph and Telephone Public Corp. is a vivid example of the troubled times in Japan. For years a surefire source of steadily expanding business for communications-equipment makers, NTT's spending program was scuttled first by the oil crisis and in 1976 by the Lockheed payoff scandal. Its budget was cut for the first time since Japan's postwar economic explosion began.

The oil crisis raised operating costs and left less money in the budget for equipment purchase. The Lockheed scandal paralyzed the government, delaying passage of rate increases needed to pay for projects. Before the rate bill was passed in November, NTT had to cut spending plans twice during 1976. Deferred equipment purchases ranged from technically simple telephone instruments to the highly sophisticated electronic exchanges. NTT's original five-year plan for this period called for the installation of 370 electronic telephone exchanges. After the oil shock, the figure was revised downward to 300, with 80 units to be installed in fiscal 1976. But the worsening financial situation caused another revision of the year's plans to 70 at the beginning of 1976, and delay in passing the rate bill caused further downward revision to only 50 exchanges. Now that purchases are picking

up, they will include a different mix of technology than planned. For example, exchanges in which core and wire memories have been replaced by 4-k n-channel metal-oxide-semiconductor ICs are scheduled for field trial this year, with the complete changeover at the beginning of 1978. The new exchanges should cut system cost 20%.

Facsimile transmission keeps gaining in Japan. Domestic sales in 1976 exceeded $50 million, and 35% growth to almost $92 million is expected this year.

INDUSTRIAL

Capital lack hinders growth

Industrial controls made a 14% recovery last year to $883.1 million but should regain more strength, growing by 24% to $1.09 billion. Process controls, the largest segment of the industrial market, was still below the 1974 peak in real dollars, and, despite a gain this year, will not return to it.

Capital investment in many industries using these controls is at a low level, compared to the growth period before the oil crisis. In fact, capacity in many sectors is excessive. If the major industries do not return to a high growth rate, there cannot be much expansion of industrial instrument and test-equipment use. Present industrial markets are primarily for replacement, pollution abatement, safety enhancement, and small expansion.

In 1976, companies finally began to sell previously announced microprocessor-based systems. Yokogawa Electric Works Ltd. claims to have sold 29 of its 32-loop-per-microprocessor Centum systems, with the average installation controlling 50 loops and selling for slightly more than $175,000.

Yamatake-Honeywell claims only between 10 and 20 sales of its TDCS systems, jointly developed with Honeywell in the U.S. But it claims a larger dollar total for these sales than Yokogawa. The company says the eight-loop-per-microprocessor systems go mostly to large capital-investment projects.

Toshiba, which also uses an eight-loop-per-microprocessor design in its Tosdic system, has developed a design suitable for systems ranging in size. Hokuskin took a different route that led to October's announcement of its 900/TX system, a year or more later than other companies. The system is designed for a variable number of loops per microprocessor, depending on the work load of each of the loops.

Sometimes new business appears unexpectedly. For example, Konishiroku, Japan's No. 2 film manufacturer, decided to offer color film with 24 frames and needed new automated processing equipment. And Fuji Film, the No. 1 maker, had to buy new equipment to compete.

INSTRUMENTS

Consumer gains help sales

The *Electronics* market survey shows that test-equipment sales rose about 9% last year to $358.5 million and will rise another 10% to $395.7 million this year. This does not represent new highs for the industry, but rather the start back toward peak revenues last achieved in real dollars during 1973. The recovery was not evenly spread among products or manufacturers, though.

Leading the increase were sales of test equipment used for consumer goods exported to the U.S. and elsewhere, especially sales to CB manufacturers. Takeda Riken sold more spectrum analyzers than in 1975, and Matsushita Communication Industrial Co. says that it did well 50-channel synthesizers and other CB test equipment. But Yokogawa Electric says it sold more panel meters for bench and laboratory power supplies than its customers sold to CB manufacturers.

In the microwave field, Yokogawa-Hewlett-Packard is starting to sell $15,000-to-$35,000 instruments, a class it could not previously move. Yet it finds selling low-priced digital multimeters and probes to be a problem, because the prices have dropped too low to make it worthwhile for salesmen to hawk them to customers.

Matsushita, on the other hand, has high hopes for its low-priced 7-to-10-megahertz oscilloscopes designed with a short CRT having a wide deflection angle [*Electronics*, Oct. 14, p. 17E]. It plans to produce them at a rate of 1,000 units per month, several times the usual rate. In general, oscilloscope prices are down, and there is more demand for inexpensive types, with increased competition from companies that used to make hobby or service equipment.

DEFENSE AND SPACE

Major buys, but not in 1977

Japan's cabinet and the National Defense Council have approved an "outline of the national defense plan" as a follow-on to the fourth five-year plan, which ends March 31. It stresses quality rather than quantity. In fact, the number of aircraft will probably be reduced with the phaseout of Korean-War-vintage F-86s. The Lockheed payoff scandal that rocked the government had less effect on defense spending, with attention focusing on civilian aircraft purchased by All Nippon Airways.

The major new weapons systems to be considered during the early years of the new plan include the FX fighter, most likely the United States F-15; an aircraft early-warning system, probably from Grumman, and an antisubmarine system, which could be the Lockheed P3C. In general, systems of this nature start with parts supplied from America and proceed to almost complete domestic production. Even if they are included in the budget for fiscal 1977, big spending will undoubtedly be deferred to subsequent years.

The Japanese Defense Agency has in its budget a request for one fixed three-dimensional radar from Mitsubishi for about $7 million and one transportable 3-d radar from Nippon Electric for about $6.3 million.

The National Space Development Agency has asked for an increase in funds of 15% over the $132.9 million it received during fiscal 1976 for 1977 operations. If approved, it would make the agency's budget third behind the United States and European agencies in the non-Communist world. □

JAPAN/EUROPE MARKETS FORECAST 1977

	JAPAN			WEST EUROPE		
	1975	1976	1977	1975	1976	1977
COMPONENTS, TOTAL (millions of dollars)	**3,735.5**	**4,867.4**	**5,487.6**	**5,000.4**	**5,661.4**	**6,371.9**
PASSIVE AND ELECTROMECHANICAL	**1,801.9**	**2,415.5**	**2,685.9**	**2,685.3**	**2,969.6**	**3,294.2**
Capacitors, fixed	405.6	559.8	632.8	546.6	618.1	701.2
Capacitors, variable	30.0	46.6	47.4	39.7	44.2	46.4
Connectors, plugs, and sockets	68.8	93.0	102.6	300.7	334.7	373.8
Filters, networks, and delay lines	---	---	---	57.8	64.4	70.9
Loudspeakers (OEM type)	128.3	168.3	187.7	137.3	148.0	162.7
Microphones (OEM type)	38.8	51.1	55.4	34.0	38.1	42.0
Microwave components	---	---	---	21.6	22.7	24.7
Potentiometers, composition	117.8	174.0	202.8	120.1	136.9	144.5
Potentiometers, wirewound	15.6	22.4	25.5	81.8	91.4	107.0
Printed circuit boards	172.1	233.9	264.0	280.1	310.5	348.3
Quartz crystals (including mounts and ovens)	---	---	---	35.9	40.3	44.0
Relays (for communications and electronics)	149.8	164.0	181.3	256.5	272.5	294.4
Resistors, fixed (including wirewound)	129.3	169.3	173.4	229.6	253.3	271.0
Resistors, nonlinear	---	---	---	27.6	30.3	33.7
Servos, synchros, and resolvers	12.6	14.0	14.7	50.2	56.1	64.7
Switches (for communications and electronics)	122.7	176.0	193.4	156.5	171.5	192.9
Transducers (pressure, strain, temperature, etc.)	7.7	8.0	8.4	---	---	---
Transformers, chokes, coils, TV yokes, and flybacks)	402.8	535.1	596.5	309.3	336.6	371.8
SEMICONDUCTORS, DISCRETE, TOTAL	**561.2**	**698.2**	**800.7**	**644.8**	**717.8**	**816.9**
Microwave diodes, all types (above 1 GHz)	7.8	7.6	9.0	11.1	12.4	14.8
Rectifiers and rectifier assemblies	115.3	134.1	145.1	116.7	134.9	157.4
Signal diodes (rated less than 100 mA, including arrays)	53.0	83.9	115.4	62.0	66.9	74.8
Thyristors (SCRs, four-layer diodes, etc.)	28.9	35.4	34.7	64.8	74.2	84.1
Transistors, bipolar power (more than 1-W dissipation)	117.5	146.1	162.6	119.0	131.8	153.8
Transistors, bipolar small signal (including duals)	206.6	251.4	276.2	210.1	227.0	249.1
Transistors, field-effect (power and small-signal)	6.6	8.7	11.9	7.2	9.6	12.4
Tuner varactor diodes	10.8	11.4	22.6	18.4	21.3	24.1
Zener diodes	14.7	19.6	23.2	35.5	39.7	46.4
SEMICONDUCTORS, INTEGRATED CIRCUITS, TOTAL	**554.7**	**816.5**	**970.9**	**496.9**	**620.2**	**765.3**
Hybrid ICs all types	43.9	57.3	64.8	49.1	59.3	69.1
Linear ICs (except op amps)	85.8	124.0	146.2	115.9	131.7	151.4
Op amps (monolithic only)	11.5	17.7	14.9	26.1	30.0	33.8
Logic circuits, bipolar	97.8	110.8	136.1	140.9	164.8	189.6
Logic circuits, MOS and C-MOS	81.0	106.6	133.1	45.2	62.6	88.6
Memory circuits, bipolar	10.7	13.9	17.1	18.5	24.5	32.5
Memory circuits, MOS and C-MOS (except microprocessors)	56.5	95.5	133.3	53.9	70.4	88.3
Microprocessors (includes CPU, memory, and I/O chips)	17.1	26.9	33.6	9.9	19.3	40.5
Calculator chip sets	92.6	110.7	118.3	10.8	16.8	18.8
Watch and clock chip sets	8.3	13.8	20.2	5.6	11.0	18.1
Other special-purpose circuits	49.5	139.3	153.3	21.0	29.8	34.6
SEMICONDUCTORS, OPTOELECTRONIC, TOTAL	**150.8**	**151.8**	**184.0**	**58.3**	**69.8**	**86.6**
Circuit elements (photoconductive cells, photodiodes, etc.)	12.4	17.6	24.4	17.1	20.2	24.5
Discrete light-emitting diodes	16.6	21.6	28.3	12.3	15.5	20.6
Readouts	119.9	109.3	127.0	27.9	32.5	38.7
Photovoltaic (solar) cells	1.9	3.3	4.3	1.0	1.6	2.8
TUBES, TOTAL	**666.9**	**785.4**	**846.1**	**1,115.1**	**1,284.0**	**1,408.9**
Cathode-ray tubes (except for TV)	3.9	3.9	4.0	25.9	29.2	33.0
Camera tubes and image intensifiers	20.4	21.0	22.1	45.6	52.1	59.8
Power tubes (below 1 GHz), vacuum, total	30.1	30.1	30.1	60.9	64.7	69.8
Power tubes (below 1 GHz), gas or vapor	7.0	6.9	6.9	19.6	20.9	22.7
Microwave tubes, total	49.0	48.0	52.4	79.1	87.0	94.6
Cooker magnetrons	35.0	33.0	36.7	---	---	---
Receiving tubes	12.8	9.0	8.8	64.5	60.2	53.7
TV picture tubes, black and white	39.6	43.4	44.2	106.4	97.5	89.3
TV picture tubes, color	504.1	623.1	677.6	713.1	872.4	986.0
EQUIPMENT, TOTAL (millions of dollars)	**10,497.1**	**11,671.5**	**13,661.6**	**19,394.0**	**21,411.5**	**23,682.0**
CONSUMER, TOTAL	**4,444.2**	**4,730.6**	**5,446.6**	**6,165.1**	**6,700.8**	**7,121.4**
Audio tape recorders and players	537.6	603.8	635.6	493.8	506.2	521.0
Citizens' band transceivers	4.7	5.8	6.8	---	---	---
Electronic ranges (microwave ovens)	284.2	285.6	312.7	---	---	---
Hi-fi equipment	584.6	772.4	900.9	710.7	769.0	851.1
Musical instruments (organs, electric guitars, etc.)	160.0	178.3	189.3	---	---	---
Phonographs and phono radio combinations	285.1	200.9	166.7	333.3	354.5	366.5
Pocket calculators (four-function, personal)	196.0	149.5	139.3	---	---	---
Radios (including car radios)	170.6	182.8	185.6	714.7	760.2	777.7
Radio/recorder combinations	363.8	347.2	359.1	322.9	351.1	369.4
TV sets, black and white	87.0	82.8	84.5	722.5	701.3	669.3
TV sets, color	1,582.5	1,671.9	1,766.0	2,867.2	3,258.5	3,566.4
Video games	---	---	358.7	---	---	---
Video tape machines (consumer)	67.0	94.7	115.3	---	---	---
Watches and clocks, electronic	121.1	154.9	226.1	---	---	---

	JAPAN			WEST EUROPE		
	1975	1976	1977	1975	1976	1977
COMMUNICATIONS, TOTAL	**1,442.0**	**1,567.4**	**1,867.5**	**3,940.3**	**4,334.7**	**4,944.3**
Broadcast	37.4	55.3	63.0	121.8	128.5	131.8
Cable TV	11.1	11.2	12.1	30.5	39.2	32.5
Closed-circuit TV	16.6	18.8	21.6	80.7	83.2	97.7
Data communications	67.8	69.2	73.8	89.1	107.8	125.2
Facsimile terminals	40.1	53.2	71.8	---	---	---
Intercoms and systems	23.7	26.6	36.8	109.6	118.3	128.4
Laser communications	0.0	1.0	12.3	---	---	---
Microwave relay	99.9	118.4	128.9	154.6	171.2	188.2
Navigation aids, except radar	116.2	122.0	138.5	307.3	327.4	366.6
Paging (public and private)	34.3	38.5	45.1	16.6	19.4	22.3
Radar (airborne, ground, and marine)	88.0	94.3	104.2	575.9	632.9	714.1
Radio communications, except broadcast	365.8	400.7	477.0	656.7	720.5	828.4
Telephone switching, PABX[1]	75.6	88.8	124.1	494.1	525.4	580.9
Telephone switching, public[1]	155.0	163.7	223.0	379.0	493.8	687.1
Telephone and telegraph carrier	292.0	283.8	308.9	892.7	927.5	989.2
Video recorders and players (non-consumer)	18.5	21.9	26.4	31.7	39.6	49.9
COMPUTERS AND RELATED EQUIPMENT, TOTAL	**3,119.4**	**3,673.7**	**4,336.6**	**6,439.2**	**7,285.0**	**8,203.9**
Data processing systems, total[2]	1,959.4	2,271.9	2,633.4	3,379.1	3,821.9	4,286.8
Microcomputers (basic chassis value less than $1,500)	31.8	39.5	53.5	---	---	---
Mini (system value less than $50,000)	117.3	158.0	276.6	299.8	346.7	381.4
Small (up to $420,000)	350.8	406.1	481.1	717.4	822.4	895.9
Medium (up to $1,680,000)	501.8	534.8	578.7	1,289.3	1,430.5	1,542.1
Large (up to $3,360,000)	625.9	732.5	746.2	669.7	755.5	872.9
Giant (more than $3,360,000)	331.8	401.0	497.3	402.9	466.8	594.5
Add-on memories	62.2	69.9	78.1	81.3	92.7	106.4
Data acquisition	64.3	60.7	67.5	129.2	136.3	137.1
Data entry/output	222.7	292.4	377.3	558.5	626.2	704.9
Data storage	390.2	474.9	503.1	1,142.1	1,260.3	1,368.0
Data terminals	228.5	271.6	384.6	293.6	372.4	465.4
Electronic office equipment	153.6	186.9	229.7	786.5	880.7	998.1
Billing and accounting machines	68.5	73.7	98.0	487.3	550.9	619.7
Calculators	85.1	113.2	131.7	228.9	255.5	281.5
Office type	54.2	67.7	72.1	143.8	156.2	166.6
Scientific type	30.9	45.5	59.6	62.2	70.6	80.6
Point-of-sale	38.5	45.4	62.9	68.9	94.5	137.2
INDUSTRIAL, TOTAL	**776.0**	**883.1**	**1,093.2**	**1,302.8**	**1,398.3**	**1,526.7**
Industrial X-ray inspection and gauging	---	---	---	54.6	58.1	61.1
Machine tool controls	---	---	---	88.7	97.6	106.1
Motor controls	122.4	174.8	209.8	---	---	---
Photoelectric controls	---	---	---	45.3	49.1	54.7
Pollution monitoring	66.4	108.4	157.3	24.1	26.3	29.2
Process-control systems	528.0	533.2	652.7	1,020.3	1,092.9	1,195.3
Ultrasonic cleaning and inspection	59.2	66.7	73.4	19.2	20.2	21.8
Welding (with electronic controls)	---	---	---	50.6	54.1	58.5
MEDICAL, TOTAL	**270.0**	**304.0**	**340.0**	**790.1**	**873.3**	**990.6**
Diagnostic equipment, except X-ray	72.6	86.0	103.3	183.3	198.9	220.8
Patient-monitoring	16.7	19.0	21.4	67.4	75.7	77.6
Prosthetic	14.8	16.1	17.7	53.0	58.6	61.6
Surgical support	3.9	4.5	5.1	---	---	---
Therapeutic, except X-ray	6.5	7.5	8.4	38.5	44.1	50.2
X-ray equipment, diagnostic and therapeutic	155.5	170.9	184.1	447.9	496.0	580.4
POWER SUPPLIES, TOTAL	**87.9**	**119.3**	**132.5**	**231.3**	**250.1**	**270.8**
Bench and lab	14.0	23.5	27.2	21.0	22.9	24.6
Industrial heavy-duty	16.2	17.7	19.6	65.2	70.9	77.1
OEM and modular	57.7	78.1	85.7	145.1	156.3	169.1
TEST AND MEASUREMENT, TOTAL	**328.6**	**358.5**	**395.7**	**525.2**	**569.3**	**624.3**
Amplifiers, lab type	6.0	6.4	7.2	9.0	9.3	9.9
Analog voltmeters, ammeters, and multimeters	14.5	15.7	17.8	27.6	27.9	28.3
Analytic instruments, research or clinical	154.8	161.8	175.8	---	---	---
Automatic test equipment (IC, component, and board)	11.3	14.4	16.1	43.5	48.9	54.9
Calibrators and standards, active and passive	8.7	8.9	9.9	16.1	17.2	18.2
Counters and timers	8.2	9.6	11.1	39.7	41.5	44.4
Digital multimeters	7.1	8.2	9.3	38.2	42.2	47.9
Microwave test instruments	7.7	7.9	7.9	42.0	47.3	53.4
Oscillators	8.0	8.9	9.8	18.1	19.2	20.0
Oscillators and accessories	31.6	36.9	41.0	95.4	102.5	111.7
Panel meters	27.0	30.0	34.8	35.6	37.3	41.4
Phase measuring equipment	1.4	2.1	2.4	---	---	---
Power meters	2.9	3.5	4.0	---	---	---
Recorders	19.9	21.7	23.7	89.2	96.8	104.1
Signal generators, analog	10.6	11.6	12.5	33.8	36.6	40.2
Signal generators, synthesizer	4.3	4.7	5.1	12.3	14.6	17.4
Spectrum analyzers (audio to 1 GHz)	4.6	6.2	7.3	24.7	28.0	32.5
AUTOMOTIVE, TOTAL	**29.0**	**34.9**	**49.5**	**—**	**—**	**—**

[1]Electronic or semielectronic. [2]Includes stand-alone minicomputers but not computers that are integral parts of process-control and similar systems. ---No estimate available.

Figures in this chart are based on inputs obtained from an 11-country survey made by *Electronics* in September and October 1976. They show consensus estimates for consumption of components, valued at factory prices, used to produce equipment for both domestic and export markets and for consumption of electronic equipment, with domestic hardware valued at factory sales price and imports at landed cost.

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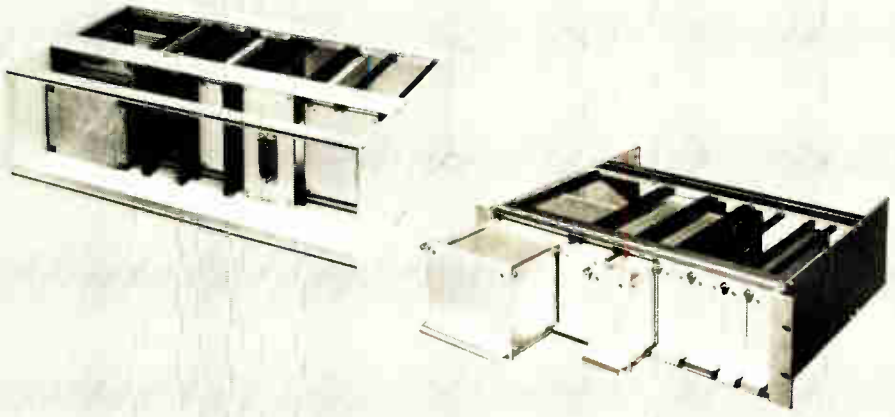

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Gates convert J-K flip-flop to edge-triggered set/reset

by David L. DeFord
Colorado Video Inc., Boulder, Colo.

Set/reset flip-flops with edge-triggered inputs are not readily available in the common logic families, but can be built with a few standard gates and a J-K flip-flop. Both positive- and negative-transition triggering are easily configured with the use of NOR and NAND gating, respectively.

In the schematic below, when the flip-flop is triggered by an active transition at the set (S or $\overline{S}$) input, that input is disabled and the reset (R or $\overline{R}$) input is enabled. The flip-flop can then change state only upon an active transition at the reset input, and once this occurs, the set input is again enabled, completing the cycle.

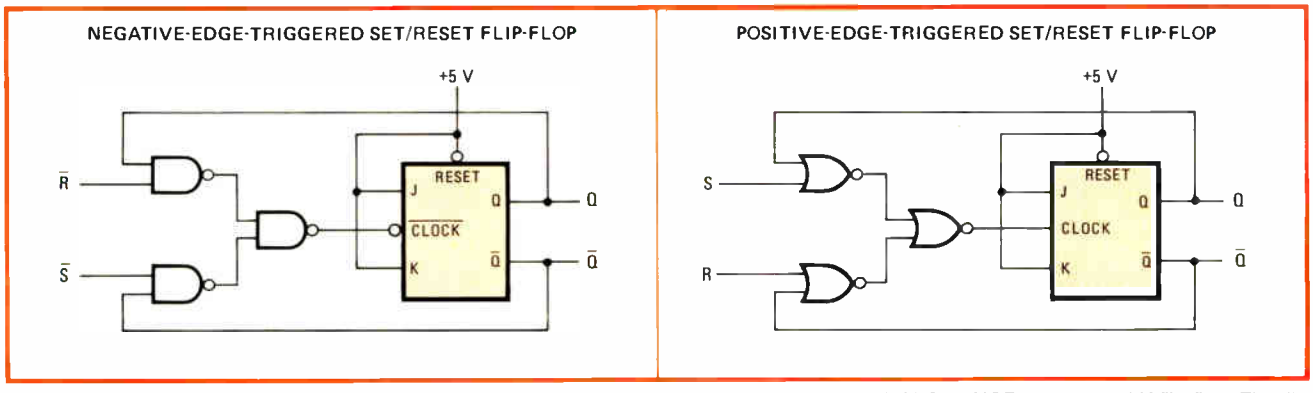
As with all logic circuits, certain minimum pulse widths and timing restrictions must be observed. The input signal must remain stable following an active transition until the new outputs of the flip-flop have settled on the gate inputs. Using standard transistor-transistor-logic devices, the minimum pulse width for the negative-edge-triggered inputs is 65 nanoseconds in the worst case, but typically about 32 ns. In the positive-edge-triggered configuration the worst-case value is 77 ns, but typically 40 ns.

If low-power Schottky TTL is used, the worst-case minimum pulse width is reduced to 45 ns for both circuits and a typical value might be about 25 ns.

Since specifications vary between manufacturers, the minimum pulse widths may be calculated from the actual propagation delays to logic-1 (t_{pd1}) and logic-0 (t_{pd0}) levels of the individual gates and flip-flops. The formulas for the negative- and positive-edge flip-flop are:

$$\downarrow\ t_{w(min)} = t_{pd1}(\text{NAND}) + t_{pd0}(\text{NAND}) + t_{pd0}(\text{FF})$$
$$\uparrow\ t_{w(min)} = t_{pd1}(\text{NOR}) + t_{pd0}(\text{NAND}) + t_{pd1}(\text{FF})$$

Failure to observe the minimum pulse widths can result in extra pulse inputs to the J-K flip-flop, returning it prematurely to its original state. In addition, the set and reset pulses should be separated by at least a minimum pulse-width spacing, since neither of the inputs has priority, and erroneous triggering may otherwise result. □



Getting the edge. Negative- or positive-edge-triggered R/S flip-flops can be made by adding NAND or NOR gates to a J-K flip-flop. The flip-flop at left must be negative-edge triggered, like the 7473, while the unit at right must be positive-edge triggered, like the 7470.

Multiplexer chip forms majority-vote circuit

by Edwin P. Crabbe Jr.
GTE Automatic Electric Laboratories, Northlake, Ill.

□ An eight-channel digital multiplexer chip such as the 74151 can make an efficient three-input majority-vote circuit in which the output-logic level always agrees with the majority of the input levels. The uses of such a circuit range from the innocuous—decision making for electronic games—to the critical—reliability enhancement of triply redundant fail-safe systems.

As shown in the schematic of Fig. 1, the votes are registered at data-select lines A, B, and C of the multiplexer, and the data inputs, $D_0 - D_7$ are wired so as to produce an output at Y in accordance with the truth table.

With the addition of a few inverters, the system can be equipped with a master override, vesting any of the three voters with the power of veto. Figure 2 details the setup. A logic 1 at master-input A causes an output in agreement with the A vote, regardless of the votes of B and C.

Similarly, a logic 1 at master-input B effects an output equal to B's vote, and so on. With all the master inputs low, the output is again the majority of the inputs.

Systems with more than three voting inputs can only be practically implemented with a programable read-only memory, as majority-vote circuits cannot be cascaded. □

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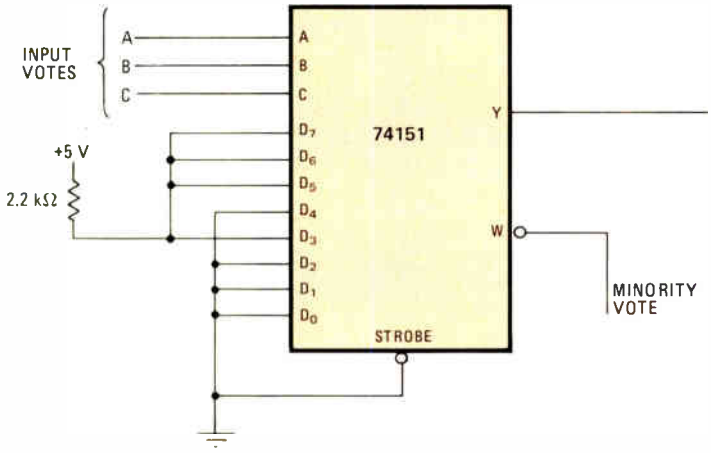
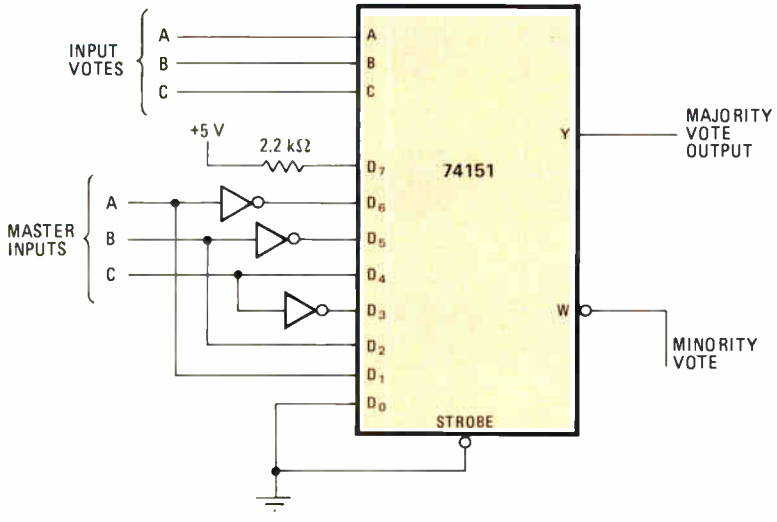


TRUTH TABLE			
VOTING INPUTS			Y OUTPUT
A	B	C	
0	0	X	0
0	X	0	0
X	0	0	0
1	1	X	1
1	X	1	1
X	1	1	1
X = DON'T CARE			

1. Majority rules. The three binary address lines are the inputs to a majority-vote circuit based on a 74151 multiplexer. The output at Y is in agreement with the majority of the inputs, and the output at W, complementary to Y, is the minority vote.



TRUTH TABLE						
VOTING INPUTS			MASTER INPUTS			Y OUTPUT
A	B	C	A	B	C	
0	0	X	0	0	0	0
0	X	0	0	0	0	0
X	0	0	0	0	0	0
1	1	X	0	0	0	1
1	X	1	0	0	0	1
X	1	1	0	0	0	1
0	X	X	1	0	0	0
1	X	X	1	0	0	1
X	0	X	0	1	0	0
X	1	X	0	1	0	1
X	X	0	0	0	1	0
X	X	1	0	0	1	1
X = DON'T CARE						

2. Veto power. Adding a few inverters to the circuit provides it with master-override capabilities. Whichever input is selected as master, the output always agrees with the vote of that input, regardless of the votes of the other two.

Simple logic single-steps SC/MP microprocessor

by Richard Gersthofer
Industrial Automation and Research, Vancouver, B. C.

Single-cycle and single-instruction processing capability in a microprocessor system is invaluable for hardware troubleshooting as well as program debugging. An easy-to-build controller provides this capability.

When the mode switch of the controller is set to single cycle, all the stages of instruction processing may be observed by monitoring the logic states of the pins on the microprocessor chip. Alternatively, in the single-instruc-

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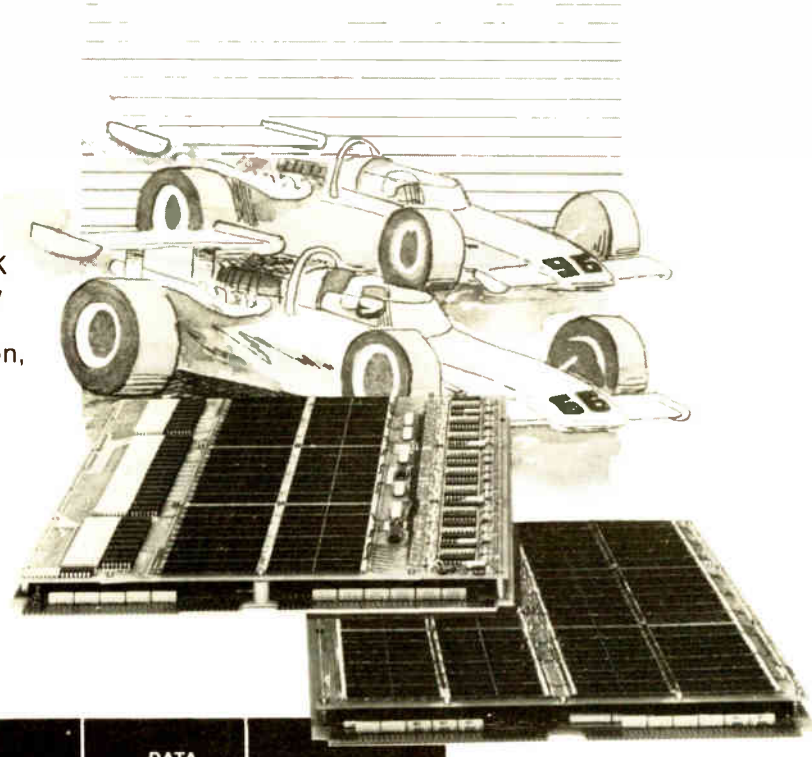

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MODEL	696	698	Micro 3000 Q.D.	Micro 3000 Q.D.	Store 1680		OR-103	OR-103
MEMORY SIZE	16K	32K	16K	32K	16K	32K	16K	32K
CYCLE TIME	650	650	650	850	650		650	750
ACCESS TIME	250	250	270	300	280		265	300
PHYSICAL SIZE	11.75x15.4 x1.0	11.75x15.4 x1.0	11.75x15.4 x1.0	11.75x15.4 x1.0	11.75x15.4 x1.0		11.5x13.7 x1.0	11.5x13.7 x1.0
COMPATIBILITY 16K TO 32K	YES		NO		NO		NO	

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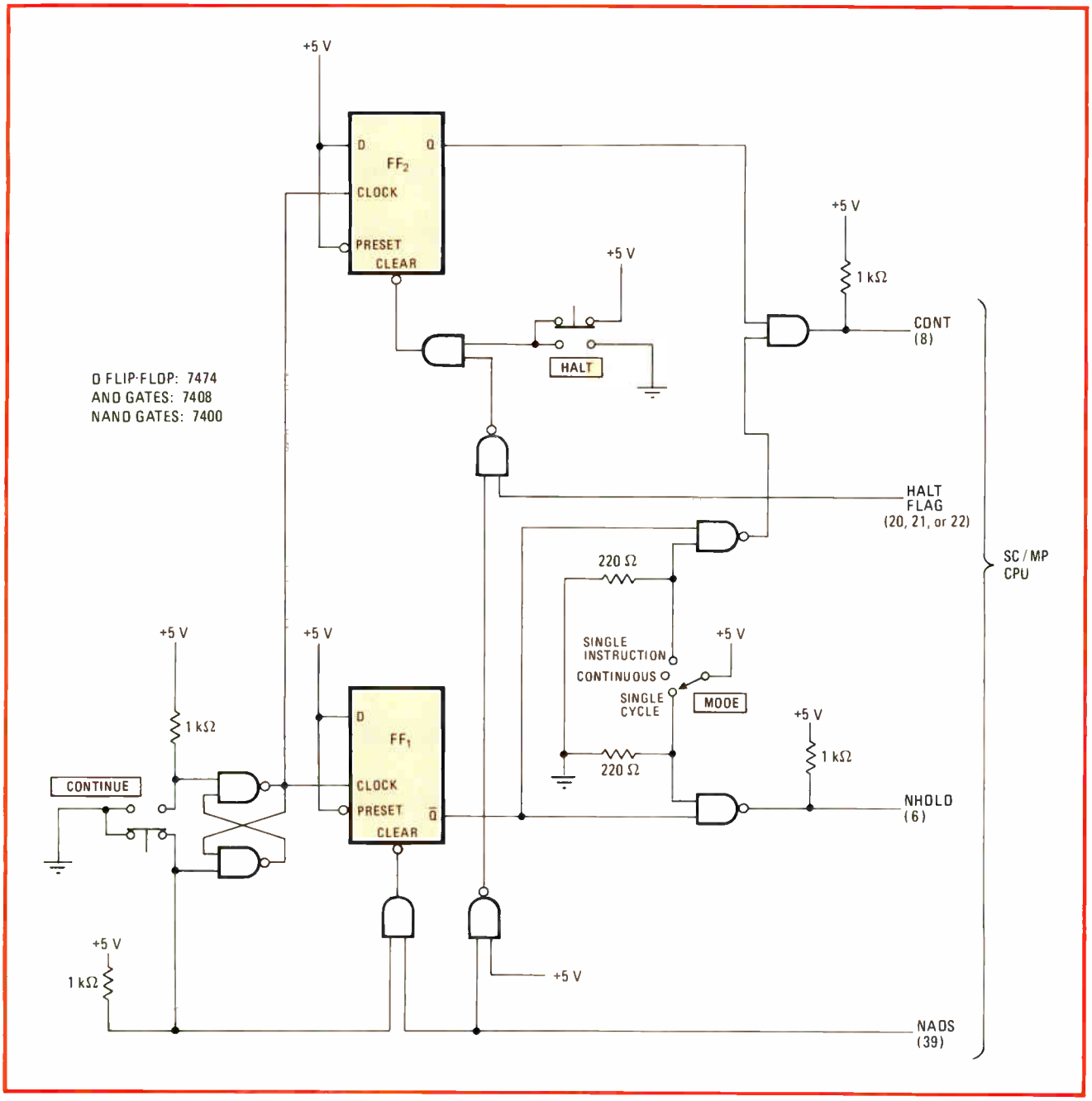
tion mode, only the effects of each instruction may be observed.

Designed for use with the SC/MP central processing unit, the controller requires no initialization. As shown in the figure, the circuit has HALT and CONTINUE push buttons, in addition to switching between single-cycle, single-instruction, and continuous modes. Program execution may be halted with the push button or under software control by pulsing the halt flag line.

In the single-cycle mode, the continue input line, CONT, of the CPU is held at logic 1. This enables normal execution of the program stored in external memory. The input/output cycle extend input, NHOLD, is kept at logic 0. Pressing the CONTINUE button toggles the first flip-flop, FF_1, driving the NHOLD high, and permitting program execution. After executing one cycle, the CPU resets FF_1 by pulsing the address strobe output line, NADS, sending the NHOLD low again. The cycle time requires only a few microseconds.

In the single-instruction mode, the NHOLD line is held at logic 1 while the CONT line is kept at logic 0. Pressing the continue button toggles the second flip-flop, FF_2, driving the CONT line high, and the CPU continues execution. After completion of one instruction, the processor resets FF_2 by pulsing its NADS line. CONT goes low until the CONTINUE button is again pressed. □



SC/MP system controller. Single-stepping through a program helps locate hardware or software errors. Circuit runs the microprocessor in single-cycle, single-instruction, or continuous mode, controlled by two push buttons. Halt may also be facilitated under software control, by having the SC/MP central processing unit pulse its halt flag line.

Chip scans keyboard without hardware interface

by Dan Hammond
Mostek Corp., Carrollton, Texas

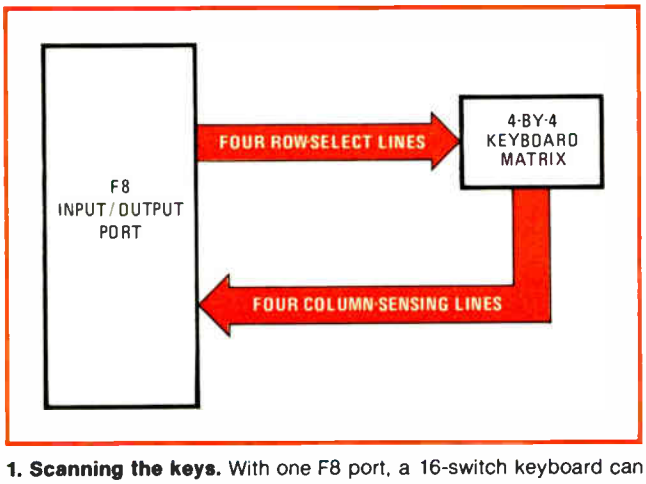
☐ Hardware to mate keyboards and microprocessors is like the grease that oils the squeaky wheel—necessary, but it would be nice to get along without it. It is possible to eliminate the hardware by taking advantage of the software of the F8 microprocessor.

Scanning the keyboard directly from one port of the microprocessor even can identify a single key touch from multiple closure signals and can correctly process simultaneous touches of more than one key. The microprocessor's secret is its software and the bidirectional property of its input/output ports, which allows transfer of 8-bit parallel data to or from the keyboard.

In scanning the 4-by-4 switch matrix of Fig. 1, the F8's central-processing-unit chip turns on one of the four row-select bits, supplying a ground return for one row of switches. The CPU then senses column data. The four column bits will indicate the condition of all four switches in the selected row. Each of the four rows is selected, one at a time, to continously provide the current status of all 16 switches.

The column data is transmitted through 4 bits of an I/O port to the CPU's accumulator register. The accumulator is an 8-bit register that functions as a holding register for arithmetic or logic or, in this case, I/O operations. Data in the accumulator may be transferred to the CPU's 64 8-bit scratchpad registers, which are the basic memory in this application.

Bounce, or multiple momentary switch closures, is a problem encountered with mechanical key switches. It produces the wave shapes of Fig. 2, rather than the step voltages desired. To prevent multiple detections of the switch closure, the bounce must be filtered out.



1. Scanning the keys. With one F8 port, a 16-switch keyboard can be scanned with no external hardware. The bidirectional property of the F8 microprocessor's I/O ports makes this possible.

Debouncing with software

A conventional solution is to use a resistance-capacitance filter to try to eliminate it. However, the F8 scanning technique filters the switch bounce in software by taking multiple samples of the switch status to verify key depression and release. Since the software must scan all switches continuously, a scratchpad register (or half of one) can maintain the status of each key switch.

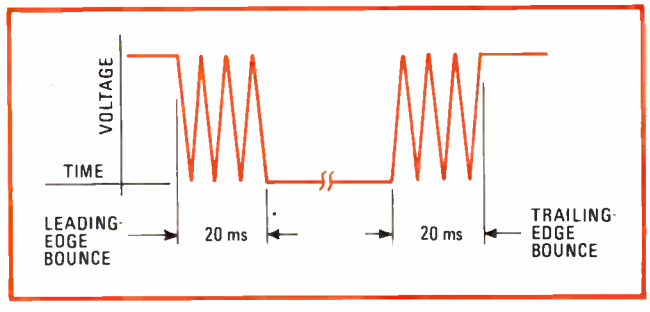
Another common requirement with keyboards is detection of all closures when more than one switch is depressed at a time. The F8's scanning can meet this requirement, which is known as N-key rollover. Since all switches are continuously scanned, the condition of each switch is always available to the processor.

Hardware design

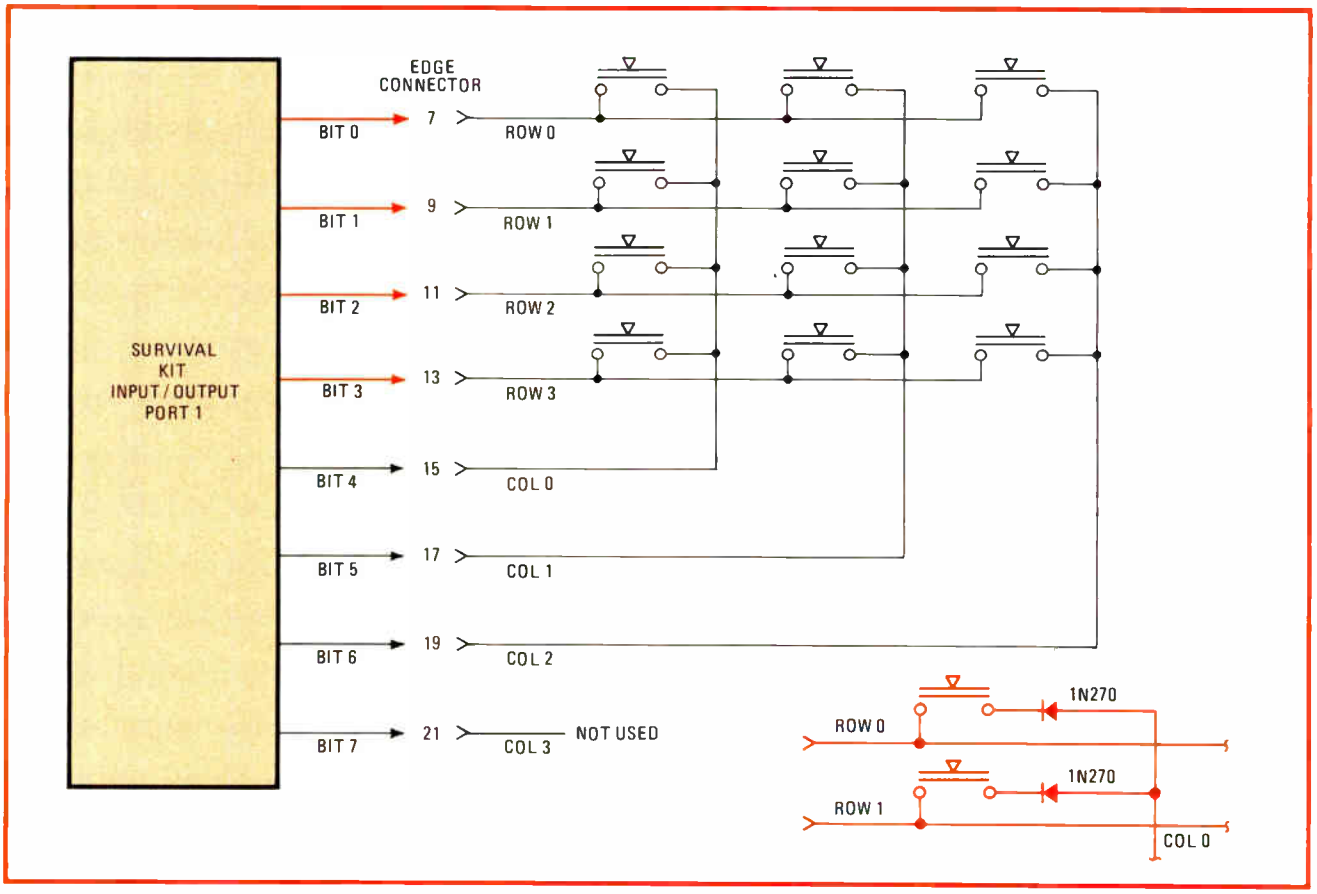
The 4-by-4 keyboard matrix of Fig. 1 is the largest one that can interface directly with one F8 I/O port without external hardware. But, to prove out the hardware and software of keyboard scanning, the more popular 4-by-3 matrix was used in a breadboard with the F8 Survival Kit (Fig. 3). This is a completely wired microprocessor-evaluation kit on a printed-circuit card with a 3850 CPU, a 3851 PSU (program storage unit), a 3853 SMI (static memory interface), a static 1,024-byte random-access memory, and a teletype-terminal interface.

This breadboard provides N-key rollover input to the processor with one exception. Depressing three keys simultaneously to form an L configuration causes an erroneous input. The addition of germanium diodes, shown in the insert of Fig. 3 on the column pole of each switch, lets the microprocessor recognize this configuration as an N-key rollover.

To sense the condition of row 0, the software produces a hex 01 (binary 0000 0001) from storage in the CPU chip to Port 1. The state of bits 4, 5, and 6 (columns 0, 1,



2. Switch bounce. Mechanical key switches have more than one closure upon actuation or release. Ordinarily, RC filters are used to minimize bounce, but the F8's software scanning technique filters bounce by taking multiple samples of the switches' conditions.



3. N-key rollover. The F8 Survival Kit uses a scanning technique to sense key actuation, filter key switch bounce and to provide N-key rollover. To prevent an erroneous input when three keys are depressed simultaneously in an L configuration, one germanium diode should be added on the column pole of each switch, as shown in the inset. The diodes prevent a false logic condition.

and 2) will have a logic level of 1 when the respective switches in row 0 are closed and a logic level of 0 when open. The other three rows are read similarly. Since the F8's I/O ports contain internal pull-up resistors to account for logic 0 levels, no pull-up resistors need be wired to the key switches.

Keyboard software

Scratchpad registers of the CPU maintain the current status for each switch. When a switch is inactive, it has a status of 0 in its register. For the switch to be processed, three consecutive scans must show switch closure.

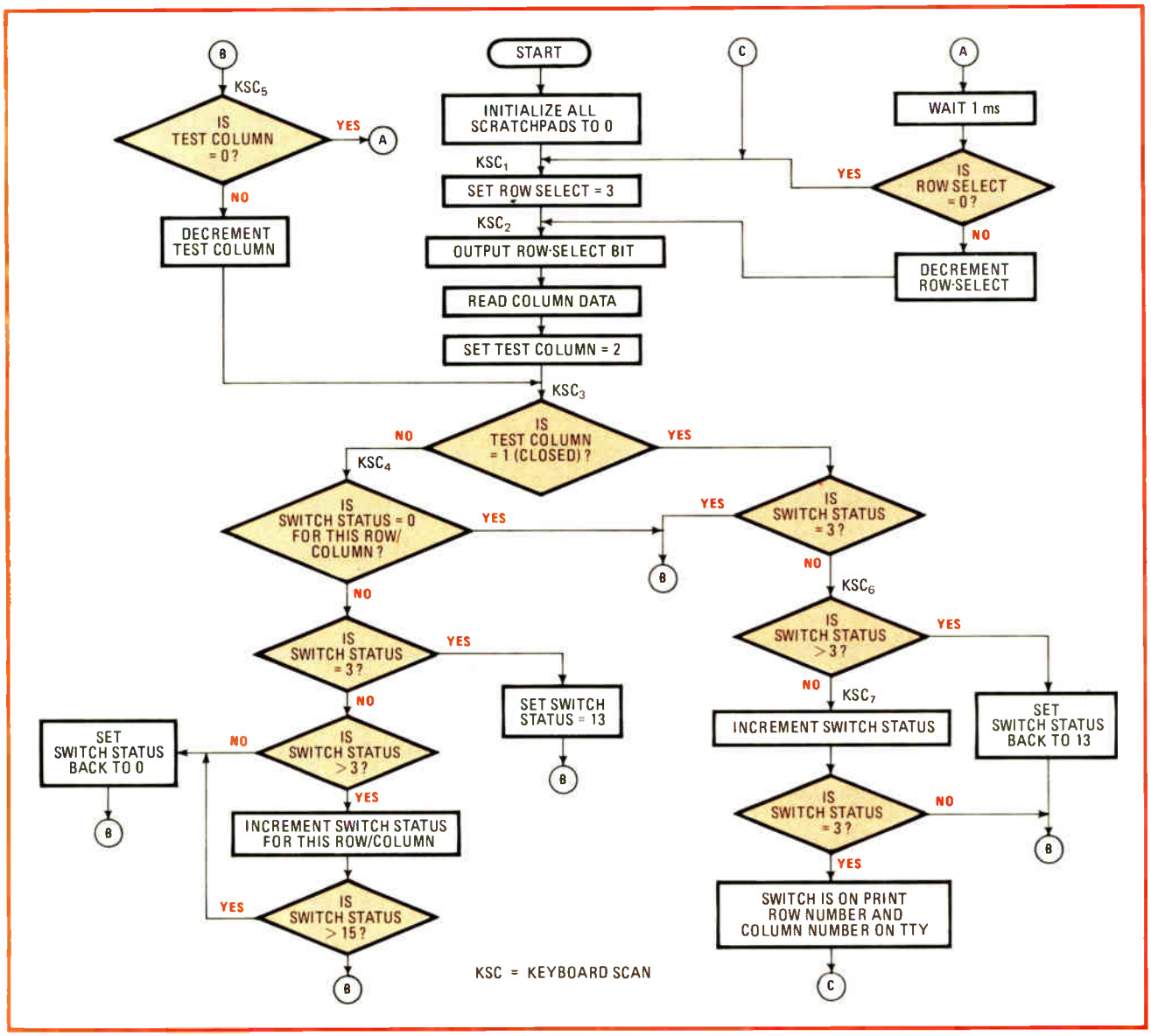
When a closed switch is first sensed, the CPU increments the register status from 0 to 1. In succeeding scans, software decisions either increment the status (if sensed to be closed) until it reaches 3 or reset it to 0 (if sensed to be open). The central processing unit then processes the switch closure, which, in this example, means the column number and row number are printed on the TTY terminal.

The register maintains a status of 3 until the first time the switch is sensed as being open. Then its status is set to 13. Three consecutive scans with the switch open are necessary to get the switch back to inactive status (0). This is accomplished by incrementing the status (if sensed open) until it reaches 15 or resetting the status to 13 (if sensed closed). If the status reaches 15, the software resets it to 0. As long as bounce occurs, the status will remain at, or will be reset to, 13.

Software flow

The flow chart of Fig. 4 shows the software logic, and the software looping necessary to institute the full scanning program and is exactly equivalent to a 75-instruction program. At the end of each row scan, there is a 1-millisecond delay that effects an interscan delay of 4 ms for each switch. To read a switch, it must be scanned at least three times. So it must be solidly on for 8 ms before being processed and solidly off 8 ms before becoming inactive. This insures that the switch status will only be processed once per depression. This debounce time sets the maximum keyboard entry rate for a given switch at one entry each 24 ms.

For some microprocessor applications, it may be



4. Scan routine. The F8's decisions and timing required for software sensing and debouncing of the 4-by-3 switch matrix proceed as shown. The KSC_N, KSC_I, KSC_J symbols are the keyboard scanning intervals used to sense the condition of a particular switch.

necessary to add more interfacing integrated circuits to expand the keyboard size. However, the basic principle of maximum use of software to avoid extra hardware still applies.

When more than 16 switches are needed in a keyboard, an additional chip must be used since the input/output ports on the F-8 are 8 bits. Adding a 4-to-16 decoder to select one of 16 rows permits scanning of as many as 64 switches.

Many off-the-shelf 4-by-3 and 4-by-4 keyboards have a common pole (the sense line). Such keyboards can be scanned with a 4-bit code selecting one of as many as 16 switches. The switch selection is decoded by a 4-to-16 decoder, which supplies a ground return to the selected switch. The CPU uses the common line to sense the condition of the switch and to transfer the data back through the I/O port to storage.

If more ports can be assigned to the keyboard interface, other options may become advantageous. For example, with two 8-bit ports, 16 switches can be read without scanning.

The basic requirements of sampling switch debounce and N-key rollover will remain in all three alternatives discussed. The best approach to a given design application will be determined by the system requirements and the architecture and software of the microprocessor. □

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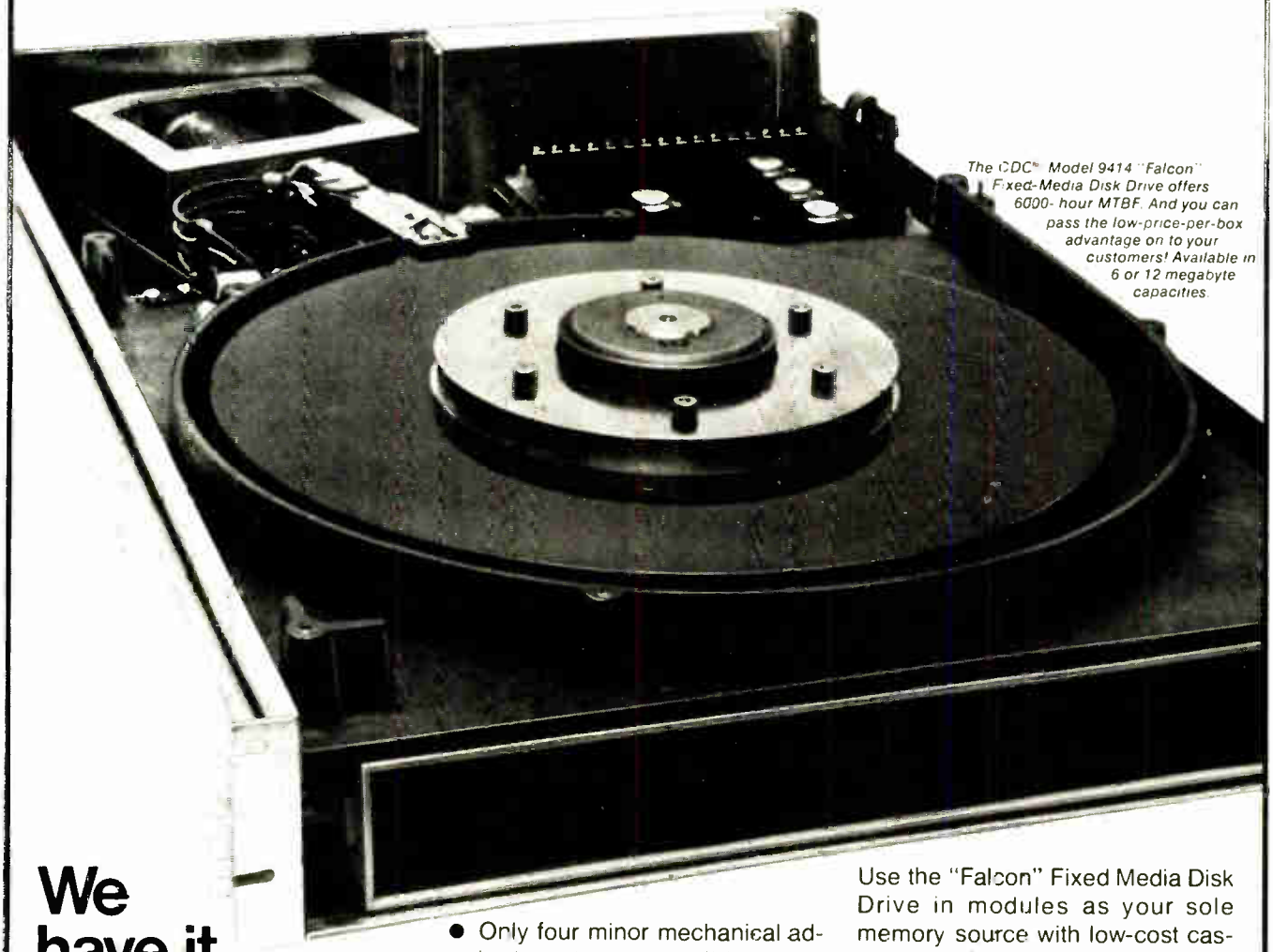

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Current indicator is overload-proof

by Henno Normet
Diversified Electronics Inc., Evansville, Ill.

A current indicator, unlike a simple pilot light, always tells you when a device is drawing power. Just a few parts—a light-emitting diode, a low-voltage diode, and a transformer wound on a toroidal core—will build one that can indicate alternating currents of well over 100 amperes with impunity. This indicator draws negligible power itself and, not being in electrical contact with the line, is isolated from it by several thousand volts.

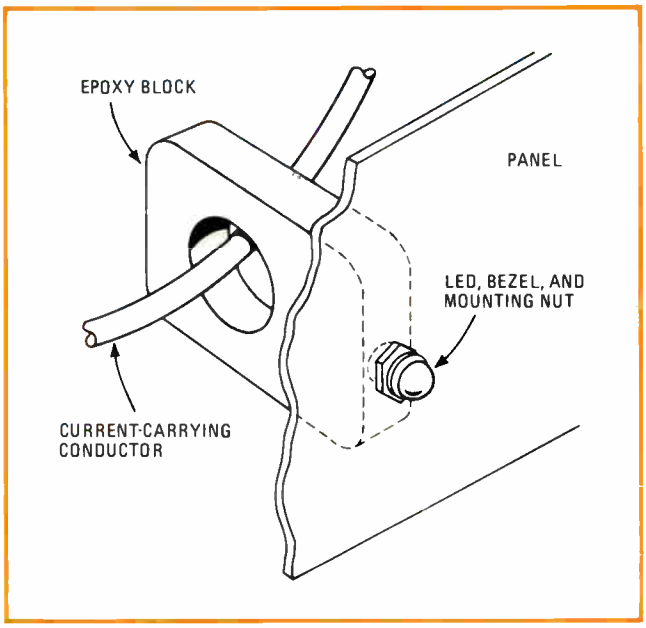
The transformer's primary winding is simply the current-carrying conductor passed through the hole in the toroid (Fig. 1). The secondary winding is approximately 200 turns of #28 AWG enameled wire, and it drives the LED directly. The low-voltage diode is inversely parallel to the LED, to protect it from the high reverse voltages that appear on alternate half cycles when the transformer is not loaded.

With the component values shown, the LED starts to glow with nearly 2 A flowing through the primary, and it reaches full brightness with roughly 10 A. As the current soars beyond 10 A, the transformer core saturates, and current in the secondary winding supplying the LED levels off at a safe value.

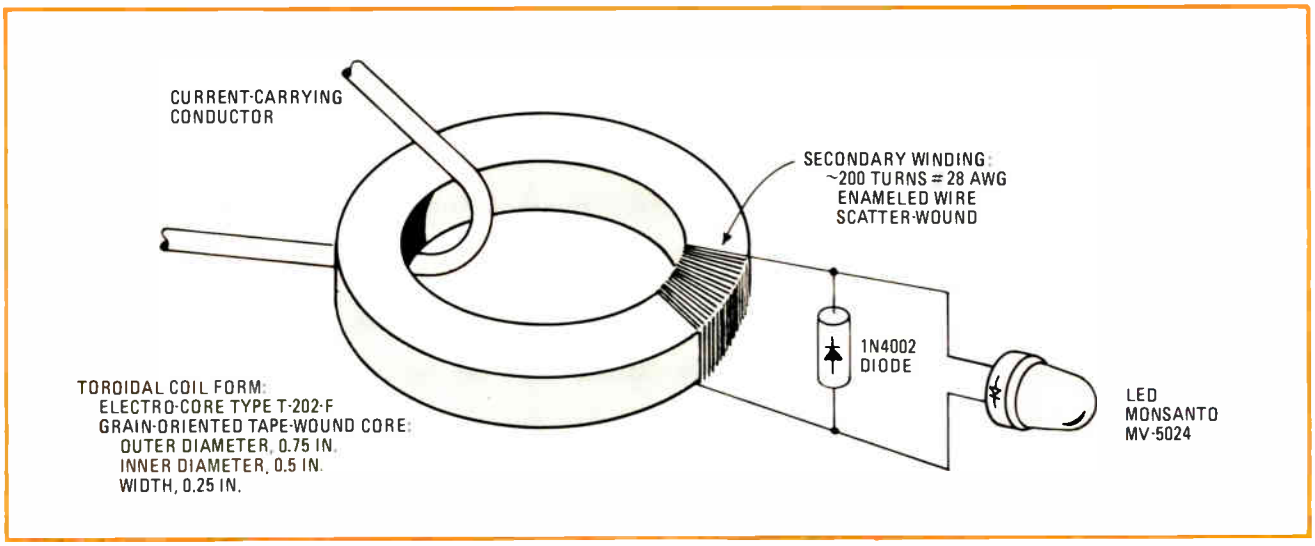
A more sensitive indicator can be obtained by increasing the number of primary turns. Five turns on the primary increases sensitivity five times.

For a practical housing, which makes the indicator easy to mount, pot the transformer and diodes in epoxy (Fig. 2). For this application, a LED with a threaded bushing such as a Dialco Diode-Lite should be used. In any event, when potting the circuit, take care to expose the threaded-bushing bezel of the LED and to leave the hole in the transformer unobstructed.

The switching threshold of the current indicator can be varied over a range of about 2 to 10 A by shunting the LED with a resistor of about 20 to 100 ohms. It should be noted that the current transformer is a far more efficient load indicator than a current shunt, which could dissipate as much as 30 watts when monitoring a 10-A current. □



1. Pot it. Potting the transformer and two diodes in epoxy creates a completely self-contained indicator unit. The bushing-type LED must have no built-in current-limiting resistor. Remember to leave the bushing exposed and the hole in the transformer core unblocked.



2. Overload-proof. Use of a simple current transformer, wound on a toroidal core, proofs this current indicator against burnout at currents as high as 100 amperes. Saturation of core limits LED current to safe value, and indicator is isolated from line by several thousand volts.

Computer/cassette interface takes tone from clock

by Alan Sahakian
Racine, Wisc.

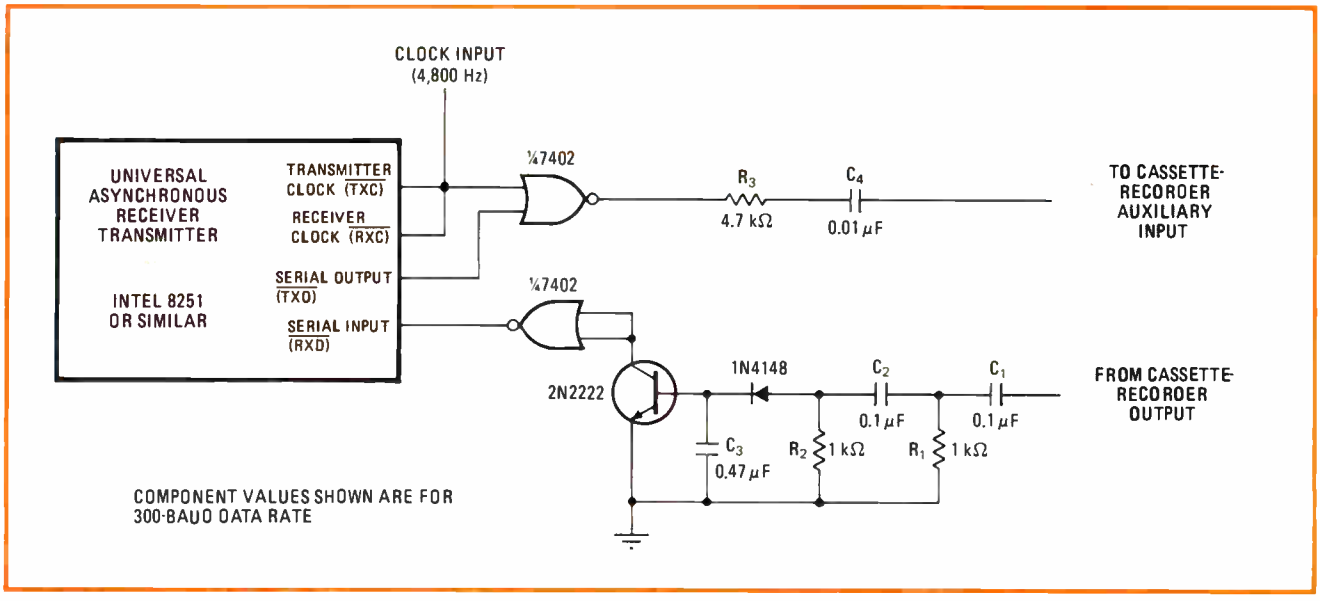
This computer/cassette-recorder interface, which simply gates a tone on and off, is far less expensive than conventional interfaces using frequency-shift keying. Although FSK systems afford the flexibility and reliability of two additional states—no carrier and both tones—this circuit's two states will suffice for many applications, such as microprocessor mass storage. And since it requires no tone generator, much less decoding circuitry, the design is cost-effective.

In the figure, a universal asynchronous receiver/transmitter (UART), which converts parallel microprocessor data to serial format and back again, is connected through a simple network to the cassette recorder. The UART used in this design must be compatible with transistor-transistor logic. A good choice is the Intel 8251, which is, in fact, a universal synchronous/asynchronous receiver transmitter. The tone recorded is actually the clock supplying the UART, an arrangement that not only reduces component count but serves to record the baud rate on the tape, and means that the circuit never requires adjustment or calibration.

In the record (or write) mode, the serial output of the UART switches the 4,800-hertz clock frequency on and off through a 7402 two-input NOR gate, and the R_3-C_4 combination couples and attenuates the signal.

In the playback (or read) mode, the signal from the cassette is conditioned by the high-pass network made up of R_1, R_2, C_1, and C_2, to improve transient response. The diode detector, together with C_3, removes the carrier from the modulated signal. The transistor amplifies and inverts the signal, driving an additional NOR gate. This extra gate, wired as an inverter, buffers the signal, as well as getting it back to its original phase.

In this use of the 8251 UART, a clock frequency 16 times the baud rate is chosen, so that a typical rate of 300 baud is produced from a clock of 4,800 Hz, well within the bandpass of most cassette recorders. □



Easy interface. Far simpler than frequency-shift-keying systems, this computer/cassette-recorder interface does not even need a tone generator—the clock to the universal asynchronous receiver/transmitter provides it with a tone, which is gated on and off.

Calculator notes

Programing the SR-52 for engineering-format display

by Daniel Ozick,
New Rochelle, N.Y.

The display of numbers in engineering format—scientific notation in which the exponent is an integral multiple of three—is a convenient feature of some calculators. Electrical engineers in particular, whose proficiency in prefixes such as tera-, giga-, femto-, and atto- merits a minor in linguistics, will appreciate this quick SR-52 program that formats the display in engineering notation.

Shown in the table, the program is a 78-step software module that can be nested within other programs to provide the engineering display. Since all transfers are made to labels, the program is position-independent within the registers.

When given a number, the main routine, labeled E′, stores the engineering-notation exponent in register R02 and the mantissa in register R03. When the program halts, the mantissa is displayed; pressing the E label

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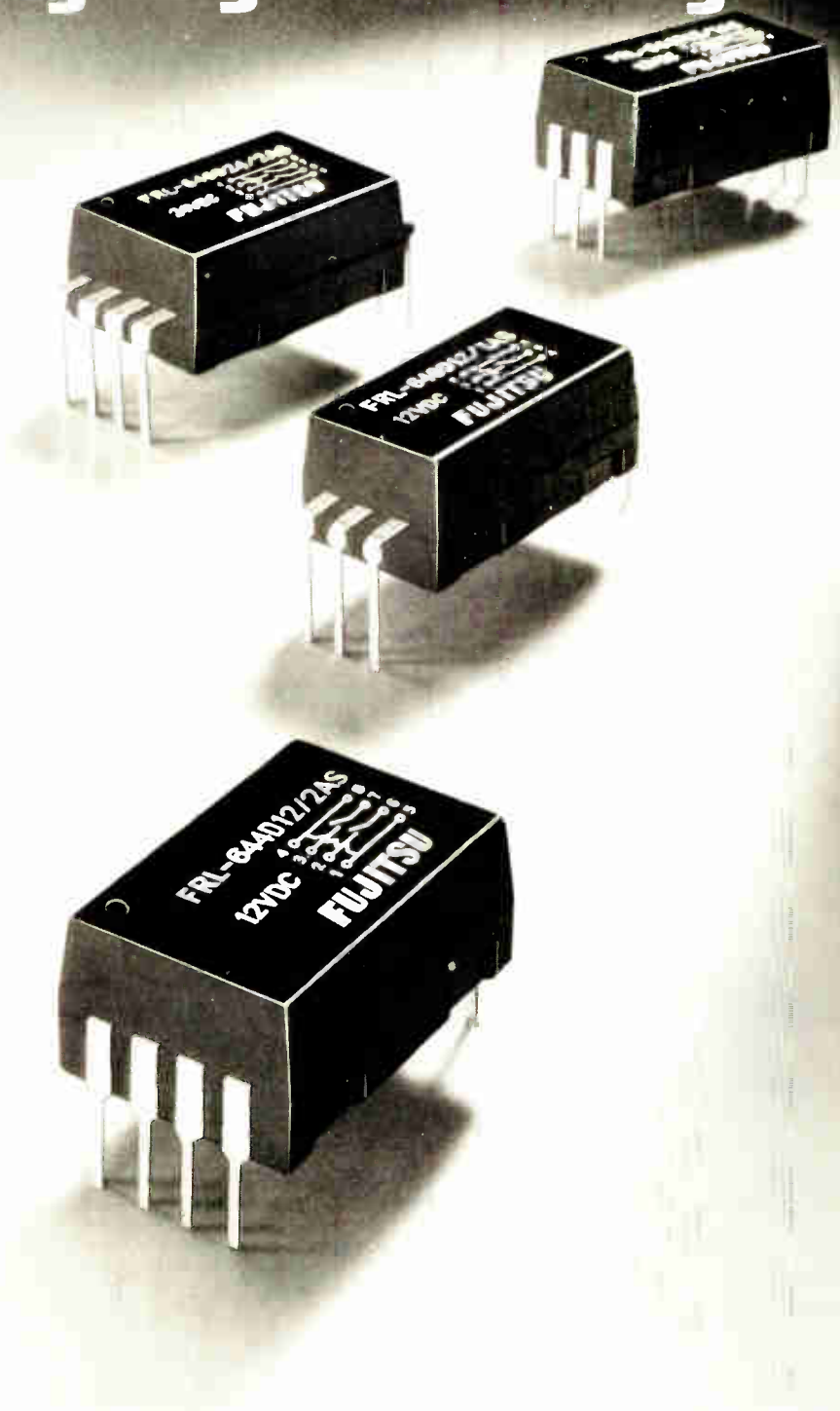

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Contact Arrangement	Grid	Package*	Coil Voltage
1 Form A	Compact (FRL-644)	Standard	5/6/12/24V DC
		Shielded	
	Standard (FRL-648)	Standard	
		Shielded	
1 Form B	Compact (FRL-644)	Standard	5/6/12/24V DC
		Shielded	
	Standard (FRL-648)	Standard	
		Shielded	
2 Form A	Compact (FRL-644)	Standard	5/6/12/24V DC
		Shielded	
	Standard (FRL-648)	Standard	
		Shielded	
2 Form B	Compact (FRL-644)	Standard	5/6/12/24V DC
		Shielded	
	Standard (FRL-648)	Standard	
		Shielded	

*Models with clamping diodes to be available soon.

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Circle 116 on reader service card

displays the exponent, and pressing D recalls the mantissa.

The program can be tailored to suit the user's needs. If in a capacitance calculation, for example, the less commonly used unit of nanofarads (10^{-9} F) is not desired, the following steps could be inserted beginning at location 047:

RCL 02 + 9 =
INV if zro 3′
3 SUM 02 LBL 3′

This substitutes micro- units for nano- units and advances the remainder of the program 15 locations. □

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

SR-52 PROGRAM FOR ENGINEERING NOTATION DISPLAY

LOC	CODE	KEY	COMMENTS
000	46	LBL	Adjusts display for rounding operations and stores value to be converted in R01
	10	E′	
	57	fix	
	00	0	
	42	STO	
005	00	0	
	01	1	
	90	if zro	Avoids "log 0"
	87	1′	
	28	log	Finds integer value of exponent in scientific notation and stores in R
010	24	CE	
	22	INV	
	52	EE	
	75	−	
	93	.	
015	05	5	
	95	=	
	52	EE	
	22	INV	
	52	EE	
020	42	STO	
	00	0	
	02	2	
	55	÷	Provides 3-way branching: scientific-notation exponent may equal 3n, 3n+1, or 3n+2 where n is an integer
	03	3	
025	75	−	
	42	STO	
	52	EE	
	22	INV	
	52	EE	
030	95	=	
	90	if zro	
	87	1′	
	80	if pos	
	88	2′	
035	01	1	Causes exponent value in R02
	85	+	
	46	LBL	
	88	2′	
	01	1	

LOC	CODE	KEY	COMMENTS
040	95	=	to be an integral multiple of 3
	22	INV	
	44	SUM	
	00	0	
	02	2	
045	46	LBL	Calculates value of mantissa for display in engineering notation and stores it in R03 for possible re-display
	87	1′	
	43	RCL	
	00	0	
	01	1	
050	55	÷	
	01	1	
	00	0	
	45	y^x	
	43	RCL	
055	00	0	
	02	2	
	95	=	
	42	STO	
	00	0	
060	03	3	Restores display to "initial mantissa format" and halts, displaying eng.-not mantissa
	22	INV	
	57	fix	
	22	INV	
	52	EE	
065	81	HLT	
	46	LBL	Displays exponent for engineering notation
	15	E	
	43	RCL	
	00	0	
070	02	2	
	81	HLT	
	46	LBL	Recalls value of engineering notation mantissa
	14	D	
	43	RCL	
075	00	0	
	03	3	
	81	HLT	

LABELS	
D	RCL mantissa
E	Exponent
E′	Convert

REGISTERS	
R01	Number to be converted
R02	Value of exponent
R03	Value of mantissa

Engineer's newsletter

Here's to fuss-free inversion

A spare inverter gate can be a handy item to have around when you're trying to debug your logic design. But finding one on the board and then having to connect or disconnect it whenever you want to switch between the normal and invert modes can be bothersome. Instead, says Robert A. Dougherty of Dunedin, Fla., **build an easy-to-use inverter from an exclusive-OR gate and a subminiature single-pole double-throw slide switch.**

First, break the line to be inverted, bridging the gap with one input of the gate and its output. Then tie the other gate input to the switch's center contact, ground one outer contact (the normal position), and wire the other outer contact (invert) to the power supply through a resistor.

With the switch in its normal position, the switched gate input is pulled low and the gate's output follows the circuit input. With the switch in the invert position, the switched gate input is high and the output is the complement of the input. If the exclusive-OR gate is the quad 7486 package, then use a 5.1-kΩ power-supply resistor, adds Dougherty.

Ringing 40+ changes on the decibel

Think you know what dB means? Sure, it's the log to the base 10 of a power ratio, but there are also more than 40 other specific ways it's presently being used, says Peter N. Saveskie of TAI Inc. For example, dBc stands for dB Collins, a ratio with an 0-dB reference that is 0.775 volt across any impedance, while **dBe is a Siemens term based on 0.775 v across a low impedance.** Volume 5, No. 12 of this company's newsletter, "Consuletter International," defines such terms. If you'd like a copy, write to TAI at 7700 Arlington Blvd., P.O. Box 24, Falls Church, Va. 22046.

Are you getting the salary you should?

How does your salary stack up against the income ranges newly recommended by the National Society of Professional Engineers? The NSPE works from **a base salary of $14,300, which it says represents the most currently available average annual starting range for new engineering graduates,** and it sets up eight classes of engineers. The group then notes each class's income range expressed as a percentage of the base salary. Four ranges, with typical titles, are as follows:

- Junior engineer: 90% to 130%
- Senior engineer: 185% to 255%
- Principal engineer: 260% to 360%
- Chief engineer: 300% to 450%

For a copy, ask for publication no. 0006 from the NSPE at 2029 K St. N.W., Washington, D.C. 20006.

Inch by inch, millimeter by millimeter

Ready or not, the U.S. is on its way to metrification. Next year's American National Metric Council Conference and Exposition, set for March 21 to 23 at the McCormick Inn in Chicago, has a theme of "Transmetric," referring to the present period of transition to the metric system. The U.S. Metric Board may be operational by mid-1977, and the conference will include a session on the board's role and responsibility. For more details of the conference, write to ANMC at 1625 Massachusetts Ave., Washington, D.C. 20036.

Stephen E. Scrupski

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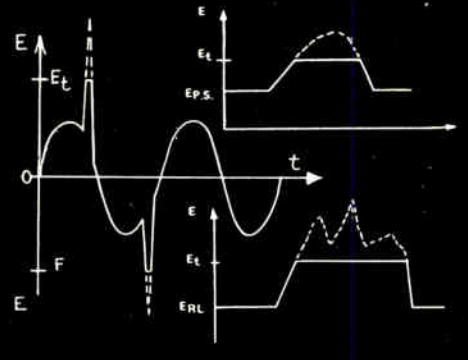
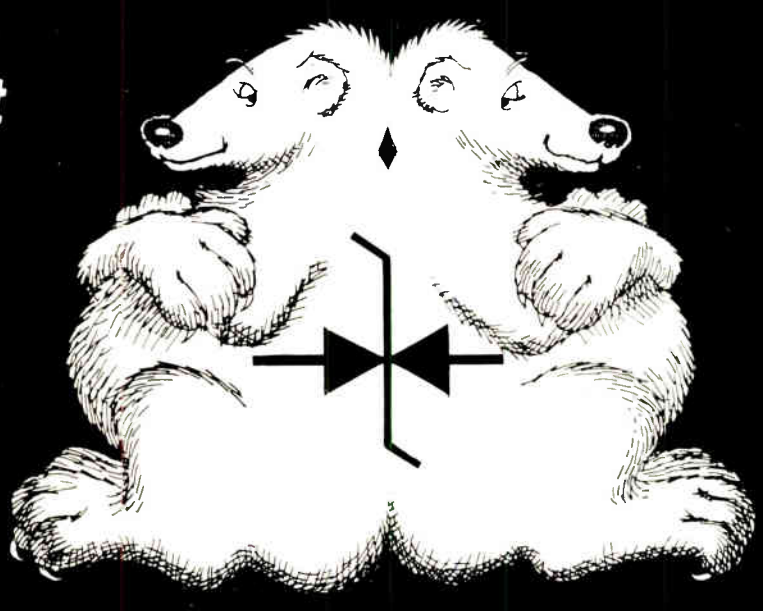
New! Bi-polarity Silicon Transient Suppressors!





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Types: IN6102 through IN6137
Break down Voltage V(BR):
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Peak Surge Voltage (Vsm): 11.0 to 286.0V
Peak Surge Current (Ism): 45.4 to 1.7A
Temperature Coefficient of (VBR): .05 to.11%/°C
Case Size (Max.): .140" D x .165" L

1500 Watt
Peak Pulse Power

Types: 1N6138 through 1N6173
Breakdown Voltage V(BR):
From 6.8 to 200 Vdc ±10%
Peak Surge Voltage (Vsm): 11.0 to 286.0V
Peak Surge Current (Ism): 136.4 to 5.2A
Temperature Coefficient of V(BR): .05 to.11%/°C
Case Size (Max.) .180" D x .165" L

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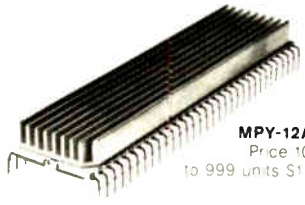

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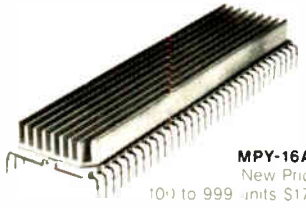

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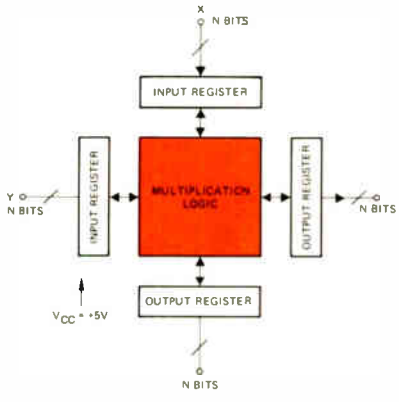

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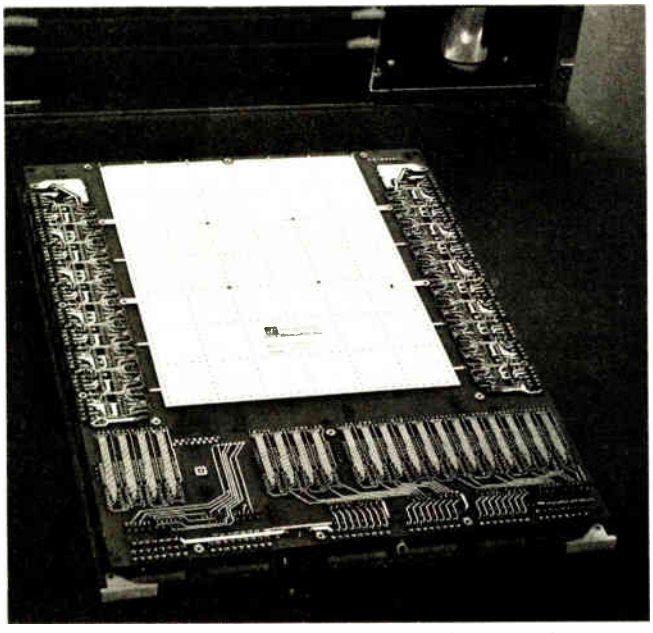

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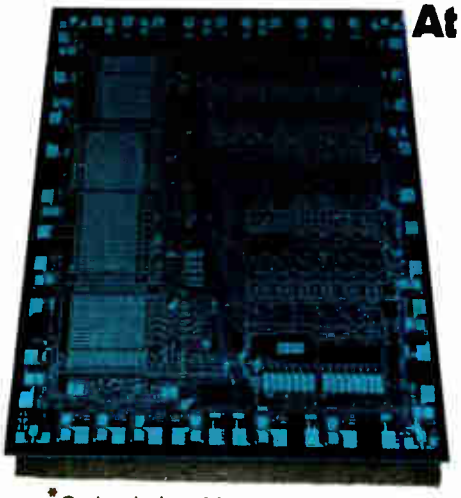

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Tiny packaged ICs replace chips

Family of 17 analog circuits is expected to replace naked chips in hybrid assemblies: digital logic circuits will be next

by John Gosch, Frankfurt bureau manager

With its marketing sights set on manufacturers of hybrid circuits, Philips in the Netherlands is about to announce a family of integrated circuits that comes in a package less than 10 millimeters long and 4 mm wide. The SO series of devices is intended to replace the naked chips used in hybrid circuits.

Circuit assembly with such chips, the Dutch company says, has several disadvantages: the process is difficult to automate, and the need to bond several chips can result in low overall yield. Further, in handling unprotected chips, special precautions are called for. And after assembly, the naked chips must either be protected or the finished hybrid circuit must be encapsulated.

The miniature SO devices represent the third step in an evolutionary development process that began in 1971 when Philips came out with a miniature IC for the Swiss watch industry. This was followed in 1974 by the development of an eight-pin SO package for circuits other than for watches. Now, the SO series comprises packages with five pin configurations and for 17 standard analog circuits—from simple voltage followers and general-purpose operational amplifiers to double-balanced modulators and limiting intermediate-frequency amplifier/fm detector combinations.

While production of these 17 SO devices is now under way at the company's subsidiary, Faselec, in Zurich, Switzerland, Philips is getting ready to put logic circuits into similar packages. Of the firm's Locmos 4000 series of logic ICs, which currently encompass about 75 types, 20 will soon be available in SO packages in volume quantities.

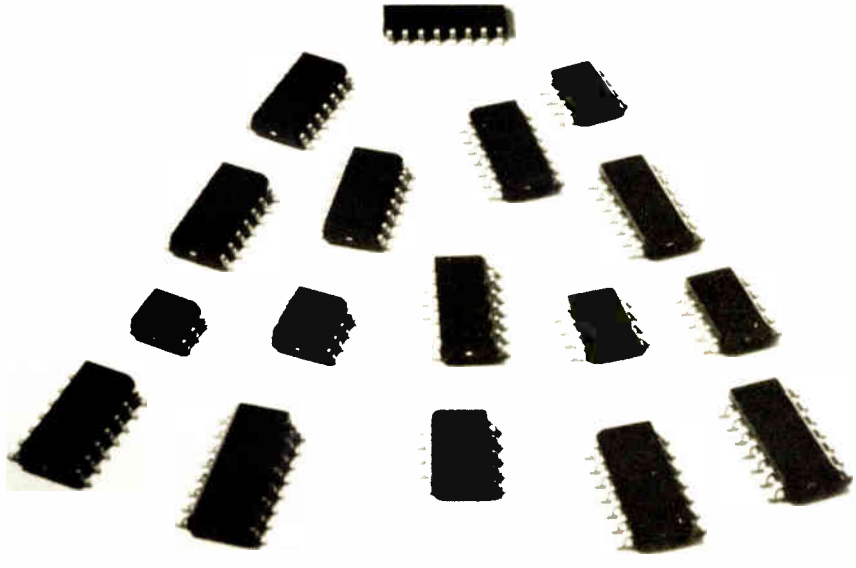
With such a wide range of analog and logic ICs in miniaturized packages, Michael Fletcher, product manager for industrial circuits at Philips' components-producing Elcoma division in Eindhoven, believes his company to have a decided edge over other firms that are also offering small-packaged ICs. Of note, Fletcher points out, is the variety of pin configurations characterizing the SO series.

The dual in-line SO packages provide 6, 8, 10, 14, or 16 pins. Pitched at 1.25 millimeters (or 0.05 inch), the pins on each side of the package will fit metrically or imperially dimensioned layouts. The pins, about 1 millimeter long, are bent at right angles to facilitate mounting by reflow soldering.

All five package types are the same height—1.45 millimeters. In length, the packages range from 3.55 mm for the smallest, the SO-6 (six-pin) version, to about 9.8 mm for the largest, the SO-16 (16-pin) type.

The SO packages, Fletcher says, should be of interest to more than manufacturers of hybrid circuits. Producers of printed-circuit-board assemblies may also find them suitable for mounting on pc boards for applications in camera-shutter controls, portable communications and paging systems, and for industrial-control equipment.

Considering their size, the SO packages have good power-dissipation properties, Fletcher notes. When they are mounted on a ceramic substrate, the heat is rapidly conducted away from the source. The small package height and short pins make for thermal resistance between junction and solder pads that is about the same as for a normal dual in-line package mounted on a printed-circuit board.



Philips, Elcoma Division, P.O. Box 532, Eindhoven, The Netherlands [338]

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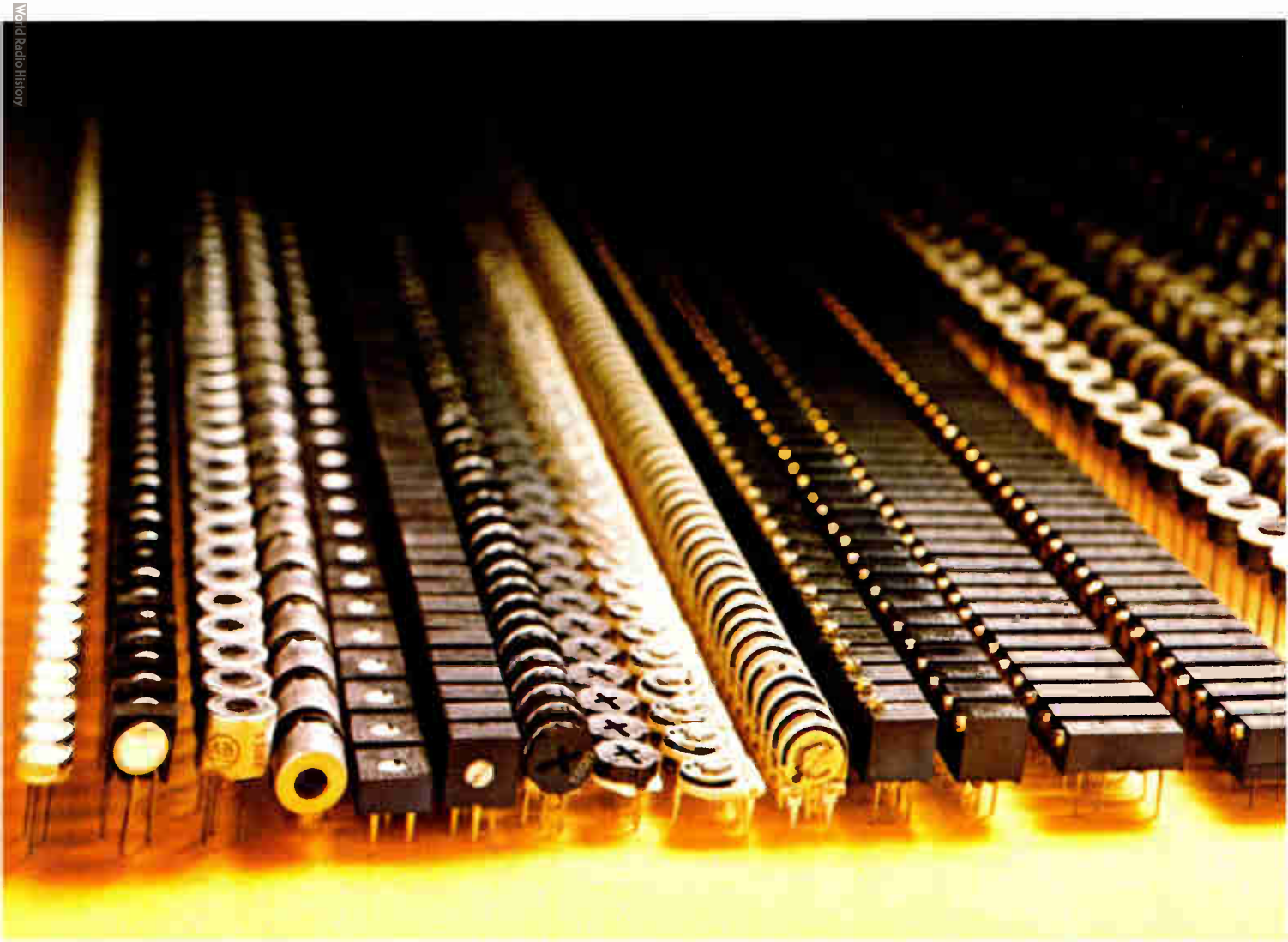

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Type E: ⅜" square, single turn, 10 ohms to 2 megs ±10%, 0.5W at 70°C, immersion sealed, 13 terminal options, Publication 5219. **1000 piece price $0.49.**

Type D: ⅜" diameter, single turn, 10 ohms to 2 megs ±20%, 0.5W at 70°C, dust cover, 6 terminal options, Publication 5240. **1000 piece price $0.42.**

Type 90: Approx. 7/16" square, single turn, 100 ohms to 2 megs ±20%, 0.5W at 70°C, open frame, 2 terminal options. Publication 5242. **1000 piece price $0.55.**

Type MT: ⅜" square, 20 turn, 10 ohms to 2 megs ±10%, 0.5W at 70°C, immersion sealed, 3 terminal options, Publication 5241. **1000 piece price $1.18.**

Type RT: ¾" long, 20 turn, 10 ohms to 2 megs ±10%, 0.75W at 70°C, immersion sealed, 3 terminal options, Publication 5237. **1000 piece price $0.65 or 0.93.**

CARBON COMPOSITION TRIMMERS

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.**

Type F: ½" dia., single turn, 100 ohms to 5 megs ±10% or 20%, 0.25W at 70°C, immersion sealed, 6 styles, non-linear tapers, Pub. 5234. **1000 piece price $1.00 to 1.62.**

Type O: ½" dia., single turn, 100 ohms to 5 megs ±10% or 20%, 0.40W at 70°C, immersion sealed, 4 styles, non-linear tapers, Pub. 5235. **1000 piece price $1.20 to 1.58.**

Type FD: ½" dia., 2 sec., 1 turn, 100 ohms to 5 megs ±10% or 20%, 0.25W at 70°C, immersion sealed, 4 styles, 5 tapers, 2 atten. Pub. 5231. **1000 piece price $2.65 to 4.10.**

Type BT: ½" dia., 2 section, 1 turn, for 75 ohm Bridged-T pad applications, dust/splash resistant, side and top adjust versions. Pub. 5236. **1000 piece price $2.49.**

Type N: 1¼" long, 25 turn, 100 ohms to 2.5 megs ±10% or 20%, 0.33W at 50°C, immersion sealed, Publication 5206. **1000 piece price $2.50 or 2.65.**

Type R: 1¼" long, 25 turn, 100 ohms to 2.5 megs ±10% or 20%, 0.25W at 70°C, immersion sealed, bushing mount option, Pub. 5205. **1000 piece price $2.87 to 3.73.**

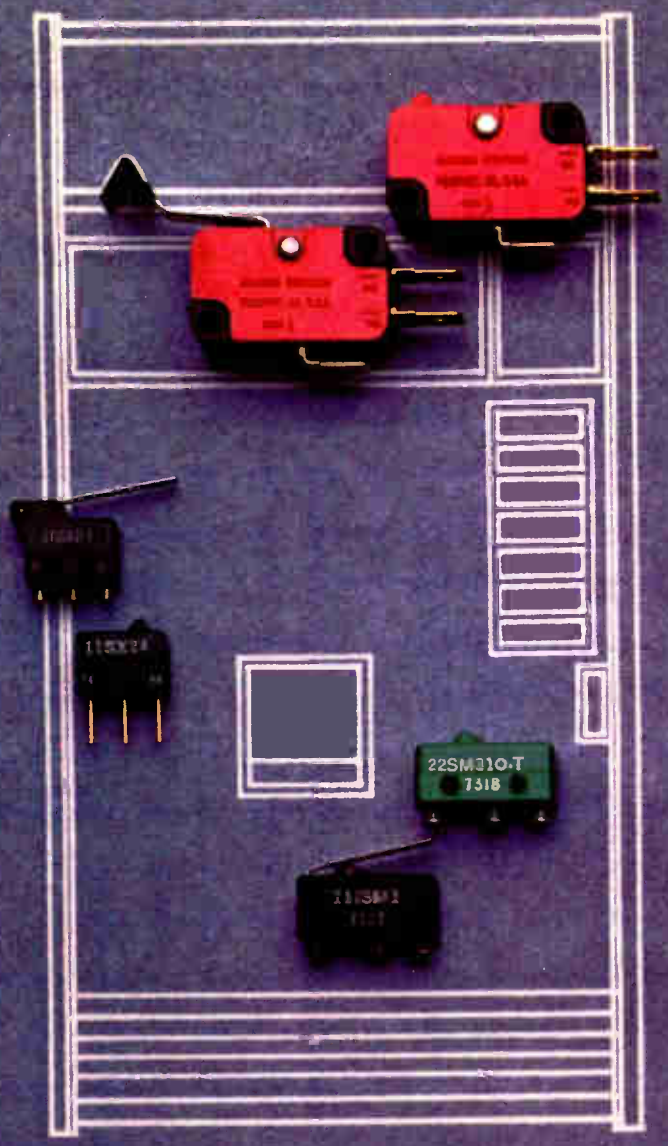
Quality in the best tradition.

ALLEN-BRADLEY
Milwaukee, Wisconsin 53204

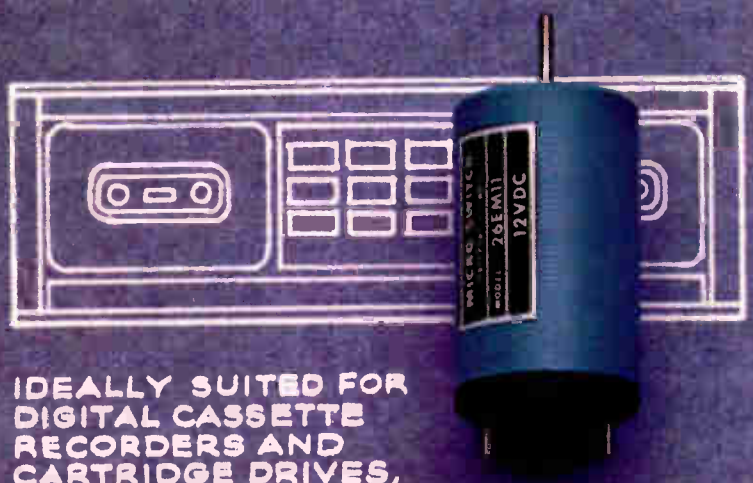
EC120

Circle 127 on reader service card

Some of these components will probably



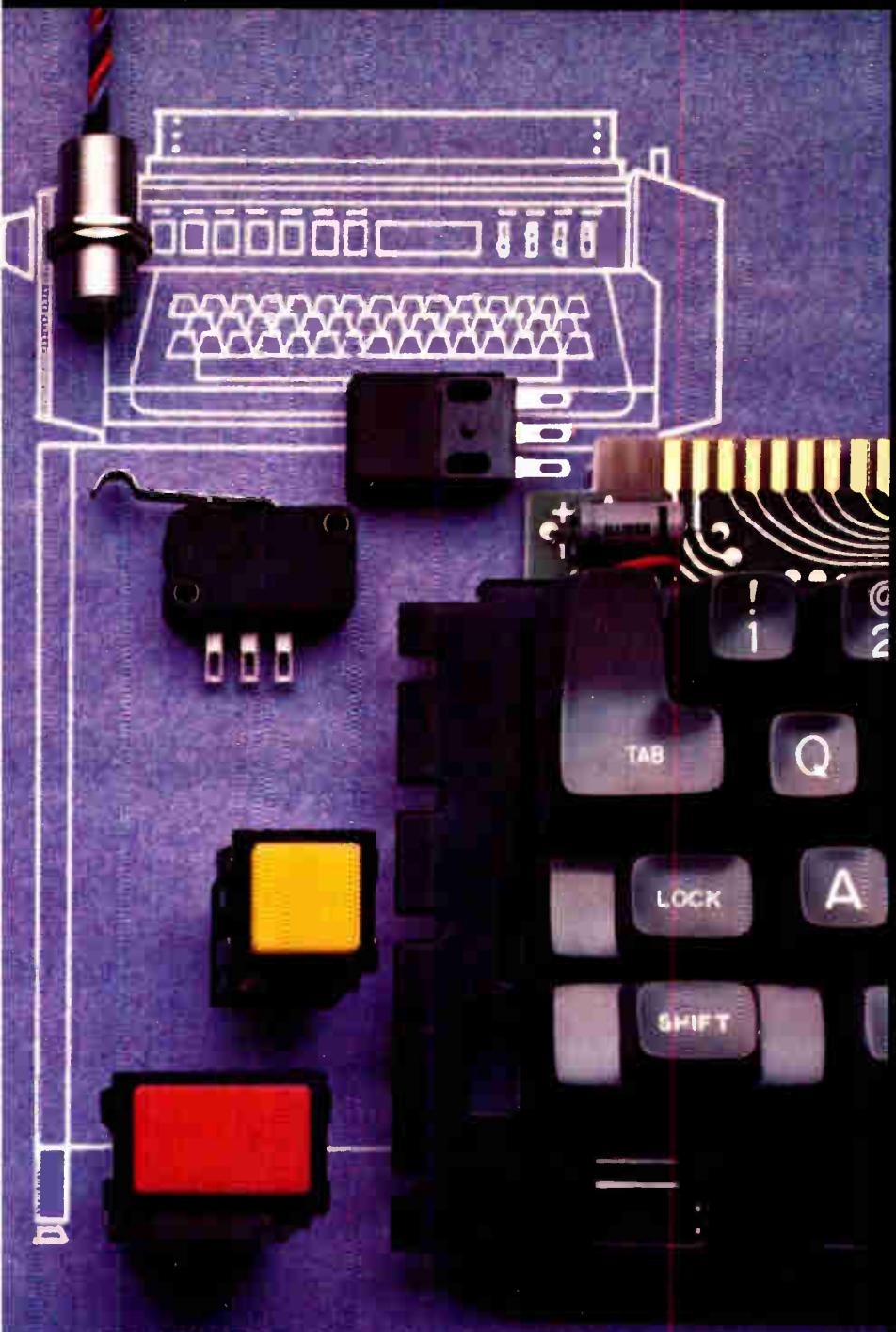
SNAP-ACTION V3, SM AND SX SWITCHES PROVIDE HIGH RELIABILITY AND ARE CAPABLE OF HANDLING HIGH OR LOW ENERGY CIRCUITS; PROVIDE OUTSTANDING PERFORMANCE FOR SELECTION, TIMING AND DISPENSING FUNCTIONS IN VENDING MACHINES.



IDEALLY SUITED FOR DIGITAL CASSETTE RECORDERS AND CARTRIDGE DRIVES, THE 26 EM MOTOR USES A HOLLOW ROTOR TO PROVIDE THE LOWEST POSSIBLE ROTOR MASS, RESULTING IN VERY LOW INERTIA. DIRECTLY INTERCHANGEABLE WITH MOTORS MADE OUTSIDE USA.

MINIATURE SERIES 8 SWITCHES PROVIDE THE ATTRACTIVE APPEARANCE, SMALL SIZE AND RELIABILITY NEEDED FOR HAND-HELD DIGITAL TIMERS. OFFER A WIDE VARIETY OF OPERATORS INCLUDING TOGGLES, PADDLES, PUSHBUTTONS, LIGHTED AND UNLIGHTED ROCKERS.

never wear out. The others will just come close.



MICRO SWITCH COMPONENTS ARE IDEALLY SUITED FOR APPLICATIONS LIKE THIS PRINTER AND OTHER COMPUTER PERIPHERAL EQUIPMENT. FOR INSTANCE, THE SD KEYBOARD OFFERING HIGH RELIABILITY, LOW PROFILE AND LOW COST; THE AML LIGHTED PUSHBUTTONS, FEATURING QUALITY APPEARANCE AT A LOW COST, ELECTRICAL FLEXIBILITY, INCLUDING SOLID STATE VERSIONS; PLUS A COMPLETE LINE OF SOLID STATE POSITION SENSORS OFFERING ALMOST INFINITE LIFE AND COMPATIBILITY WITH COMPUTER LOGIC.

The solid state keyboard, AML lighted pushbuttons and solid state position sensors you see here will probably never wear out. Because they're all solid state.

Each is based on a Hall effect integrated circuit. A circuit that's been tested through billions of operations without failing. Even once. And proven by performance in a variety of applications. The other components you see here come close. Simply because of the way they're designed and put together.

Like the long-life versions of our snap-action V3, SM and SX precision switches. Available in a wide variety of sizes, electrical capabilities and ratings, terminals, actuators, contact forms and operating characteristics—they've been tested to a mechanical life of over 10,000,000 operations.

Or the Series 8 miniature manual switches. Designed with epoxy-sealed terminals on most versions for extra reliability. And offered with virtually any operator you might need. Plus terminals that include solder, quick-connect, printed circuit or wire-wrap.

The same standards of quality and product flexibility go into the 26EM DC motor. It's a miniature motor designed with low inertia operational characteristics. And just one of a line that ranges up to the 500VM, a motor capable of accelerating to 4000 RPM and stopping over 1000 times per second.

If you'd like more information on any of these components, contact your nearest MICRO SWITCH Branch Office or Authorized Distributor.

And find out how you can get a component that goes on forever. Or at least comes very, very close.

MICRO SWITCH

FREEPORT, ILLINOIS 61032

A DIVISION OF HONEYWELL

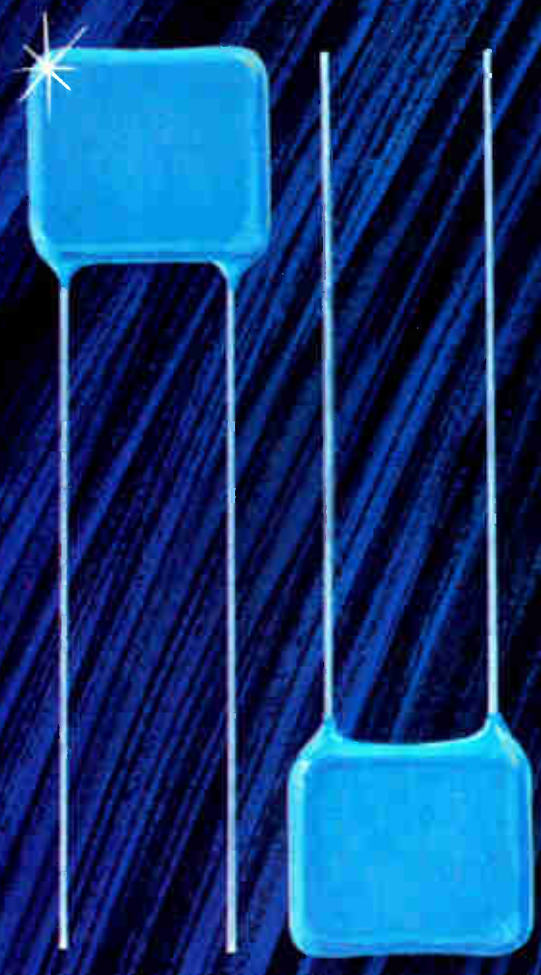
MICRO SWITCH products are available worldwide through Honeywell International.

Circle 129 on reader service card

We'll flip you over your ceramic capacitor specs...

heads you win tails you win

Heads are our standard line of MONO-KAPS™. Radial-leaded, epoxy-coated monolithic ceramic capacitors with noble-metal electrodes whose proven formulation has not been modified or compromised. They meet MIL requirements, and are available off-the-shelf in a broad range of capacitances and voltage ratings to meet your specific needs.



Tails are our BME-Radials™. They protect you from the noble metal cost spiral, and save you money right up front. They are the product of our unique BME capacitor technology which eliminates noble metal entirely from electrodes and terminations. But they'll meet most of the same circuit requirements with no sacrifice.

So you see, it's up to you — MONO-KAPS or BME-Radials. Both are immediately available in quantity from the only people who give you the choice. Either will do the job without compromise. Call or write for all the details today.

CENTRALAB/USCC 4561 Colorado Blvd. • Los Angeles, CA 90039 • (213) 240-4880

Electronics • GLOBE-UNION INC

"See our complete catalcg in EEM pages 317 to 335, and gold book pages 103 to 121, or contact us directly."

Components

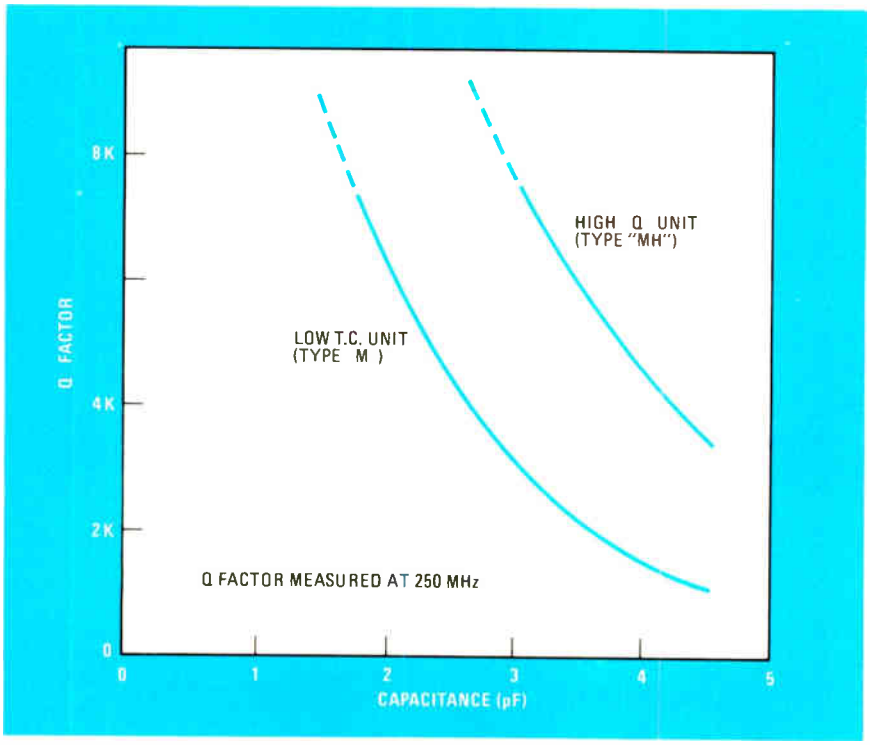
Sapphire cuts capacitor loss

Trimmer units with sapphire dielectric offer high stability

Sapphire, long used as substrate material for high-performance integrated circuits, is now helping boost the performance of subminiature trimmer capacitors. Synthetic sapphire, which is crystal-grown in a vacuum the same way as silicon, is extremely strong, resistant to heat, and chemically inert. It has a low dielectric loss tangent of 0.0003 out to a frequency of 10 gigahertz.

Voltronics has introduced a line of trimmer capacitors, the M series, that use a sapphire dielectric to keep losses low and stability high over temperature and vibration extremes. The small tubular capacitors measure only 0.12 inch in diameter by 0.35 in. long at minimum capacitance (tuning piston fully extended) and are well suited for use in high-Q tuning circuits up to 3.5 gigahertz. The numerous mounting configurations provide the flexibility to use the capacitors in cavity and strip-line circuits, as well as on the alumina substrates of microwave integrated circuits.

The line of standard and high-Q trimmer capacitors has a capacitance range of 0.6 to 4.5 picofarads. The standard line has a minimum Q of 1,000 at maximum capacitance



New products

(worst case) and at 250 megahertz. The high-Q version boasts a Q of 3,000 at the same frequency. At lower capacitance settings, the Q increases with both types. The temperature coefficient of the standard line is −50 ±50 ppm/°C; the high-Q line has a TC of +350 ±50 ppm/°C.

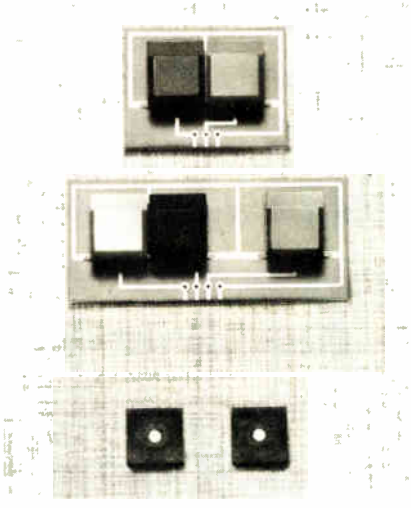
All capacitors are rated at a working voltage of 500 volts and a dc withstanding voltage of 1,000 v. The operating temperature range is from −55°C to +125°C, and the units can withstand mechanical shocks of 100 g for 6 milliseconds and vibrations of 20 g at 10 to 2,000 cycles per second.

The capacitors are available from stock in small quantities, with 30-day delivery quoted for larger orders. Prices are $7.45 each in single quantities, $3.85 each for 2,500 to 4,999. Also, designer kits are available with 12, 24, and 36 pieces.

Voltronics Corp., West St., East Hanover, N.J. 07936 [341]

Compact push-button switch offers spdt contacts

A line of rectangular push-button switches that can be mounted on 0.5-inch centers is supplied with single-pole double-throw contacts. Intended for direct interfacing with logic circuits, the switches have ratings of 20 volts at 10 milliamperes. Because the spdt switch

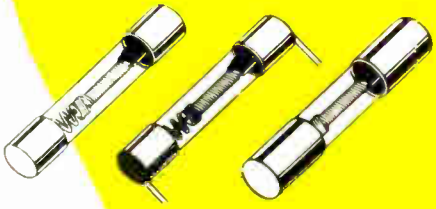


BUSS® Fuses

FOR QUALITY-RELIABILITY

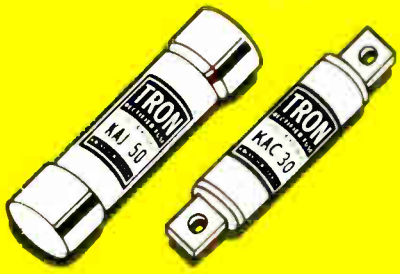
For anything you need in protecting electronic circuits and devices —

FUSETRON®
dual-element — time-delay fuses



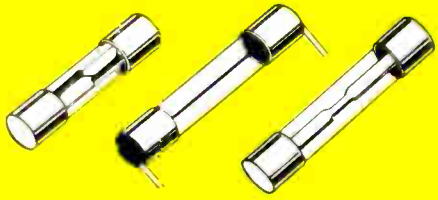
Avoid nuisance opening, yet get full short-circuit protection. Available from 1 100 amp. to 40. Size ¼ x 1¼ in. and 9 32 x 1¼ in.

TRON® rectifier fuses



Provide extremely fast opening and high degree of restriction of let-thru current to protect Solid State Devices. Ampere rating ½ to 1000 in voltages up to 1500.

BUSS GLASS TUBE FUSES
"quick-acting"



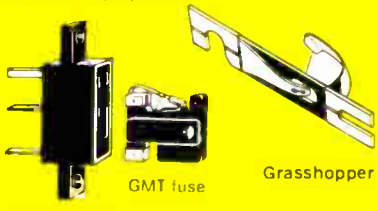
Provide high speed action to protect delicate instruments and apparatus. Available from 1 500 to 30 amp. Size ¼ x 1 in. and ¼ x 1¼ in.

BUSS Signal-Indicating Alarm-Activating FUSES

Available with time-delay or quick-acting characteristics. Available from 1 10 to 30 amp. Size ¼ x 1¼ in. and 13 32 x 1½ in.

BUSS Fuses for TELEPHONE COMMUNICATIONS Similar equipment

Series 70



HLT holder GMT fuse Grasshopper

TRON® Sub-Miniature Pigtail Fuses

Size only .145 x .300 in. Glass tube permits visual inspection. Hermetically sealed. Available from 1 200 to 15 amp.

BUSS Sub-Miniature GMW fuse

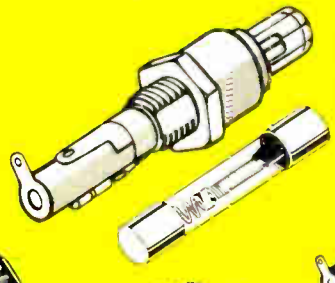
and HWA fuseholder.

Full size .270 x .250 in. with window to check fuse element. Available 1 200 to 5 amp

BUSS SNAP-LOCK FUSEHOLDER

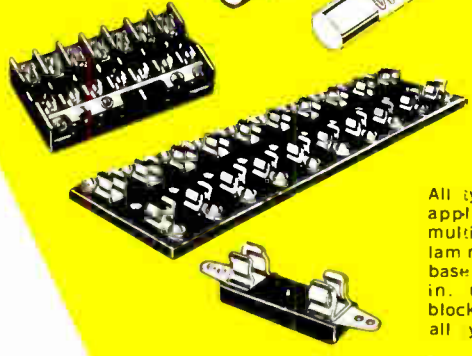
Rear panel mount fuseholder for ¼ x 1¼ in. fuses. Snaps into place. Specify HTA-00 for space saver type. HLD-00 to take visual indicating fuses. HKP-00 for standard fuseholder. HJM-00 to take ¼ x 1 in. fuses.

HKP
panel mounted fuseholder for ¼ x 1¼ in. fuses.



BUSS FUSES and FUSEHOLDERS
to meet military specifications.

HKA
lamp indicating, signal-activating fuseholder.



BLOCKS FOR BUSS FUSES

All types available for every application. Single pole, multiple pole, small base, laminated base, porcelain base for fuses from ¼ x 5/8 in. up. Also signal fuse blocks and special blocks of all types.

FOR THE PROTECTION OF ALL ELECTRONIC CIRCUITS

Write for Bulletin SF8
— See for yourself —

BUSSMANN MANUFACTURING
a McGraw-Edison Company Division
St. Louis, Missouri 63107

SUPPLIED THE ECONOMICAL WAY THRU DISTRIBUTORS
BUSS FUSES
THE QUALITY LINE

provides a normally closed contact pair, the switch is easy to debounce and in some C-MOS applications needs no debouncing at all.

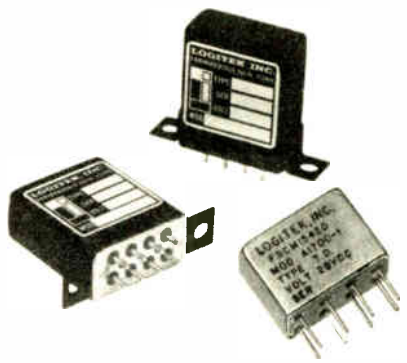
For enhanced reliability each series R switch uses a U-shaped member for each pole. Thus each contact is redundant; a single spdt switch is supplied in a six-pin package. In the RE subseries the contacts are installed on a customer-designed printed-circuit board to allow the redundant leads to be brought out separately and so to make coding circuits easier to build. Subseries REK switches are self-contained with their pins located on 0.2-by-0.4-in. centers. In OEM quantities, the switches sell for about 20 to 25 cents each.

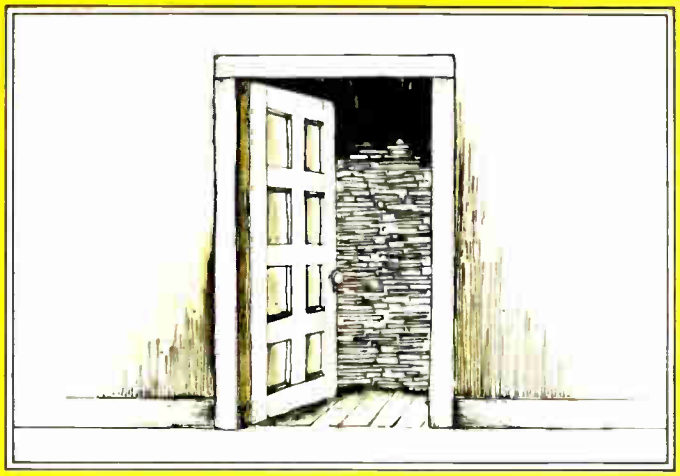
IEE/Schadow Inc., a subsidiary of ITT, 8081 Wallace Rd., Eden Prairie, Minn. 55343. Phone (612) 944-1820 [343]

IC-based time-delay relays are for aircraft use

Built around an integrated timing circuit, the model MIS is a rugged time-delay relay that operates from standard aircraft power—that is, 16 to 31 v dc. The unit has a solid-state output with specifications that meet MIL-R-83726/13, which means that it can sink 300 milliamperes at room temperature. A companion unit, the model MIR, is identical to the MIS except that it includes a set of double-pole double-throw relay contacts. The contacts are rated at 2 amperes.

The relays are offered with factory-set delays from 50 milliseconds





A roomful of boards.

How a leading manufacturer of electronic products repaired over 10,000 defective boards in 30 days using Zehntel's in-circuit tester.

What to do when you've accumulated over 10,000 defective circuit boards?

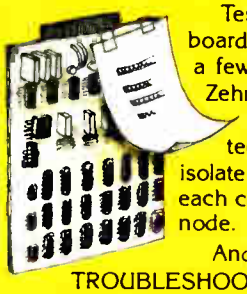
A major manufacturer of consumer products faced this problem recently.

The boards had piled up because it took technicians an average of over an hour to locate problems and repair a board.

This company got out of the dilemma with a Zehntel TROUBLESHOOTER test system.

Incredible but true, over 10,000 defective boards were diagnosed and repaired in 30 days, using Zehntel's in-circuit inspector.

The roomful of boards evaporated!



Test time per board was reduced to a few seconds with Zehntel's in-circuit measuring techniques which isolate and measure each component and node.

And since TROUBLESHOOTER prints out all of the defects on a board that failed, a technician could repair a bad one in just a few minutes.

Zehntel's in-circuit test system paid for itself on this cleanup job alone — and during the 30 day period also did regular production testing.

This is not an isolated case . . .

Zehntel in-circuit test systems are reducing test/repair time for many of the country's largest companies who build TV sets, AM-FM radios, CB's, automotive electronics, medical equipment, computer peripheral instruments — literally all kinds of industrial and consumer products. In fact, our customer list reads like "Who's who in electronics".

Easy to use

Using our tester, non-technical operators can inspect hundreds of boards daily. The operator merely puts the board on our test fixture and pushes the start button. If the board is good, that's it. If the board fails, precise rework instructions are automatically printed. Typical test time: 5 to 30 seconds!

Summing up the advantages — TROUBLESHOOTER:

- Tests a wide variety of products
- Detects and pin points single or multiple defects on an entire assembly in seconds
- Eliminates need for technically-oriented operator
- Prints specific rework instructions for defective assemblies
- Is easy to program since each step deals with a single component
- Adapts to any flat assembly regardless of its complexity
- Can generate statistical data on component failures

Zehntel,® Inc.

2440 Stanwell Drive, Concord, CA 94520
Tel: (415) 676-4200 • TWX: 910-481-9471

Circle 135 on reader service card

to 300 seconds. Available tolerances are 5% and 10%, and the units will operate over the range from −55°C to 125°C. Relays with delay-on-make and delay-on-break action can be supplied.

Logitek Inc., 42 Central Ave., Farmingdale, N.Y. 11735. Phone Herb Fischer at (516) 694-3080 [344]

Solid-state fuses rest automatically

The Iso-Switch is a solid-state fuse that operates much like a circuit breaker with automatic reset. For currents below its trip point, it acts like a resistor with a relatively low resistance. As the current tries to exceed the trip value, the device goes through a negative-resistance region and then behaves like a 500-megohm resistor. When the circuit fault is removed—that is, when the voltage across it is reduced below the trip voltage—the Iso-Switch reverts to its low-resistance state.

Available with trip currents from 10 microamperes to 10 milliamperes, the fuse's insertion resistance ranges from 40 kilohms down to about 1 kilohm. The bidirectional devices, which have an operating time well below 1 millisecond, can withstand up to ±1,000 volts. They measure 1.125 inches long and are 0.375 inch in diameter.

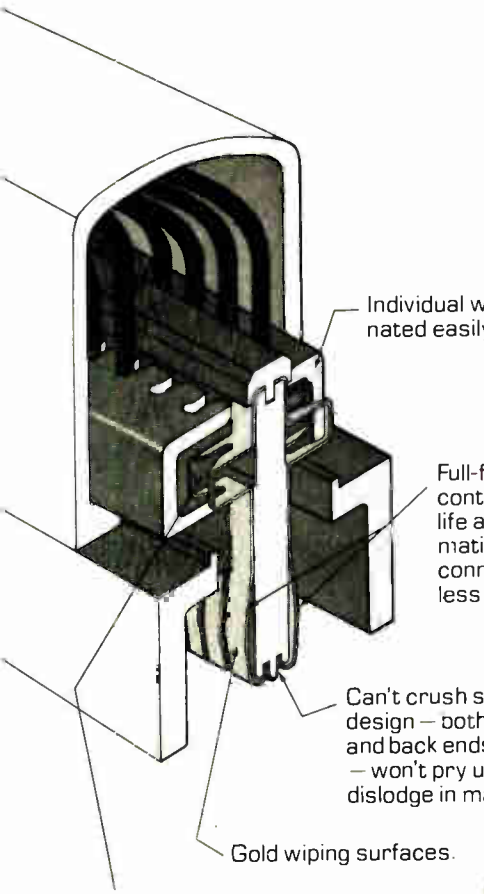
Priced at about $30 each, the Iso-Switch is currently available on a two-week free-trial basis. Delivery is from stock.

Ohmic Instruments Co., Canton at Railroad Avenue, St. Michaels, Md. 21663. Phone (301) 745-2277 [345]

Joystick toggle switch occupies less than 0.7 in.^{3}

A nine-position, momentary-contact, joystick toggle switch with four single-pole, single-throw switches measures only 0.81 by 0.82 by 1.05 inches. It operates in an XY-axis mode with one position each on the ±X and ±Y axes. Movement at 45°

A sleeper.



Individual wires reterminated easily by hand.

Full-flexing spring contacts — long life and positive mating with any connector, regardless of brand.

Can't crush spring leaf design — both leading and back ends entrapped — won't pry up or dislodge in mating.

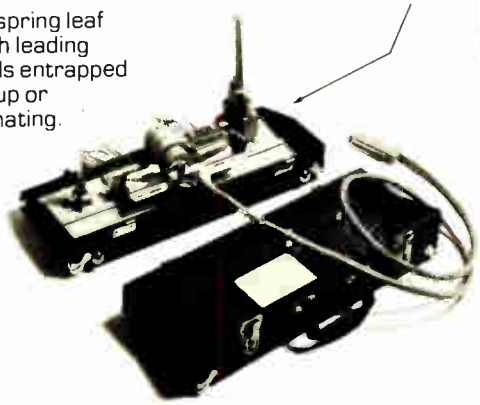
Gold wiping surfaces.

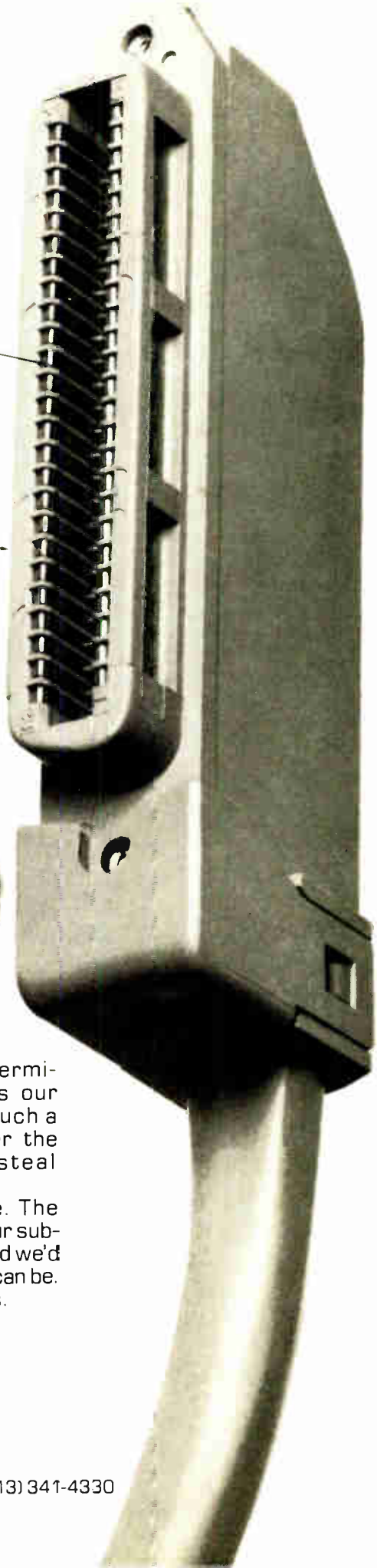
Contact area on each wire is larger than a cross section of the wire itself (.012 sq. in. on 24 awg.). 4 contact areas on each wire (not just 2); strain relief on each wire.

Intermateable with other industry standard 50 pin ribbon contact connectors.

Looks as good as it works. Clean design. High impact plastic, in cable-matching light olive gray.

Can be terminated with one finger on our Pushover field termination tool. The Vitel-F is part of our system. Really the most important part.





The plain truth is, there just isn't another 50 contact solderless connector you can buy that's this good.

Take a look at the details of the Vitel-F. Compare it with whatever you're now using.

Costs? We'll bet it's no more than you're now paying — probably less; this is a competitive business, you know.

But, frankly, the field termination tool that completes our system, The Pushover, is such a dramatic improvement over the others, that it tends to steal the show.

It shouldn't, of course. The connector is what you and your subscribers have to live with... and we'd like to show you how easy that can be.

Call or write us for details.

Viking
CONNECTORS

Viking Industries, Inc./21001 Nordhoff Street/Chatsworth, CA 91311 U.S.A./(213) 341-4330

Circle 137 on reader service card

New products

to those axes actuates both switches associated with the axes closest to the motion. The switch's ninth position is the center off position, to which it always returns when finger pressure is released.

Machine Components Corp., 70 Newton Rd., Plainview, N.Y. 11803. Phone D. Lester Dubov at (516) 694-7222 [346]

Silvered-mica capacitors are rated to 2,500 WVdc

A line of dipped silvered-mica capacitors with capacitances from 5 to 13,000 picofarads is offered with working-voltage ratings from 1,000 to 2,500 v dc. The capacitors come in two case sizes—CD19 and CD30. Both operate over the temperature range from −55 to 125°C. The CD19 units are offered only in a 1,000-v version, while the CD30 is supplied in 1,000-, 1,500-, 2,000-, and 2,500-v types.

Cornell-Dubilier Electronic Corp., Avenue L, Newark, N.J. 07101. Phone William Carlson at (201) 589-7500 [347]

Wall-plug-in transformers have center tap, ground

Two wall-plug-in power transformers that carry Underwriters Laboratories' Class-2 listing are provided with four output terminals—three provide a center-tapped 24-volt output, and the fourth is a power ground. One unit is rated at 7 volt-amperes and the other at 10 v-a. Because they make it easy to develop positive and negative dc voltages, the transformers are well suited for use with modems, data-communications equipment, and equipment containing microprocessors.

To protect the devices they power from line noise, the transformers are designed to have a low interwinding capacitance of less than 30 picofarads. Available from stock, they sell for about $4 each in original-equipment quantities.

Ault Inc., 1600 H Freeway Blvd., Minneapolis, Minn. 55430 [348]

Static 4K RAMs!

SY2114's
are now available.

Call Synertek.

The guys up the block and around the corner at Intel developed a nice 1Kx4 static RAM a while back. We're pleased to tell you that we're another source for the 2114. It's now in production and we have a good supply of parts to sell.

The 2114 is a great way to go if you want an easy-to-design-with memory for microcomputer systems. And it's **totally static.** No Chip Enable pulsing required. No clocking needed. And, of course, the SY2114 requires no refresh circuitry. You put an address in, you get data out. It's that simple.

We're in a family way.

Synertek 4K static RAMs form a unique family: Besides the 2114, we've got the SY5255 (also 1Kx4, static, but with National's pinouts) for mid-range applications and next we'll have a new 4Kx1 device for large-scale systems.

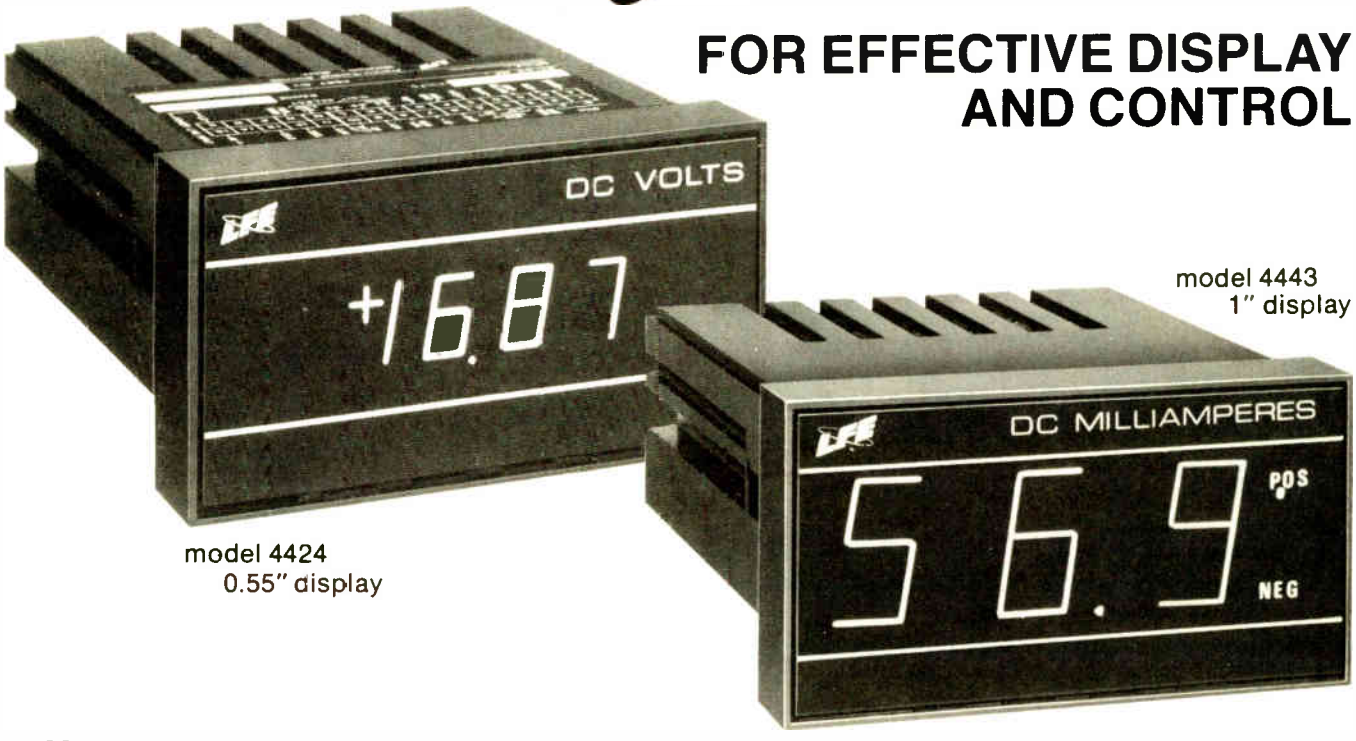
Samples and details are available from Bob Cushman. Call him or drop us a line at (408) 984-8900, 3050 Coronado Drive, Santa Clara, CA 95051.

Synertek.
Solutions.
Not problems.

Circle 139 on reader service card

The Easy Reader

FOR EFFECTIVE DISPLAY AND CONTROL



model 4424
0.55" display

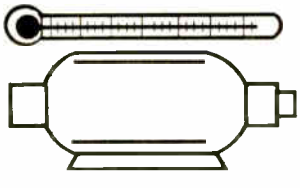
model 4443
1" display

LARGE BRIGHT DISPLAY

LFE series 4400 DPM's are more readable than conventional LED displays. They provide a unique one inch display and uniform high intensity digits. Also, gaps between digit segments have been eliminated.

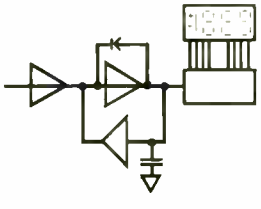
LOW PRICE, HIGH VALUE

Use of the latest conversion techniques allows series 4400 to have fewer components and single board construction. Technological breakthrough provides proven LFE quality and reliability at a new low cost.



RPM, °F, volts, AC, amps, °C, DC, – – – – – – – – – – – – – – – – –

LFE series 4400 DPM's can accept optional second printed circuit board to provide for most signal conditioning conversions. Complete boards available for linearized thermocouple, RTD, AC motor speed, power line, and other special inputs.



ACCURATE DISPLAY, RELIABLE PERFORMANCE

FET high impedance input, multiplexed BCD output, high noise rejection, plug-in digits, auto polarity, flashing over-range, automatic zero, space saving design, and other features are standard. A lengthly burn-in and an exhaustive computer controlled checkout insure high reliability.

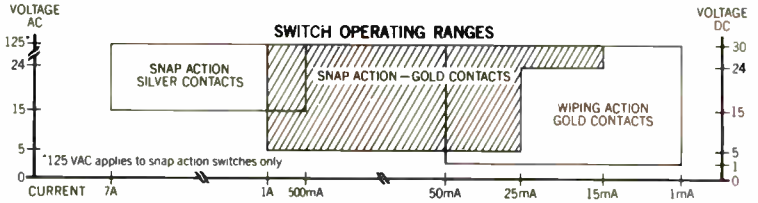
Nationwide network of modification/distribution centers provide local stocking, modification, and repair. Contact your local representative for applications assistance. For complete details on series 4400 DPM's write to LFE Corporation, Process Control Division, 1601 Trapelo Road, Waltham, MA, 02154, or telephone 617-890-2000.

LFE CORPORATION

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).

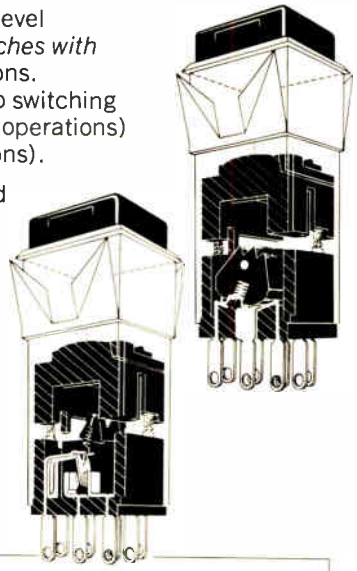


Reason 2: Dialight's snap-action and wiping-action switches come in a new modular design concept . . . a common switch body for either high or low current operation. All 554 series switches and matching indicators have the same rear-panel projection dimensions.

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	○	○	○	○	○	○

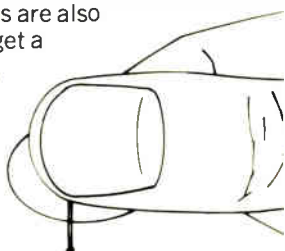
OPTIONS	PUSH BUTTON CAP SIZES				
	½" Sq.	⅝" Sq.	⅝" x ¾"	¾" Sq.	¾" x 1"
BEZEL MOUNTING TO ACCOMMODATE	○	○	○	○	○
BEZEL MOUNTING WITH BARRIERS TO ACCOMMODATE		○	○	○	○
PANEL MOUNTING TO ACCOMMODATE	○	○	○	○	○
MATCHING INDICATORS	○	○	○	○	○

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 141 on reader service card 141

Semiconductors

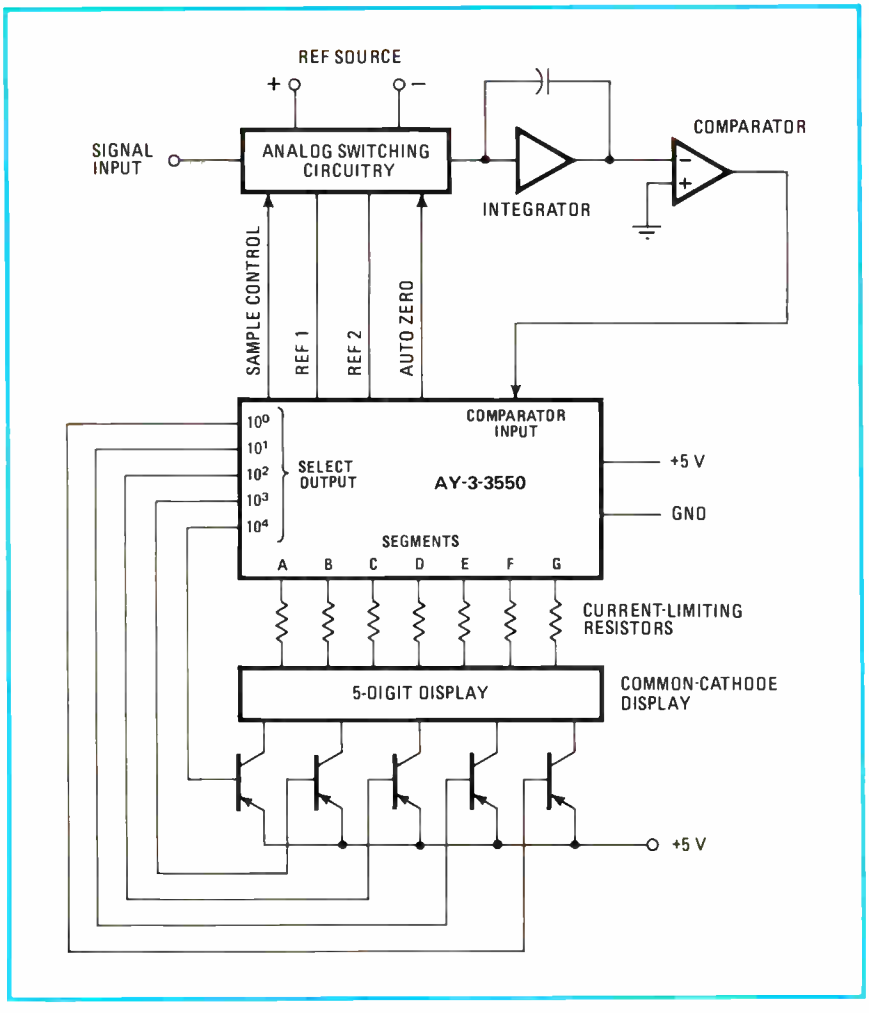
Converter chip has dual outputs

4¾-digit multimeter/counter provides 7-segment and multiplexed BCD outputs

In the budding market for digital-voltmeter chips, manufacturers thus far have been concentrating on single- and two-chip analog-to-digital converters for 3-digit (±999) and 3½-digit (±1,999) bench, field, and panel-mounted test and measuring instruments. Now, General Instrument Corp.'s Microelectronics group in Hicksville, N.Y., is setting its sights on the process-control and medical-instrumentation markets with a new n-channel metal-oxide-semiconductor chip that has all the counting and display logic for a high-resolution 4¾-digit (±29,999) multimeter.

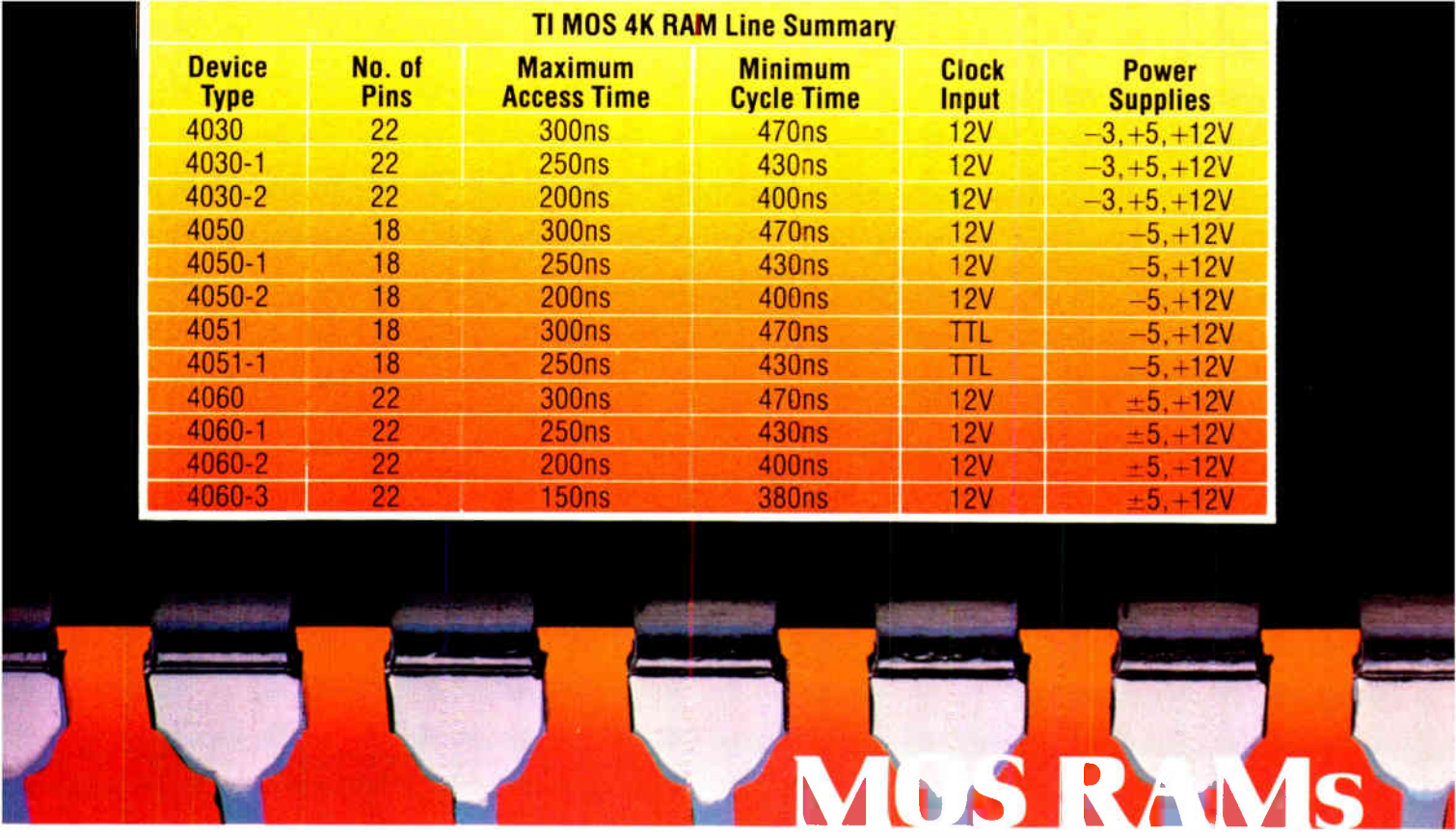
The new microcircuit, the AY-3-3550, "is unlike most available digital voltmeter chips where the outputs are multiplexed onto either a BCD bus for interface to a wide variety of displays or a 7-segment bus for interface to light-emitting-diode and similar displays," says product marketing manager John J. Wunner. The new chip, "has both direct 7-segment LED drive and multiplexed BCD outputs." It also provides six-range autoranging, autopolarity, autozeroing and three on-board oscillators that control the sample rate and reset, digit-select multiplexing, and BCD counting.

Priced at $14.50 each in quantities



TI MOS 4K RAM Line Summary

Device Type	No. of Pins	Maximum Access Time	Minimum Cycle Time	Clock Input	Power Supplies
4030	22	300ns	470ns	12V	−3, +5, +12V
4030-1	22	250ns	430ns	12V	−3, +5, +12V
4030-2	22	200ns	400ns	12V	−3, +5, +12V
4050	18	300ns	470ns	12V	−5, +12V
4050-1	18	250ns	430ns	12V	−5, +12V
4050-2	18	200ns	400ns	12V	−5, +12V
4051	18	300ns	470ns	TTL	−5, +12V
4051-1	18	250ns	430ns	TTL	−5, +12V
4060	22	300ns	470ns	12V	±5, +12V
4060-1	22	250ns	430ns	12V	±5, +12V
4060-2	22	200ns	400ns	12V	±5, +12V
4060-3	22	150ns	380ns	12V	±5, +12V

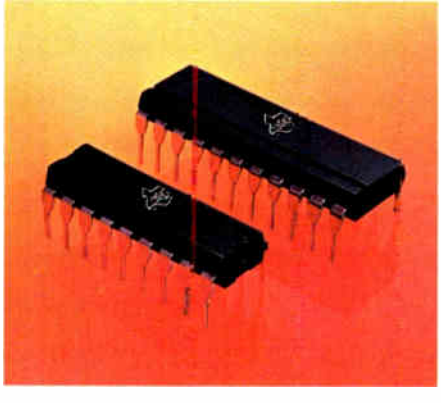


4K RAMs. Choose from 12. From the first source. Texas Instruments.

If your system depends on memory performance, you can't afford a wrong choice.
Since memory is critical to your system cost and performance, selection of a 4K RAM supplier is crucial. You need the experience and capability that comes from the largest 4K RAM manufacturer in the world. Texas Instruments.

By combining a single transistor cell with N-channel silicon gate process to fabricate 4K RAMs three years ago, TI earned the leadership position in high volume MOS RAM production.

This manufacturing method became the industry's standard.



And it's easy to see why TI continues to be an acknowledged leader: Proven reliability. Volume availability. Plastic packaging expertise. And the broadest 4K RAM family.

Twelve different device types are now in production. Availability is off-the-shelf. Maximum access time ranges from 300ns to 150ns. Choose 0°C to 70°C industrial, or −55°C to 85°C extended temperature range. Hi-Rel versions too. Processed to Class B of MIL-STD-883 per Level III of TI 38510/MACH-IV Program (prefix SMC). In fact, the industry's first JAN 4K RAM specification is written around TI's 4K MOS memories.

For 4K RAMs, make the right choice. Texas Instruments. Call your TI Distributor today. He's listed to the left.

TEXAS INSTRUMENTS
INCORPORATED

63103 A

New products

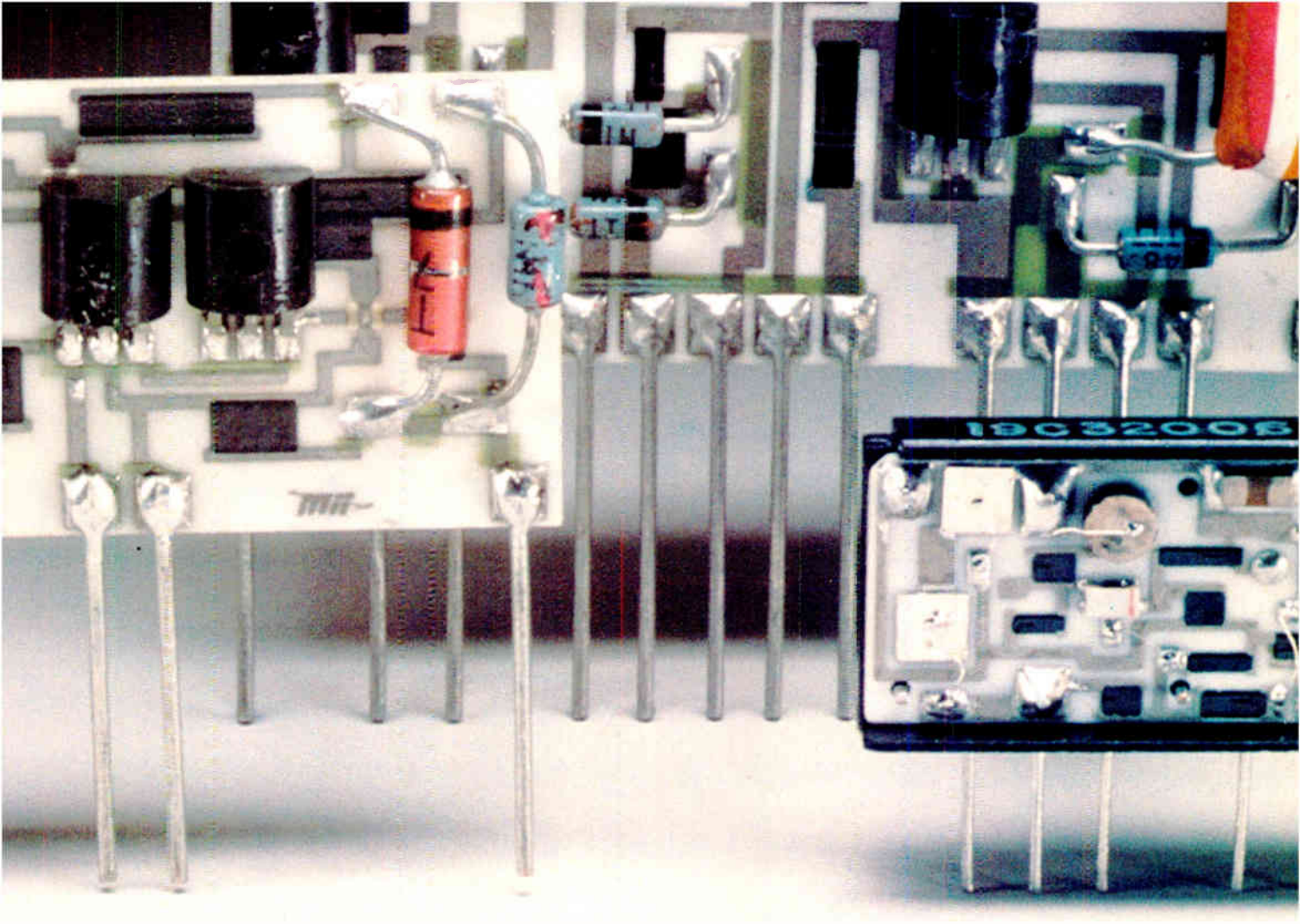
of 100, the immediately available AY-3-3550 is a dual-slope device that typically draws 12 milliamperes from a single +5-volt power supply and can handle supplies from +4.5 v to +11 v. The 40-pin chip has a conversion rate of up to 100 readings per second, and, depending on the linear circuitry, is accurate within 0.003% ±1 count over its operating-temperature range of 0°C to +70°C. However, to operate as a complete a-d converter, the integrated circuit requires two voltage references, a dual operational-amplifier package for integrator and comparator functions, plus a dozen external parts.

General Instrument expects the AY-3-3550 to be used in markets different from those of existing a-d converters, such as the recently introduced single-chip MC14433 from Motorola Inc. [*Electronics*, Dec. 9, p. 140] and Siliconix Inc.'s two-chip LD110/111, both of which are 3½-digit products.

The GI chip "is more likely to find applications in instrumentation that is more complex than low-cost digital multimeters, although its low power requirements make it useful for portable laboratory instruments too," Wunner says. "Because of its feature orientation—display and counting capability—it's more apt to find application in recording instruments, such as those used in the process-control and medical-instrument markets."

Oddly, the AY-3-3550 to date has been used only in three portable digital multimeters, having been a proprietary development for Simpson Electric Co. in Elgin, Ill. Until now, the device has not been available to the general industry. However, it has not been utilized to its full capability, notes Simpson's director of engineering Perry Toback. Thus far, it has been used in two nonautoranging 3½-digit multimeters with different cases and in a 3½-digit multimeter with autoranging. "Plans are to utilize the chip in new 4½-digit multimeters, likely due for market introduction during 1977," Toback says.

The 4¾-digit multimeter/counter circuit represents a significant ex-



Now Du Pont FORMON® Solder Compositions put it all together for thick film hybrid circuits.

Du Pont FORMON® Solder Compositions give you the same solid cost and performance benefits you've seen in Du Pont's complete compatible systems of conductor, resistor and dielectric compositions.

Unlike wave or dip soldering, FORMON Solder Compositions are selectively screen printed and reflowed, giving you:

- Constant alloy composition and consistent performance. You avoid solder pot contamination.
- Controlled deposition. Screen printing puts solder only where you want it—away from sensitive components and without "bridging" between adjacent conductors.
- Simple component assembly. Components are easily positioned on the wet solder paste, holding the components in place through reflow.

The complete line of FORMON Solder and Braze Compositions includes a full range of alloys and melting temperatures compatible with Du Pont conductors. All materials are backed by comprehensive quality control to assure purity and batch-to-batch consistency.

Du Pont Conductor Compositions	FORMON® Solder Compositions
Pd/Ag 9308 Pt/Ag 9770	10 Sn/88 Pb/2 Ag 8961 95 Sn/5 Ag 8518 62 Sn 36 Pb/2 Ag 8922
Pt/Au 9596 Pt/Au 9885	10 Sn 90 Pb 8520 60 Sn 40 Pb 8522
Au 9791 Au 9916	88 Au 12 Ge 8513 80 Au/20 Sn 8511 50 Pb 50 In 9567

If you manufacture or assemble thick film hybrid microcircuits or passive components, come to Du Pont Electronic Materials Division, the systems people in thick films. Write the Du Pont Company, Room 25451, Wilmington, DE 19898.

Electronic Materials Division

DU PONT

Electronics

Circle 145 on reader service card

New products

pansion in GI's digital voltmeter chip family, none of which has offered autoranging or autozeroing. The initial AY-5-3500 was a single-ramp, 3¾-digit voltmeter chip without autopolarity, but it could either drive a 7-segment LED or multiplex BCD outputs. The subsequent AY-5-3507 and AY-5-3510 were 3½-digit voltmeter chips with dual-ramp integration and autopolarity, with the former tailored for direct 7-segment LED drive and the latter for BCD outputs.

General Instrument Corp., Microelectronics Group, 600 W. John St., Hicksville, N.Y. 11802. Phone (516) 733-3000 [411]

Erasable 8,192-bit PROM has 450-ns access time

The TMS 2708 JL is an 8,192-bit programable read-only memory that can be erased by exposure to ultraviolet light. Pin-for-pin compatible with Intel's similarly numbered device, the n-channel silicon-gate EPROM has maximum access and minimum cycle times of 450 nanoseconds. The memory is organized as 1,024 8-bit words.

All inputs can be driven by series 74 transistor-transistor logic circuits with external pull-up resistors. Each

output can drive one series 74 TTL circuit without external resistors.

Housed in a 24-pin dual in-line package, the memory sells for $98 in small quantities. The price drops to $73 each for 25 to 99 units and to $64 per unit for quantities in excess

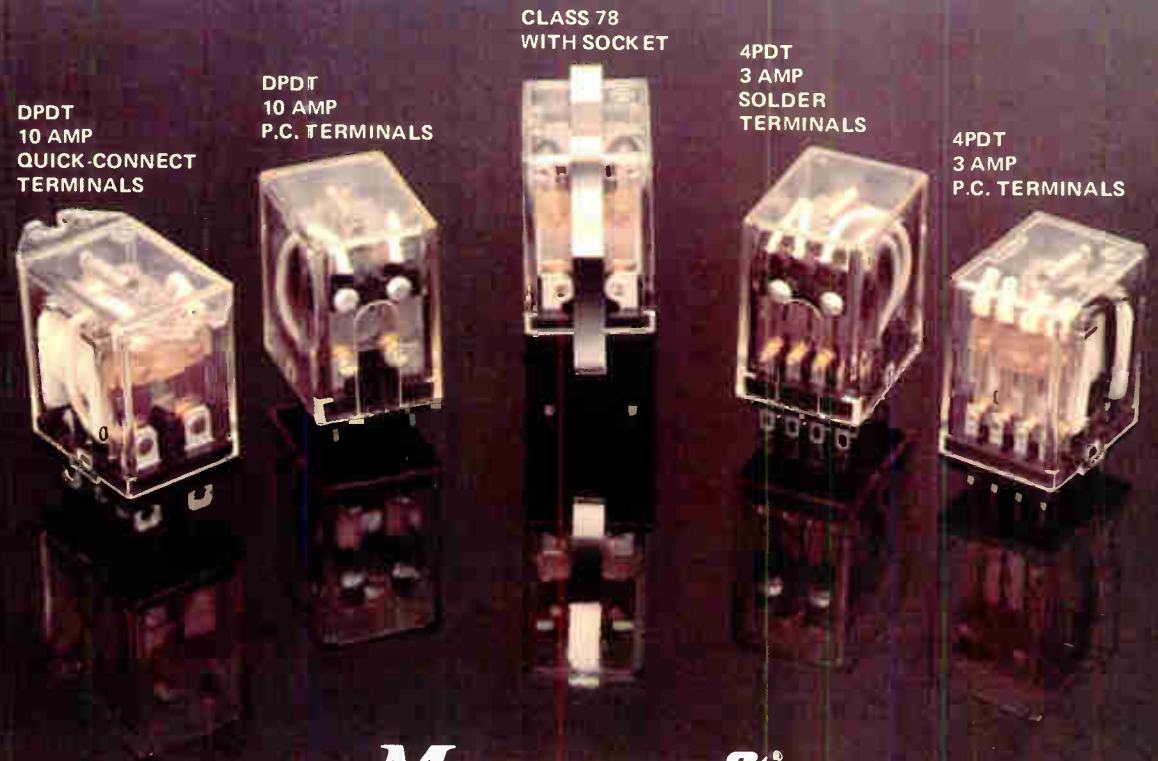
Magnecraft adds the Class 78... to make the most complete line of General Purpose Relays. Anywhere.

Class 78 type relays are widely used, general purpose relays. Slightly larger than one cubic inch, these relays provide the most switching capability per cubic inch that your money can buy. And they're interchangeable with all comparable types.

Designed with great flexibility, and in a wide range of AC and DC coil voltages, the Class 78 standard contact combinations are 4PDT for 1, 3 and 5 amps, and DPDT for 5 and 10 amp switching.

Barriered contacts available on some versions for opposite polarity switching. All relays are available with either solder, or P.C. terminals. The 4PDT version is also available with bifurcated contacts. A full range of sockets are also available. This includes screw terminals, solder and printed circuit types.

For complete information and specifications, WRITE FOR OUR CLASS 78 BULLETIN. Magnecraft Electric Company, 5575 N. Lynch Avenue, Chicago, Illinois 60630.



Magnecraft®
ELECTRIC COMPANY

Circle 147 on reader service card

New products

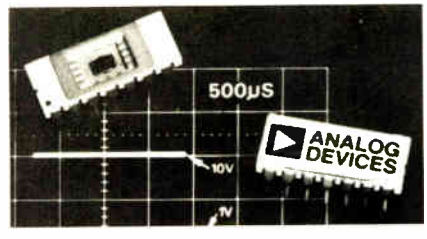
of 100. Delivery is from stock.
Texas Instruments Inc., Inquiry Answering Service, P.O. Box 5012, M/S 308 (Attn: TMS 2708), Dallas, Texas 75222. Phone David Ford at (713) 494-5115 Ext. 3281 [413]

Monolithic v-f converter operates up to 100 kHz

A monolithic voltage-to-frequency converter that sells for $9.50 in hundreds has a typical nonlinearity of 0.05% at 10 kilohertz and 0.1% at 100 kHz. Maximum nonlinearity for the AD537J is 0.15% at 10 kHz for temperatures from 0 to 70°C. A "K" version, which has a maximum nonlinearity of 0.07% at 10 kHz, is priced at $13.50. The "S" version, which sells for $19, has the same specifications, except that it maintains them over a range of −55 to 125°C.

All three units operate from a power supply of as little as 5 volts and consume only 1.2 milliamperes. They maintain their linearity down to frequencies well below 1 hertz, and they are guaranteed to operate over an 80-dB dynamic range. Output is a square wave, rather than a train of pulses, allowing the converter to transmit data over relatively narrow-band transmission lines.

Sensitive enough to transmit data from such low-level sources as thermocouples, the AD537 contains



a 1.00-volt reference supply for driving resistive transducers. A second temperature-sensitive output voltage enables the converter to function as the heart of a digital thermometer.
Analog Devices Inc., P.O. Box 280, Norwood, Mass. 02062. Phone Lowell Wickersham at (617) 329-4700 [414]

The great two for one ROM sale!

This is our wicked scheme to get you hooked on EA ROMs. If you order 1 to 1000 ROMs with new patterns before February 28, 1977 for delivery by May 30, 1977, we'll give you an equal number free.

The charge for the mask remains the same.

You'll be getting your memories from the world's largest supplier of high-density ROMs. Electronic Arrays has made ROMs with over 1800 different mask patterns. We were first to introduce big 16K ROMs. We now deliver over a billion bits of ROM every month — and are on our way to two billion per month.

For every one you buy you get another free

Here's your chance to get any of these five advanced N-channel MOS ROMs at an extraordinary bargain.

All these ROMs operate on a single +5v supply. (Many otherwise competitive ROMs require two or three supplies.) All are static. All connect directly to TTL logic. All come in 24-pin DIPs. Military versions meet the criteria of MIL STD 883 class B.

Order before February 28 to get the best ROMs at the best price ever.

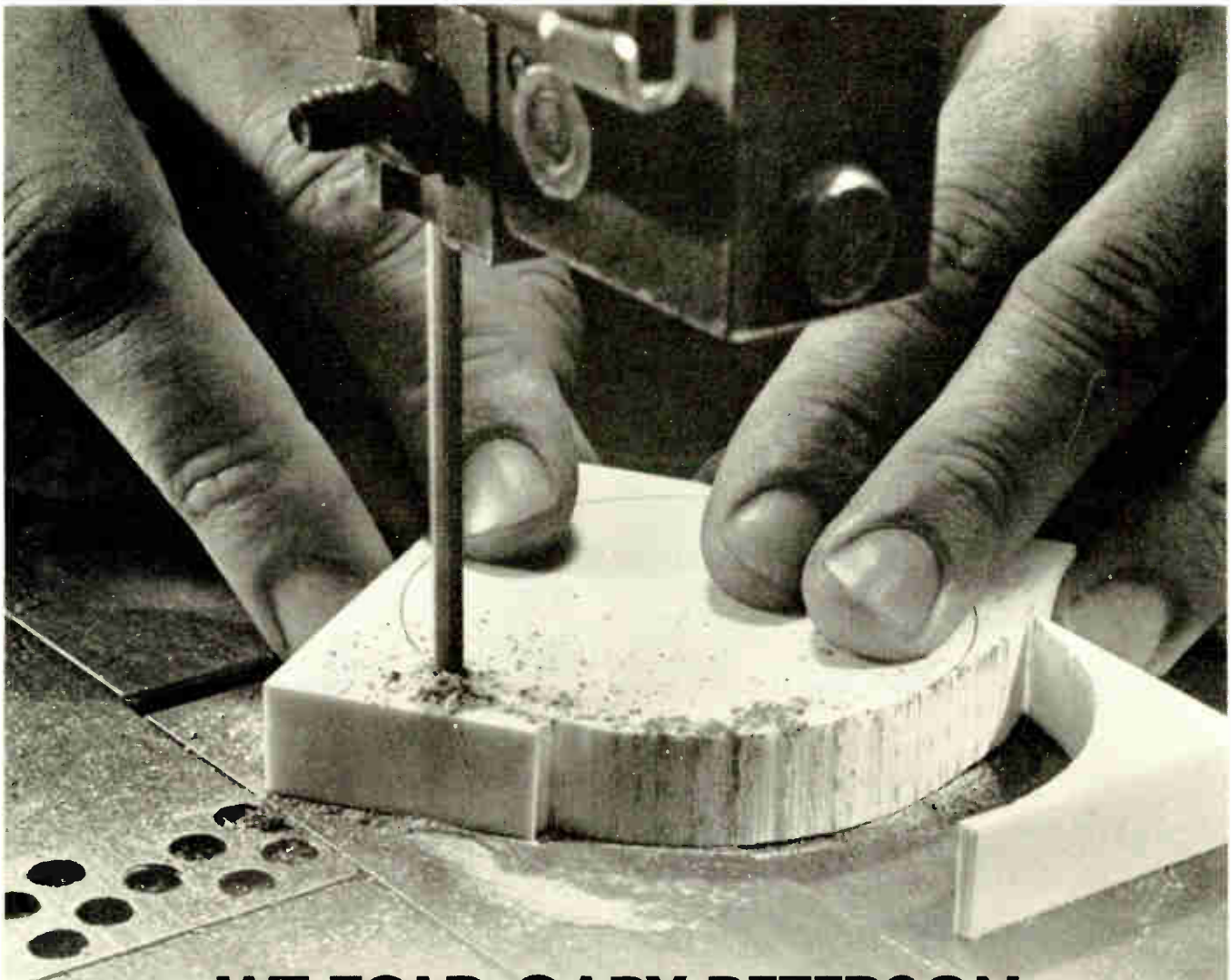
For more information, phone now on our toll-free WATS line listed below.

Type	Organization	Max. access	Power
EA4700	1024 x 8	350 ns	500 mW (.06 mW/bit)
EA2308* /8308A	1024 x 8	400 ns	500 mW (.06 mW/bit)
EA4600	2048 x 8 or 4096 x 4	550 ns	575 mW (.03 mW/bit)
EA8316E* /2316E	2048 x 8	425 ns	600 mW (.04 mW/bit)
EA8316A* /2316A	2048 x 8	600 ns	550 mW (.03 mW/bit)

*Intel replacement

Electronic Arrays Inc., 550 E. Middlefield Rd., Mountain View, Calif. 94043/tel. (415) 964-4321
TWX 910-379-6985
Outside California use toll-free
WATS (800) 227-9962
EAST, Cherry Hill, NJ
(609) 795-5066
WEST, Huntington Beach, CA
(714) 968-3775
EUROPE Aalsmeer, The Netherlands, 02977-23722
FAR EAST, Tokyo, Japan
(03) 591-5241.

electronic arrays



WE TOLD GARY PETERSON TO CUT IT OUT.

Design engineer Gary Peterson chose MACOR machinable glass-ceramic instead of alumina or beryllia for the 2½ inch diameter circuit base that is the heart of a new angle transducer manufactured by Hewlett-Packard.

In the past, such parts might have been made from alumina or berylia in a time-consuming, costly process that involves casting or pressing in a mold, then grinding and polishing to desired flatness.

Parts made from MACOR machinable glass-ceramic can be cut from bar stock with ordinary metal-working tools in one-tenth the time. Says Peterson: "MACOR enabled us to develop a product with minimum tooling."

With MACOR™ machinable glass-ceramic from Corning, it's easy

New HP 3810A Total Station electronic distance and angle measuring device

With MACOR machinable glass-ceramic, milling, threading, and boring can be performed to precision tolerances of ±0.0005 inch, using standard metalworking tools and equipment. No firing is required after machining. Available in sheet, rod and bar stock in standard sizes.

For more information and complete specifications, phone or write: Machinable Glass-Ceramic Department, Corning Glass Works, Corning, New York 14830. (607) 974-8626

MACOR machinable glass-ceramic. A better way of doing things . . . from Corning.

CORNING

Communications

Beeper cube is small but loud

Folded-horn device has free-field output of 105 dB at 1 inch and 2.1 kHz

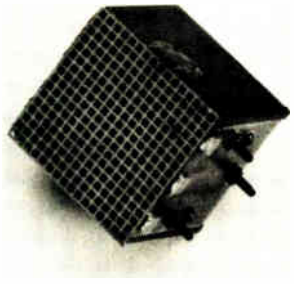
In designing transducers for portable pagers, the objective is to get the most sound out of the smallest volume at the lowest price. A miniature unit from Dyna Magnetic Devices probably comes nearer the target than anything previously developed. Its free-field sound output at 1 inch is a minimum of 105 decibels for an input power of 80 milliwatts at 2.1 kilohertz. Despite this high output, the cube-shaped device measures only 0.64 in. on a side and weighs less than 6 grams. The price in OEM quantities is less than $3.

The secret behind the transducer's performance is its folded-horn construction. In addition to a driver, the cube contains sound channels that comprise an exponential horn tuned to 2.1 kHz. Unlike a resonant cavity, the horn is a broadband device, so tuning is not critical. Its response cuts off at about 800 hertz and extends up to about 10 kHz. The performance is specified at 2.1 kHz because that frequency has become standard among manufacturers of the pocket-size paging devices commonly known as beepers.

The beeper cube is offered with impedances ranging from 2 to 2,000 ohms. It comes equipped with solder tabs for easy mounting on printed-circuit boards. A variety of mounting arrangements can be provided.

Although designed specifically for the mushrooming beeper market, which is expected to average 250,000 units a year over the next four years, the cube also has applications in computer fault alarms and in other electronic systems. In one application, for example, a beeper cube is used in conjunction with a keyboard to provide audible verification of each keystroke. Finally, because of its relatively wide bandwidth, the cube makes an acceptable loudspeaker for voice communications when small size is more important than high fidelity.

Dyna Magnetic Devices Inc., 200 Frank Rd., Hicksville, N.Y. 11802. Phone (516) 681-5100 [401]



Tone-separation filter gives 30-dB separation

A pretuned hybrid active filter that separates composite low- (200 hertz to 940 Hz) and high- (1,209 Hz to 3,000 Hz) group frequencies into independent low- and high-tone outputs provides a minimum of 30 dB of separation between low- and high-group tones. The filter is intended for such dual-tone detection applications as alarm-status reporting, supervisory control, data-transmission, radio paging, and, of course, Touch-Tone telephone signaling. Priced at $76.50 each for quantities of 10 to 24, the model 6300-001 has a delivery time of three weeks.

Data Signal Corp., 40-44 Hunt St., Watertown, Mass. 02172. Phone Clarence Walker at (617) 926-5080 [404]

9,600-b/s modem meets CCITT recommendation V.29

Developed to meet international requirements for high-speed modems that are compatible with CCITT Recommendation V.29, the LSI 96/V.29 can operate at 9,600 bits per second over M58 or M102 trans-

New products

mission lines. In accordance with the recommendation, the modem uses an adaptive equalizer, plus combined phase and amplitude modulation. The modem is available with such options as an eye-pattern generator, a four-channel multiplexer, a four-channel buffered multiplexer, remote loopback, a 75-b/s secondary channel, alternate voice/data, an elastic store buffer for master-clocked systems, and a built-in modem-sharing unit. In small quantities, the basic modem sells for $9,350. Delivery time is 30 days.

Codex Corp., 15 Riverdale Ave., Newton, Mass. 02195. Phone (617) 969-0600

Codex Europe SA, Bte 7/Ave de Tervuren 412, B-1150 Brussels, Belgium. Phone 762.23.51 [403]

Synchronous modem runs at 4,800 b/s

The Micro-Processor 48 synchronous-transmission modem operates at 4,800 bits per second. Able to work in multipoint, point-to-point, or switched environments, it uses a microprocessor to perform all arithmetic calculations involved in automatic adaptive equalization, line filtering, signal modulation and demodulation, and data randomizing. Available in both end-user and OEM packages, the modem sells for $3,000 in single quantities and $2,500 in lots of 30. It can also be leased for $105 a month on a two-year contract or $95 a month on a three-year lease.

Paradyne Corp., 8550 Ulmerton Rd., Largo, Fla. 33540. Phone Robert Budenstein at (813) 536-4771 [405]

Slow-scan TV system operates over voice lines

The Phoneline Television System, which operates at a reduced bandwidth, can transmit images from one or more closed-circuit TV cameras to one or more monitors anywhere in the world via ordinary voice-grade phone lines. The heart of the system

Developed specifically to meet the increasingly stringent safety standards and regulations for electrical and electronic products, General Electric's LEXAN 940 resin provides a new level of performance in flame-retardant materials.

Based on a technological breakthrough, LEXAN 940 resin, both opaque or transparent, offers a UL 94 V-O* rating, an oxygen index of 35 and lower smoke emission. Yet, unlike ordinary flame-retardant plastics, it doesn't sacrifice processability. Melt strength, mold shrinkage and surface appearance are excellent. Forget streaked molded part surfaces.

What's more, new LEXAN 940 resin offers all the standard LEXAN resin properties, including lower finished part cost than metal, metal-like strengths, 110°C (with impact) UL continuous-use rating, high dielectric strength, clarity or molded-in color, and excellent dimensional stability, weatherability and gloss.

Best of all, it's been proven. For case histories and complete information, write: LEXAN Products Section 286, Plastics Division, General Electric Company, One Plastics Ave., Pittsfield, MA 01201.

* This rating is not intended to reflect hazards presented by this or any other material under actual fire conditions.

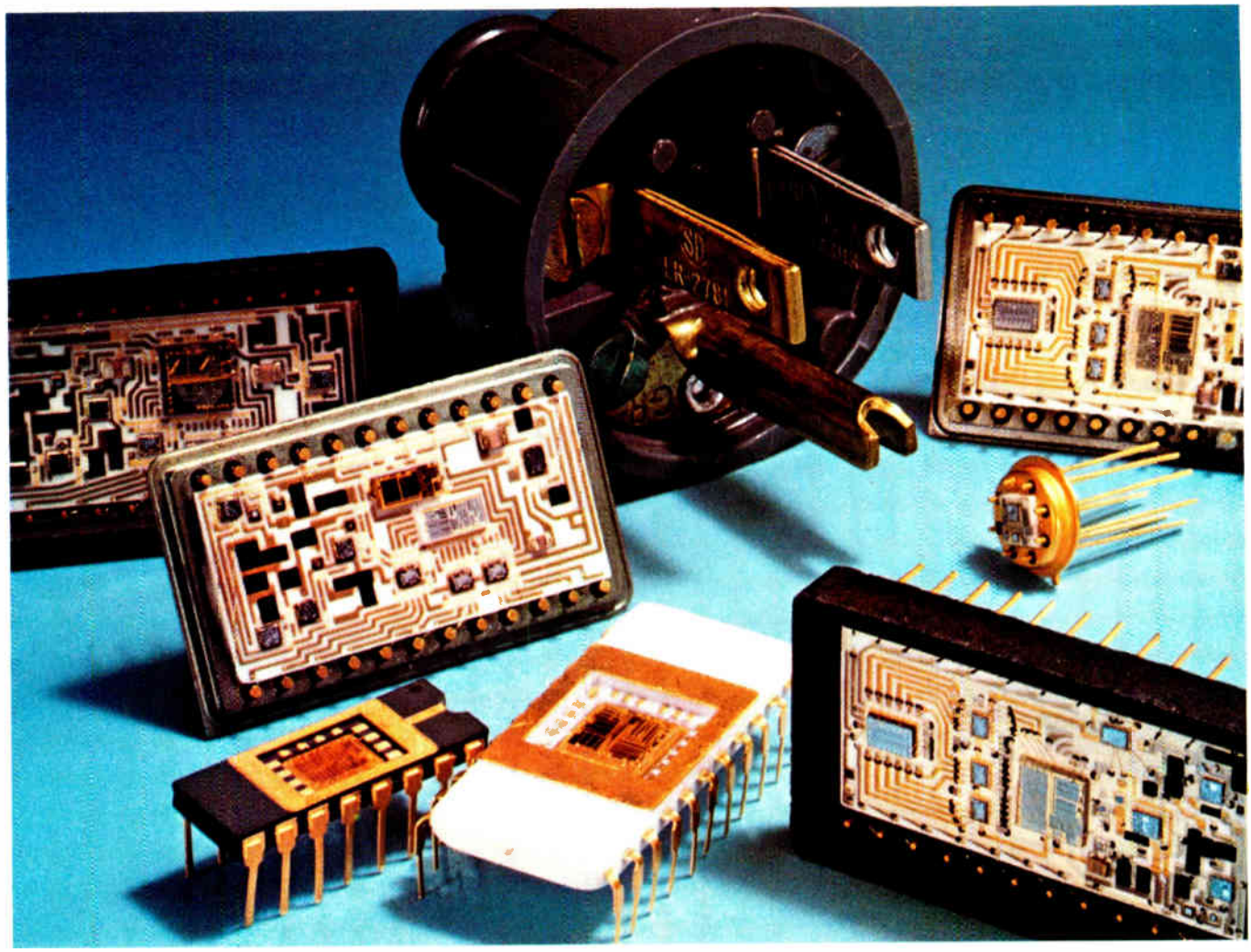
IF YOU'RE CAUGHT BETWEEN METAL'S COSTS AND FLAME-RETARDANT PLASTIC'S PROCESSING PROBLEMS, NEW LEXAN® 940 RESIN CAN GET YOU OUT.

WHAT THE WORLD IS COMING TO: GE PLASTICS

LEXAN® NORYL® VALOX® GENAL®

GENERAL ELECTRIC

Circle 153 on reader service card



Our new low-cost industrial converter products are standard, too.

Standards, like that plug, make life less complicated.

That's why we're leading the campaign to standardize converter products.

And the group you see here is just part of a growing family that starts as low as $19.50 in the 100-piece quantity.

They're on-the-shelf, for quick delivery. A new line of DAC's and ADC's for designers who can use standard functions. Plus thin-film ladder networks and a precision voltage reference to give exceptional design flexibility.

These competitively priced, industry-standard converter products can save you engineering, manufacturing, and inventory time and money. And you have a wide selection of package types and temperature ranges to fit your exact applications.

Learn more about Beckman-quality, Beckman-backed hybrids. They'll make your life easier, too.

For data, write or call Helipot Division, Beckman Instruments, Inc., 2500 Harbor Blvd., Fullerton, CA 92634. Phone: (714) 871-4848, Ext. 1776.

BECKMAN®

HELIPOT DIVISION

If you need hybrids, you should know about Beckman.

is the series 500 scan converter, which converts normal 525-line real-time images into 128-line-by-128-line images that are produced at the rate of one every 8 seconds. Motion is simulated by a wiping effect in which a new image replaces the old one by being wiped onto the screen from top to bottom.

Although the system is not suitable for fast-action situations, it is expected to have many applications such as monitoring instrument gauges, comparing signatures on checks, identifying a person's face, and security monitoring.

Robot Research Inc., 7591 Convoy Court, San Diego, Calif. 92111. Phone Joseph Hawkins at (714) 279-9430 [407]

Fiber-optic LED driver operates at 5.0 megahertz

A module that converts TTL levels into currents suitable for driving light-emitting diodes in fiber-optic communications systems operates from dc up to a minimum of 5.0 megahertz. Although the LED current is limited to 100 milliamperes by an internal resistor, provision is made for an external resistor to increase the current as high as 300 mA. The model FDM-1D-D has a strobe pin that may be used to disable the device on command. This makes it easy to distribute data from a common source, via several optical links, to various designations. Housed in a 24-pin plastic dual in-line package, the FDM-1D-D sells for $35 each in lots of one to nine, dropping to $28 in quantities of 10 to 49. Delivery is from stock to three weeks.

Radiation Devices Co., P.O. Box 8450, Baltimore, Md. 21234. Phone (301) 628-2240 [408]

Voice recorder contains no moving parts

A voice recorder that uses a solid-state memory instead of magnetic tape is reported to be much more

New products

Industrial

Panel counter is easy to program

Thumbwheel control provides readings directly in engineering units

A problem with most factoring counter/timers—meters with time periods that can be adjusted so they read directly in engineering units—has been that they are difficult to program. Typically, the user has to consult a thick reference manual to determine exactly how to connect the programing pins to get the time period he needs.

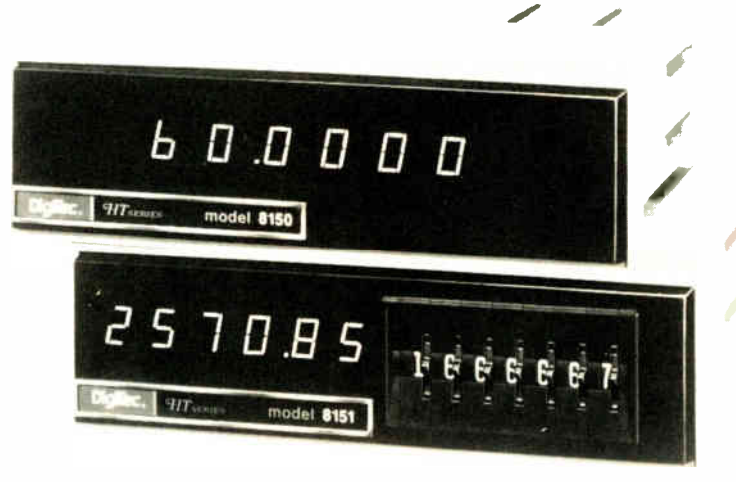
DigiTec's 8150 series makes things much simpler. With three of its models—the 8151 counter, the 8156 totalizer, and the 8159 timer—programing is simply a matter of setting an array of seven front-panel thumbwheel switches. Its other three models—the 8150 counter, the 8155 totalizer, and the 8158 timer—are programed by an orderly interconnection of decimal jumpers on the rear connector. Once the user is familiar with the instrument, he has no need to consult the instruction manual every time he wants to make a change in the program.

All six models in the series operate from any transducer that produces pulses with amplitudes from 10 millivolts to 170 V rms. Input shaping circuits span the frequency range from dc to 1 megahertz and include provision for contact debouncing. Standard features include a crystal clock for precision time measurements, C-MOS and p-MOS large-scale-integrated circuitry for high noise immunity and low power consumption, and a six-digit light-emitting-diode display.

Among the available options are a comparator alarm, binary-coded-decimal output, and two input multipliers. The comparator alarm indicates by relay closure or TTL-level output that a predetermined limit has been exceeded. The limit is set by front-panel thumbwheel switches.

Field-installable, the buffered, parallel BCD output is TTL-compatible and offers single-line-enable operation. The single-line-enable feature permits the BCD outputs of many instruments to be connected in parallel to a common data bus and addressed individually by a single line. This eliminates the costly switching of multiple BCD lines.

The input multipliers reduce the time required to make a high-resolution measurement on a low-rate input signal. One option is a simple



SHOULDN'T YOUR FREQUENCY COUNTING DOLLARS BUY TIME, TOO?

It used to be that to get time *and* frequency measurements you paid extra.

No more.

For about what you would pay for frequency measurement only, Fluke's 1900A counter gives you multi-function capability.

And for $375*, some features you just wouldn't expect.

We give you a broad frequency range from 5 Hz to 80 MHz with sensitivity of 25 mV, typically 15 mV.

Four manually selected gate times give resolution down to 0.1 Hz.

Then, true to its name, the 1900A multi-counter gives you a period mode. With it you can measure the duration of a single input cycle, useful for high resolution of low frequencies.

For finer resolution, the 1900A has a period average mode for averaging cycle times over 10, 100 or 1000 cycles.

You can't do that with "frequency only" counters.

Another extra built into the 1900A is the totalize mode. With six-digit LED display, the 1900A will totalize 10^6 events and provide overflow indication after that. And annunciation in MHz, kHz, ms or µs is automatic.

We've also built ease of operation into the 1900A. For times when training is a bottleneck, you get autoranging.

This feature automatically selects the most suitable gate time (or period averages) for the highest signal resolution without overflowing.

Simple to use.

And the 1900A has autoranging hysteresis that makes it easy to measure signals full of a lot of frequency or phase modulation.

Redundant up- and down-ranging is eliminated.

And to ensure that initial measurements are correct, the 1900A has autoreset. With it a new measurement sequence begins every time a front panel switch is activated.

Of course, you can expect Fluke quality in the 1900A. LSI/MOS circuitry design is standard. That means high performance with low power consumption.

We think anything less would be a waste of money.

And leading zero suppression will give you an unambiguous display.

The 1900A's dependable 10 MHz timebase is extremely temperature-stable and well-specified over time, too.

And don't fear that operating a 1900A in electrically noisy environments will detract from its good specs.

We planned for that.

A selectable 1 MHz low-pass filter provides input signal conditioning for accurate low-frequency measurements in the presence of noise.

And because we know that you need to make measurements away from the bench sometimes, we've provided an option that the competition doesn't. Battery operation.

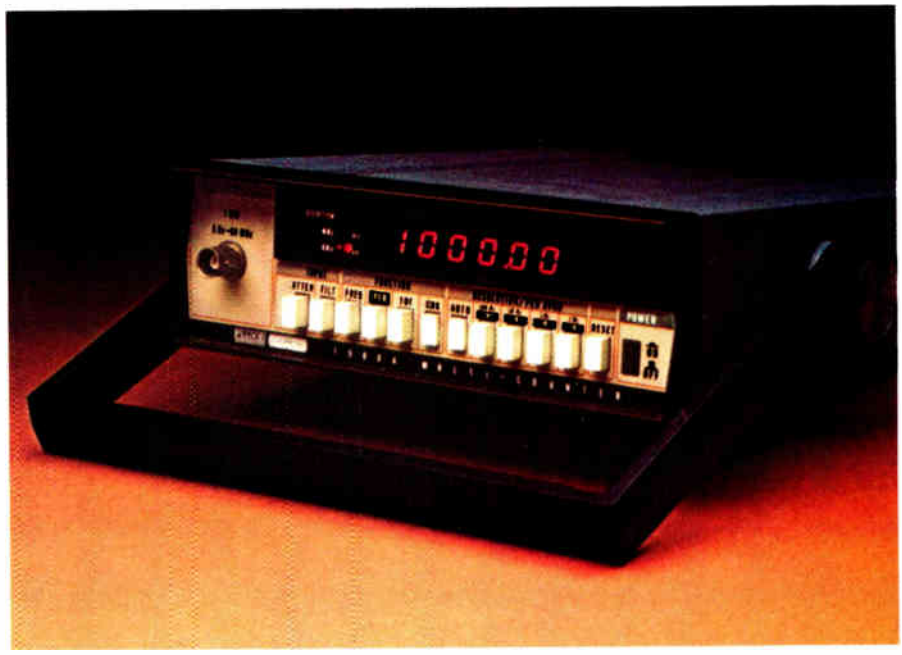
For $50 you can get a rechargeable battery pack. It's good for up to 5 hours of operation away from line power.

The 1900A also comes with a data output option with 8-4-2-1 BCD output from each digit.

So, if you want to get a lot of function for your dollar, get a 1900A multi-counter.

You'll find that economy counts.

For data out today, dial our toll-free hotline, 800-426-0361.
John Fluke Mfg. Co., Inc., P.O. Box 43210, Mountlake Terrace, WA 98043
Fluke (Nederland) B. V., P.O. Box 5053, Tilburg, The Netherlands.
Phone: (013) 673-973 Telex: 52237
*U.S. price only.



MULTIFUNCTION 1900A COUNTER. FLUKE®

For demonstration circle 160 on reader service card

For literature circle 211 on reader service card

times-two multiplier. The second provides three switch-selectable multiplication factors: 10, 100, and 1,000.

Pricing on the 8150 series panel instruments is $450 for the thumbwheel-programable units and $375 for the others. Delivery time is eight weeks.

United Systems Corp., 918 Woodley Rd., Dayton, Ohio 45403. Phone Mike Elovitz at (513) 254-6251 [371]

Digital pressure indicator includes metric scales

Designed to read pressure in pounds per square inch, bars, kilograms per square centimeter, and kilopascals, the 93PM series of digital pressure indicators contains models that cover four ranges from 3 psi full scale to 3,000 psi full scale. Each model has a conversion switch that enables it to display results in all four units.

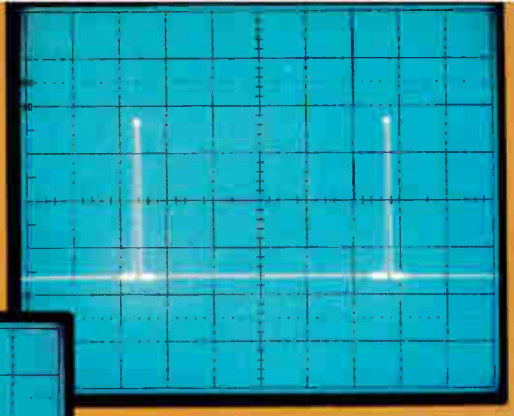
Although it measures only 10 by 6 by 3 inches, the 93PM units are completely self-contained pressure-measuring instruments. They contain an LVDT pressure sensor, a power supply, signal-conditioning circuitry, and a 3,000-count display. Priced below $600, the meters have a delivery time of six to eight weeks.

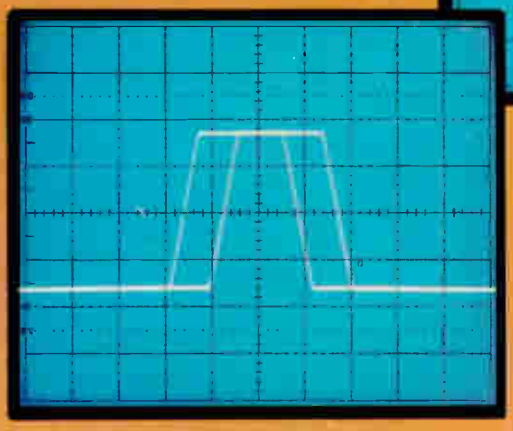
Ametek Controls Division, 860 Pennsylvania Blvd., Feasterville, Pa. 19047. Phone (215) 355-6900 [375]

Digital unit provides control of stepping motors

Designed for the open-loop control of stepping motors, the new model MCU-652 can operate in distance, speed, or acceleration modes. In its distance mode, the controller provides up to 1 million steps in increments of one step. Speeds up to 10,000 steps per second are provided in increments of one step per second, while speeds up to 100,000 steps per second can be controlled to a precision of 10 steps per second. The universal motor controller can cause

Now 1% time measurements are this easy...





1 **Position intensified spots at beginning and end of time interval.**

2 **Switch to delayed sweep mode and use Δ Time dial to superimpose beginning and end of interval.**

3 **Read time interval directly.**

Faster Timing Measurement
Differential time measurements are made faster when the new DM 44 *with Delta Delayed Sweep** and direct numerical readout is included on a TEKTRONIX Portable Oscilloscope. At the same time, measurement repeatability is improved, the chance for computational errors is eliminated, and 1% accuracy is consistently achieved. Frequency measurement (on periodic waveforms) with 2% accuracy is obtained by simply pushing the 1/Time button.

Built-in DMM as a Bonus
There's no need to carry a separate multimeter. DM 44-equipped TEKTRONIX Portables also measure dc voltage with 0.1% accuracy and temperature from −55° C to +150° C simultaneously with oscilloscope display of related waveforms. And you get ohms measurement with 0.25% accuracy as well.

Your Choice of Oscilloscope Performance
The DM 44 is available on five high-performance portable oscilloscopes to best match your performance and price needs. Choose bandwidth of 100, 200, or 250 MHz. Or select from two fast storage models. One actually stores single-shot signals at its full 100 MHz bandwidth.

Due to highly cost-effective design, the outstanding DM 44 option adds only $410 to the price of the basic portable oscilloscope chosen. All DM 44-equipped TEKTRONIX Portable Oscilloscopes, and seven more models as well, perform analysis on up to 16 channels in the digital domain by simply adding the LA 501W Logic Analyzer. Capabilities of the DM 44 are also available in the TEKTRONIX 7000 Series of plug-in oscilloscopes.

Let Us Show You
To see how the DM 44 makes faster, more accurate measurements in your application, contact your Tektronix Field Engineer. Or write to Tektronix, Inc., P.O. Box 500, Beaverton, Oregon 97077 for complete information. In Europe, write to Tektronix, Limited, P.O. Box 36, St. Peter Port, Guernsey, Channel Islands.

*Two independently adjustable delayed sweeps.

U.S. Sales Price FOB Beaverton, Oregon

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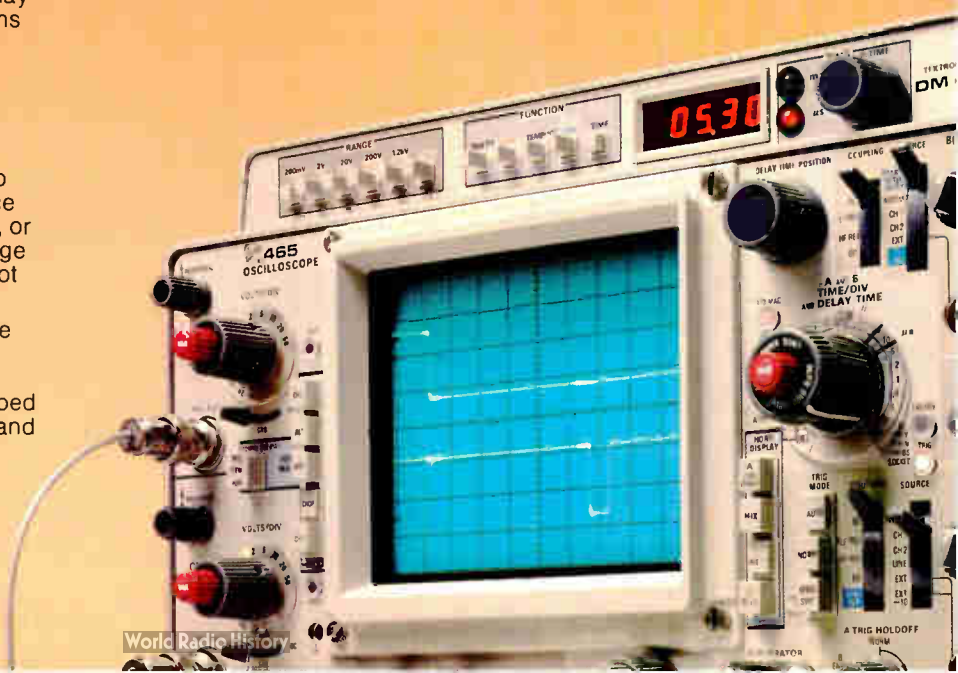
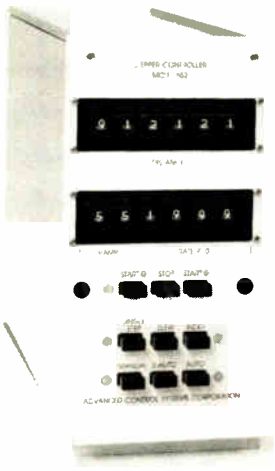


Circle 162 on reader service card

New products



a stepping motor to accelerate or decelerate at 100 different rates.

Compatible with 8- or 16-bit microprocessors, the MCU-652 has manual, semiautomatic, and automatic modes of operation. It can cause a stepping motor to single-step, index, or slew at the touch of a front-panel button. It sells for $800. Advanced Control Systems Corp., 28C Vernon St., Wakefield, Mass. 01880. Phone (617) 245-8070 [373]

Noncontacting thermometer reads from 10°C to 1,000°C

Point the model DHS-16 Heat-Spy at a target up to 20 feet away, pull the trigger, and read the target temperature on a built-in light-emitting-diode display. The instrument has a resolution of 1°C, a range of 10°C to 1,000°C, and a response time of 1 second. Targets for the infrared-sensing device can be as small as 2

New products

inches. Intended for general-purpose industrial applications such as measuring the temperature of moving glass, steel, and plastic film, the DHS-16 can also detect hot spots in rotating machinery, monitor bearings, scan piping, and perform other maintenance and troubleshooting tasks.

Heat-Spy Division, William Wahl Corp., 12908 Panama St., Los Angeles, Calif. 90066. Phone (213) 822-6144 [374]

Reference source calibrates infrared instruments

Designed for the calibration of noncontacting infrared thermometers, the model 11-210 radiation reference source uses the proven cylindrical/conical cavity design to achieve characteristics close to those of an ideal black body. To minimize alignment problems and assure accurate calibration of infrared instruments, the model 11-210 precisely follows a cosine-law distribution over the central 15° of its cone of radiation. The reference source's electronic controller can be set to produce any temperature between 50° C and 1,000° C. It uses zero-voltage switching to minimize radio-frequency interference due to switching transients.

Barnes Engineering Co., 30 Commerce Rd., Stamford, Conn. 06904. Phone Ms. Jayme Prins at (203) 348-5381 [377]

Recording wattmeter shows power-usage patterns

The Powerscribe recording wattmeter combines power-measuring transducers with a chart recorder to provide a record of instantaneous power consumption as a function of time. The unit measures true-rms power consumption regardless of waveshape or power factor. Single- and three-phase models are available.

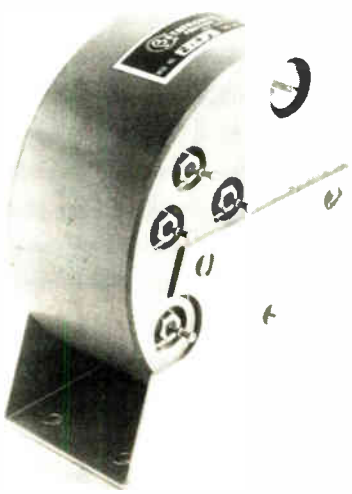
Compact and self-contained, the Powerscribe allows users to measure the cost effectiveness of a particular

machine or operation. Its permanent record makes it easy to determine on/off cycle times, maximum peak demands, and other power-flow parameters. The chart recorder uses inkless paper and can be supplied with chart speeds suitable for short- or long-term recording. The Powerscribe sells for $625.

Zi-Tech Division, Aikenwood Corp., 2151 Park Blvd., Palo Alto, Calif. 94306. Phone Geoff Ziman at (415) 326-2151 [378]

Pendulum pots measure angles from vertical

A group of pendulum potentiometers for the direct measurement of angular displacements from a vertical reference axis is offered with a choice of wire-wound or conductive-plastic elements. The pots consist of a pendulum suspended on two low-torque bearings and connected to a wiper arm. The wiper arm contacts the resistive element, which is attached to the pot case.



The mechanisms are hermetically sealed in silicone oil, which acts as a damping medium. Various oil viscosities may be specified to provide the damping characteristics required by a particular application. Pendulum potentiometers are available with diameters of 2.5 and 3.0 inches.

Pendulum Pots, Betatronix Inc., 100 Ricefield Lane, Hauppauge, N.Y. 11787. Phone Joseph J. Yanosik at (516) 543-8780 [376]

We're the only total memory supplier.

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Only Signetics has a complete line of Bipolar & MOS memories.

There are definite advantages in doing business with a total supplier. Most obvious, you get everything you need from one source without shopping all over the country. So you save time and all the hassle.

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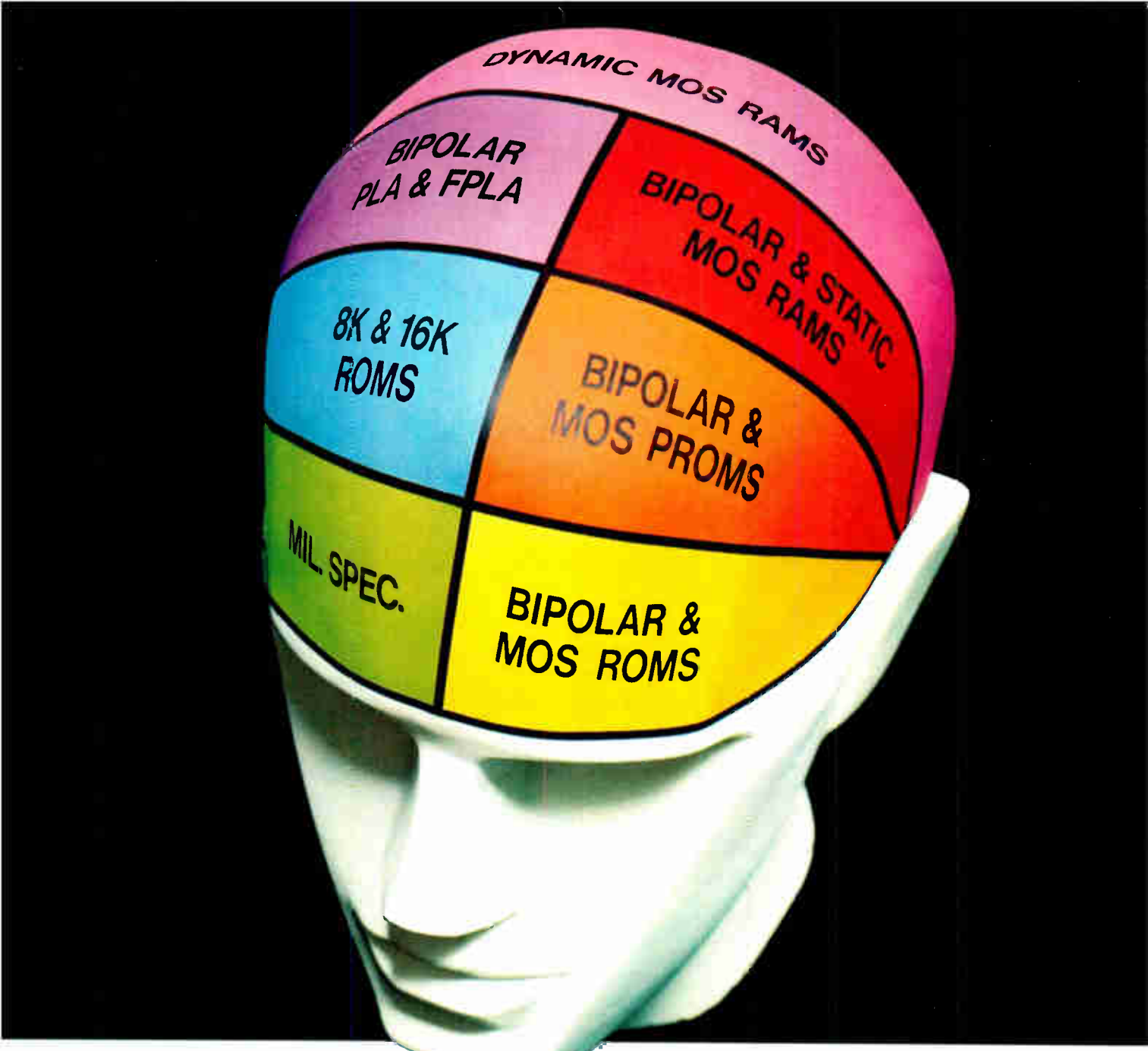
Signetics has made a positive commitment to stay ahead in technological leadership in Bipolar & MOS memories. No brag, just fact. With years of experience in supplying the needs of major customers and being a subsidiary of U.S. Philips Corporation, Signetics has the resources to make it happen.

Signetics has a total product line of memories—RAMs, ROMs, PROMs, FPLAs/PLAs and a long list of Shift Registers including 12 Static and 8 Dynamic from 100 to 1024 bits.

Signetics Bipolar & Static MOS RAMs. Signetics' total line of Bipolar & MOS devices includes all the hard-to-find and in-demand devices. 24 Bipolars—8 to 1024 bits. 14 MOS Statics—256 x 4 to 1024 x 1. 1K x 4 and 4K x 1 available 1st quarter '77.

Signetics Dynamic MOS RAMs. The most complete line of dynamic MOS RAMs from 1024 x 1 to 4096 x 1 (16, 18 and 22 pin). 1024 x 1 to 4096 x 1 organization. 16K x 1 available 1st quarter '77.

Signetics Bipolar & MOS ROMs. These mask-programmable chips offer easy word expansion. 13 Bipolars in stock—256 to 16K bits. 7 MOS Statics in stock—up to 16K bits. Plus 4 character generators including 8K's. Both T'S and OC available.



Signetics Bipolar & MOS PROMs. All readily available through a vast Signetics distributor programming network. The new 18-pin devices offer small size, high PC board packing density, low complexity, very low power, and low component and system cost. 17 Bipolars in stock from 256 to 8K bits, with 16K available 1st quarter '77. 4K and 8K MOS EROMS available 1st quarter '77.

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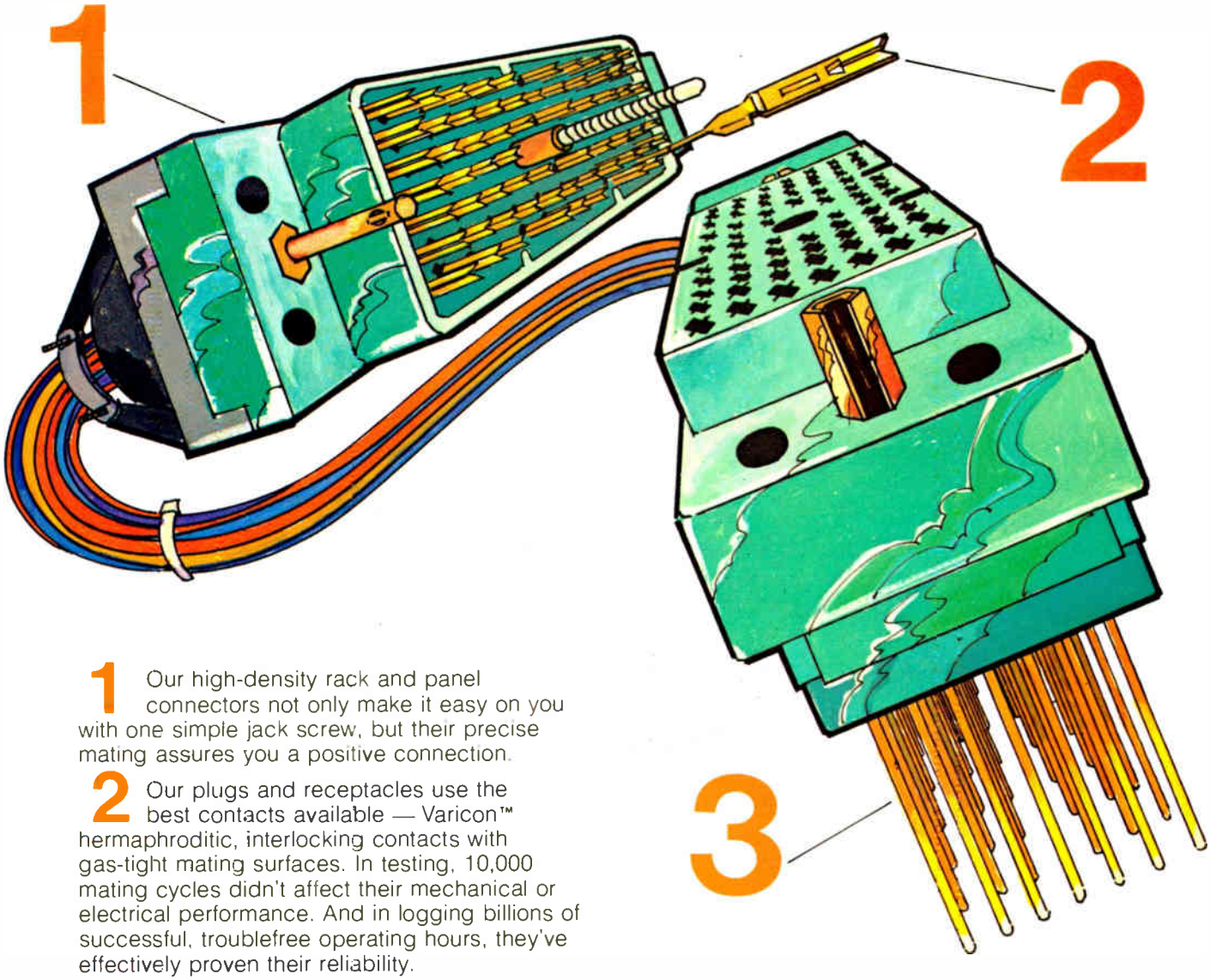
Circle 167 on reader service card

here's what counts

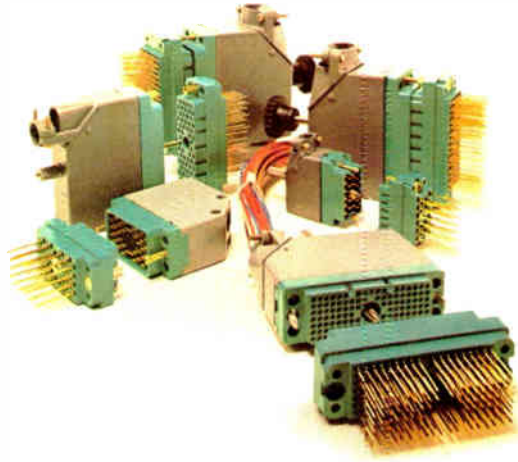


1 Our high-density rack and panel connectors not only make it easy on you with one simple jack screw, but their precise mating assures you a positive connection.

2 Our plugs and receptacles use the best contacts available — Varicon™ hermaphroditic, interlocking contacts with gas-tight mating surfaces. In testing, 10,000 mating cycles didn't affect their mechanical or electrical performance. And in logging billions of successful, troublefree operating hours, they've effectively proven their reliability.

3 They come in .100", .125", .130" and .150" contact spacings with 20 to 165 contacts and a large variety of terminations including crimp, solderless wrap, solder, et cetera. And most meet military specifications and are QPL approved. We offer covers, polarizing pins, brackets, plus a lot more — like economical pricing and immediate delivery from your local distributor. And if you need something special, we'll make it for you.

Imitation is the sincerest form of flattery. But we've got the original to give you great connections . . . worldwide.

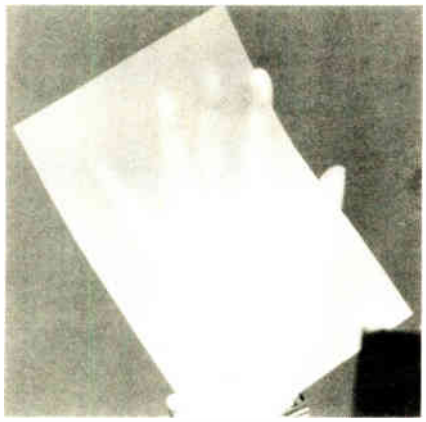


Elco Corporation
2250 Park Place. El Segundo, Ca. 90245
TWX 910-325-6602 / 213 675-3311

Elco Corporation
a Gulf + Western manufacturing company

New products/materials

Polyester film that diffuses light from light-emitting diodes and maximizes transmission without creating hot spots eliminates the need to cast diffusing elements. Called 3M Light Diffusing Film, the material was designed to provide the most readable compromise between diffusion and brightness for numerical-readout instruments such as calculators



and digital watches. Standard offerings include 3-mil and 8-mil films in rolls 11 inches wide. Optical transmission is a nominal 55%, color is neutral gray, and a transmitted gain of either 3.00 or 5.00 can be supplied.

3M Co., Industrial Optics, Visual Products Division, Dept. VP6-27, St. Paul, Minn. 55133 [476]

A conductive yarn that is more flexible and lighter than metallic filaments is available in monofilament and multifilament forms and as a cut staple fiber for blending with other fibers. Made of silver-coated polyamide, the yarn is especially useful when incorporated into systems where static electricity must be controlled. It can also serve as the shielding material in coaxial cable and has been employed in the fabrication of extremely lightweight Faraday cages.

Rohm and Haas Co., X-Static Product Group, Fibers Division, Independence Mall West, Philadelphia, Pa. 19105 [477]

A piezoceramic filter material can be used to fabricate filters that drift less than 0.1% in five years and less than 0.2% over the temperature range from −40 to 85°C. Over the more limited temperature range from 0 to 50°C, the maximum drift is 0.1%. The material is especially intended for the fabrication of intermediate-frequency filters centered at 455 kilohertz.

Channel Products Inc., 16722 Park Circle Drive West, Chagrin Falls, Ohio 44022 [480]

A ceramic marking pencil available in either brown or white leaves marks that remain visible and stable even when the ceramic substrate to which they have been applied is heated to 1,200°C. Above this temperature, the markings gradually begin to lose their color; the color burns off completely at 1,550°C. Unaffected by chlorinated hydrocarbons, alcohols, or other commonly used solvents, the markings can be heated to the 1,200°C temperature in air as well as in an inert atmosphere. The pencils are packaged and sold in lots of one dozen. Available from stock, they are priced from $15 a dozen in lots of two to $10 a dozen for orders of 20.

Electro Materials Corp. of America, 605 Center Ave., Mamaroneck, N.Y. [479]

An aerosol refrigerant that can instantly cool small parts down to −50°F (−45°C) can aid in the locating of faulty components and connections. Sprayway Instant

Freeze No. 103 is nonflammable and leaves no residue. The product is packaged in a 15-ounce aerosol can.

Sprayway Inc., 484 Vista Ave., Addison, Ill. 60101 [478]

MDB SYSTEMS presents... The LSI-11 Connection

GP Logic Modules · Peripheral Controllers · Communications · Interfaces · Special Purpose Modules · Accessory Hardware

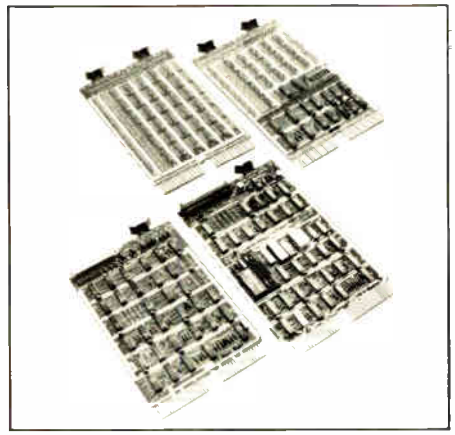
Plus: DEC's own LSI-11 Microprocessor Module. MDB Systems products always equal and usually exceed the host manufacturer's specifications and performance for a similar interface. MDB interfaces are software and diagnostic transparent to the host computer. MDB products are competitively priced; delivery is usually within 14 days ARO or sooner.

Here are some MDB Systems connections to LSI-11 microprocessors:

- ☐ General Purpose Controllers:
  - Serial for TTY, displays, communications
  - Parallel for programmed I/O and DMA
  - Do-it-yourself dual and quad wirewrap for any DIP design
- ☐ Device Controllers for most major manufacturer's
  - Printers
  - Card equipment
  - Paper tape equipment
  - Plotters
- ☐ Communications/Terminal Modules
  - Asynchronous Serial Line Interface
  - Synchronous Serial Line Interface
- ☐ MDB Backplane/Card Guide Assembly
  - MDB's is a *real* chassis, accepts eight quad modules
- ☐ Special Purpose Modules and Accessories
  - System monitoring unit provides front panel
  - Switch addressing
  - Power on/off sequencing
  - Bus extenders/terminators
  - E-PROM and PROM modules
  - Bus connectors for backplane assemblies

Check first with MDB Systems for your LSI-11 interface requirements.

MDB also supplies interface modules for DEC PCP-11, Data General NOVA, and Interdata minicomputers.



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Circle 170 on reader service card

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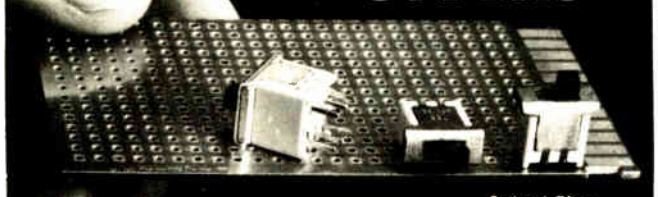

Actual Size

THE TINY SLIDE SWITCHES

TSS Series Slide switches utilize the basic contact assembly from our dependable TT Series. Available with either standard PC or Right Angle terminals. All terminals and mounting pins fall into standard 0.1" grid patterns. Double pole versions readily fit between PC boards on 1/2" centers. Gold contacts and terminals. Choice of .110" or flush actuator. Call us at (617) 685-4371 for more detailed information.

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Circle 214 on reader service card

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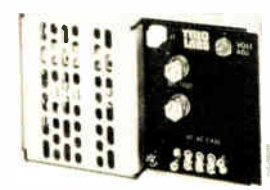
MAXI-POWER® 682



A 750 watt (5VDC at 150a) Switching Power Supply that has so many features it surpasses comparison.

- Input 208VAC nominal (115VAC-Model 683).
- Low Line -30% (146VAC).
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- Efficiency up to 85%.
- Output 2-48VDC standard.
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- Output voltage adjust.
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- Self Cooling
- Parallelable.
- U.L. recognized (approved).
- 5x8x11"
- Up to 2 watts/in^3.
- As low as 63¢/watt.

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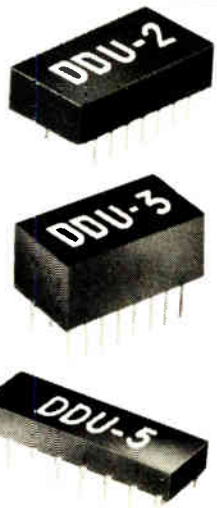
DIGITAL DELAY LINES



Data Delay Devices has developed a digital delay unit, series DDU, which eliminates the interfacing in T²L circuits.

With the following advantages:

- T²L input and outputs
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- Each tap isolated and with 10T²L Fan-out capabilities
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- Up to 10 taps

Request spec. sheet DDU

DATA DELAY DEVICES

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NI 2001 WAVEFORM AND DATA RESEARCH SYSTEMS

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For: Atkinson, Wisconsin 53538 (414) 563-8456

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Computer and communications interfacing is simplified by your choice of 8 bit parallel or 8 bit serial option boards — which include Bi ϕ level — The ANSI/ECMA Standard.

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Unit price $525, 100's $325 plus options.

MFE

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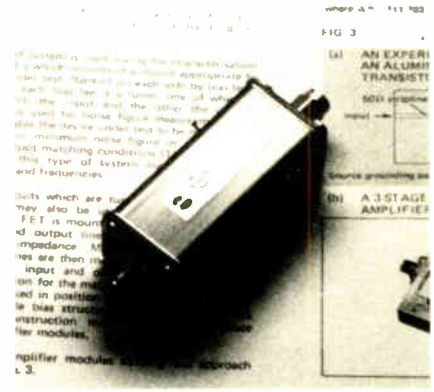
Circle 171 on reader service card

New literature

GaAs FETs. A 12-page application note covers the new techniques of circuit design and device handling required when using gallium-arsenide field-effect transistors to make microwave amplifiers. The note explains the structure and operation of

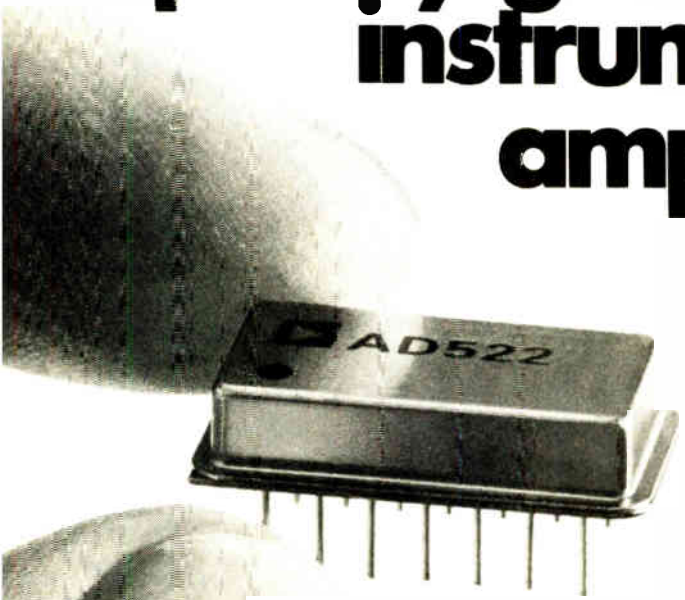


microwave GaAs FETs, shows how to characterize both devices and amplifiers, and provides practical details of circuits for amplifiers up to 6 gigahertz. Copies can be obtained from Rand Burke, optoelectronics and Microwave Marketing Manager, Plessey Microsystems, 1674 McGaw Ave., Irvine, Calif. 92714. Circle reader service number 421.

Voltage regulators. A voltage-regulator handbook that places special emphasis on design techniques also includes catalog data on most of the three-terminal and dual-tracking regulators made by National Semiconductor. The handbook starts with the basics of power-supply design and covers transformer specification, rectifier circuits and how to specify them, filtering, and load effects. Heat flow, current limiting, electronic shutdown, and the design of high-voltage circuits are among the other subjects covered. To order a copy, send $3 (California residents add 6% sales tax) to the Marketing Services Department, National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, Calif. 95051 [428]

Microcomputer terms. More than 200 microcomputer-related terms are defined in a compact 44-page booklet. Called the LSI-11 Micro-

Some companies can build a pretty good case for their instrumentation amplifiers.



We've built the best case for "worst case" conditions.

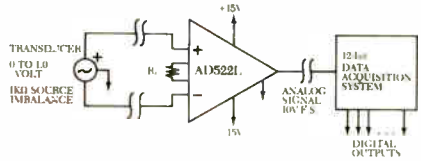
It's the hermetically-sealed, electrostatically- and electromagnetically-shielded metal dual-in-line package that protects our new AD522 precision IC Instrumentation Amplifier.

The AD522 is designed for people who need very accurate and economic amplification of low-level transducer-generated signals in environments that are characterized by noise, fluctuating temperatures, and unbalanced signal impedances. The inherent stability of its thin film substrate is also a major advantage in environments in which the location of the amplifier may be sufficiently remote so as to make recalibration difficult.

The AD522 precision IC Instrumentation Amplifier uses hybrid technology to present a bold new solution to the problems of performance, cost and measurement accuracy. It offers module performance and IC reliability at IC prices (as low as $13 in 100's). So that it fits both your "error budget" and your "cost budget".

Its rugged, MIL-quality package allows the AD522 to maintain its high accuracy under "worst case" operating conditions: output offset voltage drift below 10 μV/°C, input offset voltage drift of less than 0.5 μV/°C, CMRR above 80 dB at unity gain (110 dB at G = 1000), maximum gain non-linearity of 0.001% at unity gain, and typical input impedance of 10^9 ohms. To make our point, in a typical application as a data acquisition amplifier, the AD522 contributes an error of less than ½ LSB of 12-bit relative accuracy.

Yes, we've got a case for you. And it encloses the best precision IC Instrumentation Amplifier available. The AD522. For complete facts, send for our data sheet and application notes on the AD522. Analog Devices, the real company in Instrumentation Amplifiers.



ERROR BUDGET ANALYSIS

Error Source	Specification	Relative Accuracy, % of F.S.
Gain Nonlinearity	±0.002% max.	±0.002
Voltage Drift	$\left(\frac{50}{G} + 0.5\right)$ μV/°C max.	Negligible
CMR	86dB min.	±0.005
Noise (0.1 to 100 Hz)	15 μV p-p RTO	±0.0015
Offset Current Drift	±50 pa/°C	Negligible
Gain Drift	60 ppm/°C	Negligible
TOTALS		0.0085 (<±½ LSB of 12 bits)

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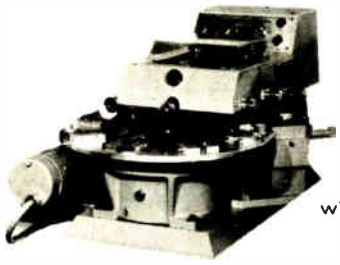
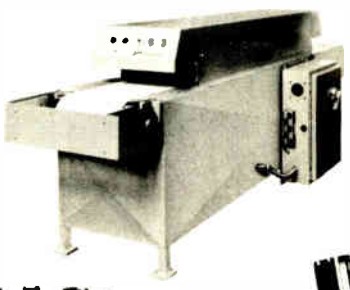
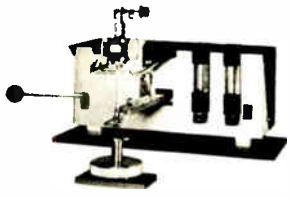


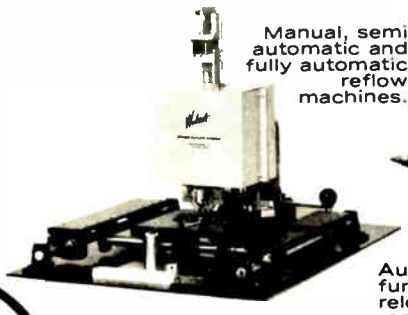
High speed turntable printers with "auto" feed and output.



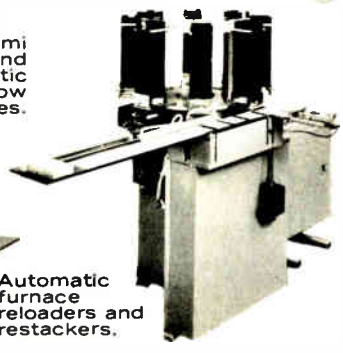
Infrared dryers, standard and custom designs.



Pulse heated tip wire bonders for hybrids.



Manual, semi automatic and fully automatic reflow machines.



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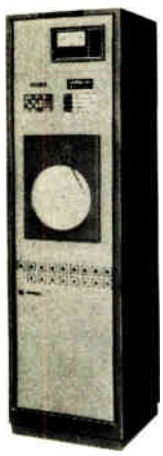
New Microcomputer Programmer System 211 for environmental simulation programs.



Thermotron System 211 enunciator panel will visually direct the operator through entire programming entry. Other features include 50 program intervals, keyboard program entry, program editing at any stage of testing. Optional second channel can be used to control humidity. Equally important, the microcomputer program (Model #013024) can be purchased separately to upgrade existing Thermotron instrument systems. Full details are spelled out in illustrated literature. Write for your copy today.

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Rated Current···AC 0.3mA
Total Flux···20mlm MIN.
Starting Voltage···AC 75V MAX.
External Resistance···150KΩ

NL-8S

ULTRA-HIGH BRIGHTNESS

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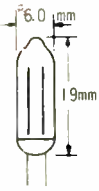
Starting Voltage···AC 85V MAX.
External Resistance···8.2KΩ



NE-2HU

CLEAR-GREEN

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NL-21G

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Circle 220 on reader service card

New literature

computer Glossary, the booklet is available from Digital Equipment Corp., Components Group, 1 Iron Way, Marlborough, Mass. 01752 [422]

Power-supply reliability. A six-page article shows how a power supply's conversion efficiency and related surface geometries provide simple methods for estimating the heat rise and reliability of the supply and their impact on system reliability. Sample calculations, warnings, and hints are included to give the system designer guidance in his quest for effective thermal management. Copies are offered by Semiconductor Circuits Inc., 306 River St., Haverhill, Mass. 01830 [424]

Electronic instruments. The line of digital electronic instruments made by United Systems Corp. is described in a 20-page catalog. In addition to multimeters, thermometers, calibrators, time-and-frequency-measuring instruments, printers, and data-acquisition systems, the catalog

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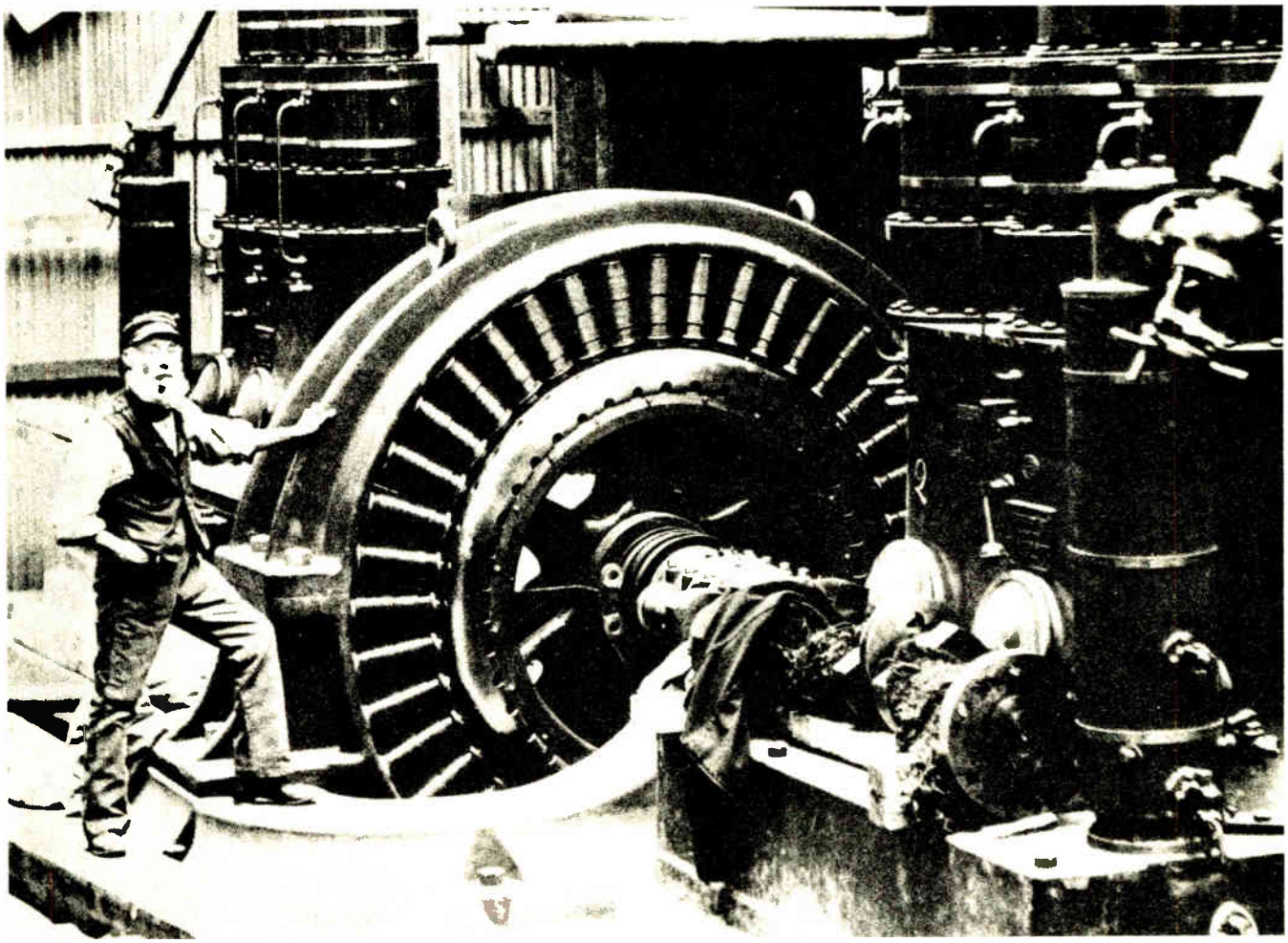

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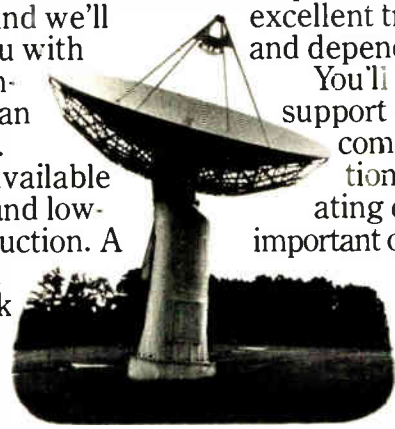

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TRW/CINCH CONNECTORS

ANOTHER PRODUCT OF A COMPANY CALLED TRW

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New literature

contains details on DigiTec's two new panel meters that can become 93 different measuring instruments. For a copy of the catalog, get in touch with your local DigiTec representative or write to United Systems Corp., 918 Woodley Rd., Dayton, Ohio 45403 [423]

Microwave sources. The range of thermionic microwave sources and accessories available from the Varian Electron Devices Group is covered in a 20-page catalog. Products described include reflex klystrons, two-cavity klystrons, extended-interaction oscillators, and backward-wave oscillators. The catalog can be obtained from Varian Electron Device Group, 611 Hansen Way, Palo Alto, Calif. 94303 [425]

ICs and power devices. A 429-page Databook on high-reliability integrated circuits and discrete power devices has been published by RCA Solid State division as a supplement to the SSD-200D two-volume Solid State Databooks. Designated SSD-230 and entitled "High Reliability Devices," the new Databook contains operating and handling instructions, processing and screening requirements, and ratings and characteristics for COS/MOS digital ICs and memory circuits, bipolar linear ICs, MOSFET devices, power transistors, power hybrid circuits, and other devices. Databook SSD-230 may be ordered for $6 from RCA Solid State distributors or from RCA Solid State Division, Box 3200, Somerville, N.J. 08876 [426]

Analog panel meters. A 44-page catalog from General Electric covers the company's line of ac and dc panel meters, frequency meters, elapsed-time meters, dc motor-load indicators, meter relays, pyrometers, shunts, and multiplier resistors. In addition, it includes an interchangeability guide, a glossary of technical terms, and a listing of the locations of distributors and modification centers. For a copy of catalog GEP-307, write to General Electric Co., 1 River Rd., Schenectady, N.Y. 12345 [427]

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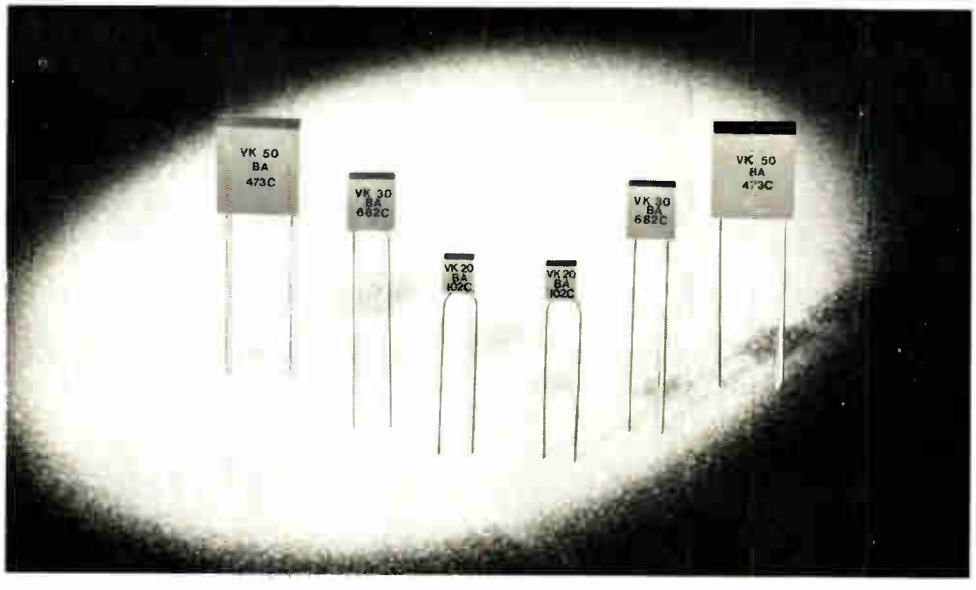

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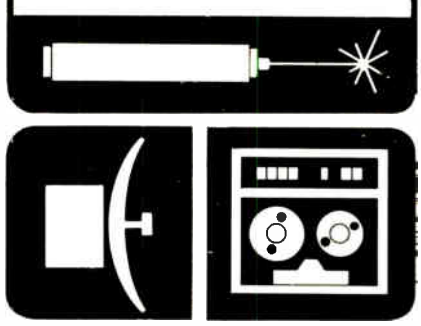

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Commercially oriented Fortune 500 client has retained our firm to select highly successful Engineering Manager. Will plan & direct high priority State-of-the-Art product development efforts and establish dollar & manpower & performance goals. Individual selected will be highly skilled executive with experience in discrete, I/C, & hybrid technologies. Successful candidate should also possess entrepreneurial attitude, high energy level & excellent administrative capabilities. Opportunity will provide extensive visibility & interface at various corporate levels. Salary range 40-45K.

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It's not as silly as it sounds. Because many bright engineers and technicians are still spending their time soldering, desoldering and resoldering. Instead of designing.

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MODEL	NO. OF TIE-POINTS	14-PIN DIP CAPACITY	MFR'S SUGGEST LIST *	OTHER FEATURES
PB 6	630	6	$15 95	Kit 10 minute assembly
PB 100	760	10	19 95	Kit with larger capacity
PB 101	940	10	29 95	8 distribution buses higher capacity
PB 102	1240	12	39 95	Large capacity moderate price
PB-103	2250	24	59 95	Even larger capacity only 2 7¢ per tie point
PB-104	3060	32	79 95	Largest capacity lowest price per tie point
PB 203	2250	24	75 00	Built-in 1% regulated 5V 1A low ripple power supply
PB-203A	2250	24	120 00	As above plus separate amp • 15V and 15V internally adjustable regulated outputs

Proto-Board breadboards are available in a variety of sizes, from 630 to 3060 solderless tie-points (six to thirty-two 14-pin DIP capacity), at prices from $15.95* (kit) to $79.95. And if you'd like built-in regulated supplies, they're available too, in models priced at $75 and $120.

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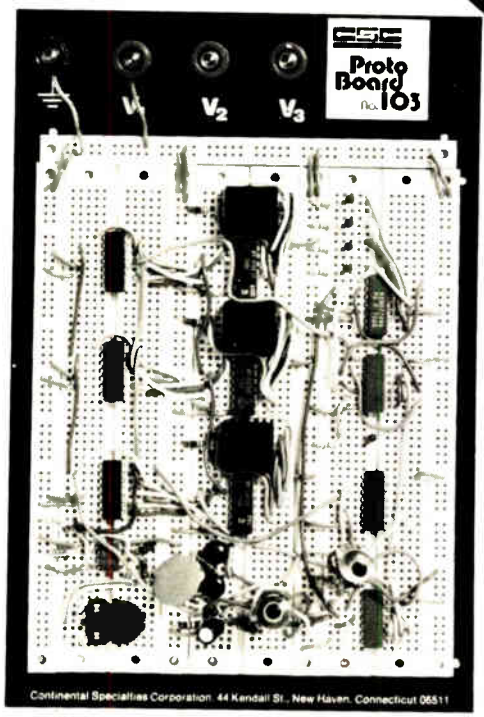
*Manufacturer's suggested list. Prices and specifications subject to change without notice.



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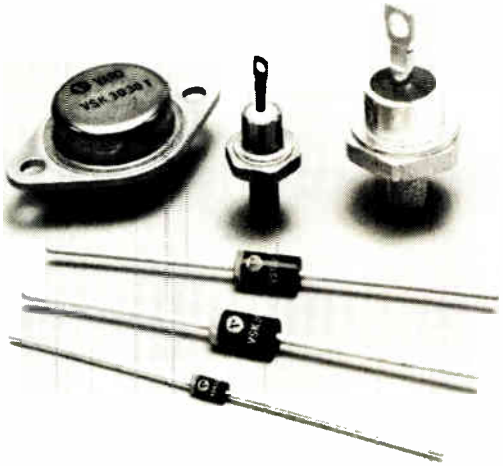

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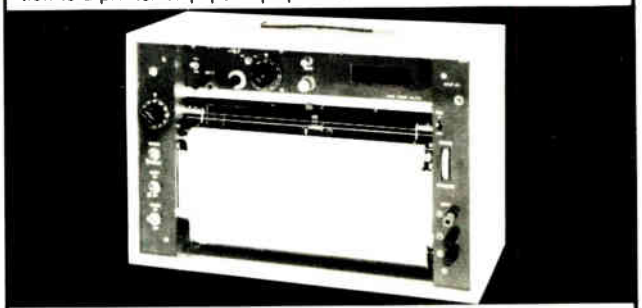

• *FEATURES*

1. Digital output terminal (10-bit binary or 3-digit BCD)
2. External clock terminal permits chart drive by external clock.

• *SPECIFICATIONS*

1. Chart width		250mm
2. Pen speed		0.8 secs full scale
3. Measurement voltage		0.5, 1, 5, 10, 50, 100, 500mV, 1, 5, 10, 50, 100V full scale
4. Chart speed		10, 20, 50, 100, 300, 600mm/hr 20, 50, 100, 300, 600mm/min
5. Digital output (A or B)		A...10-bit binary full scale at 1000 digit, 1 digit 0.1% B...3-digits BCD $10^2 10^1 10^0$ full scale 999

• *Please write us on your letterhead for detailed information.*

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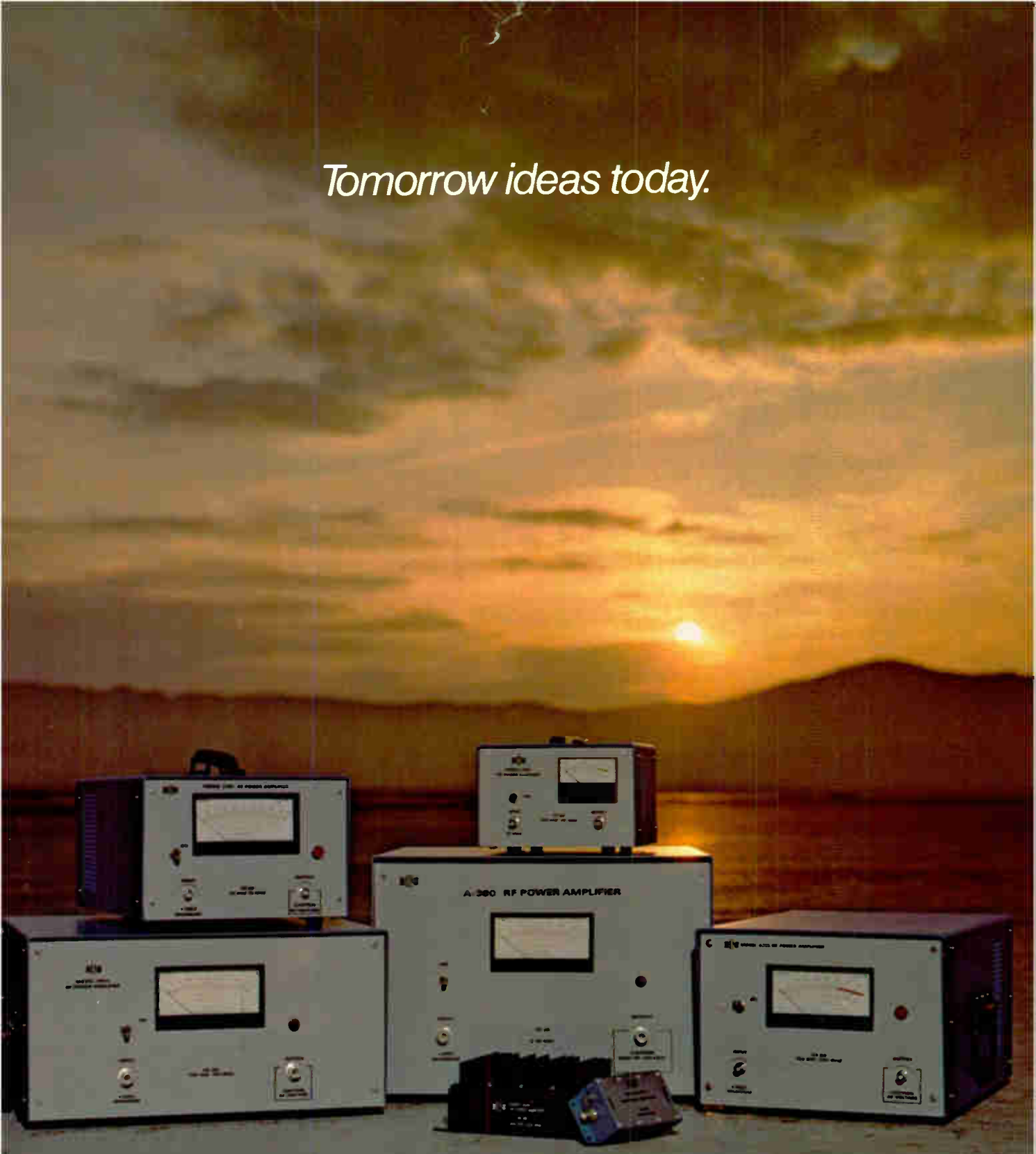

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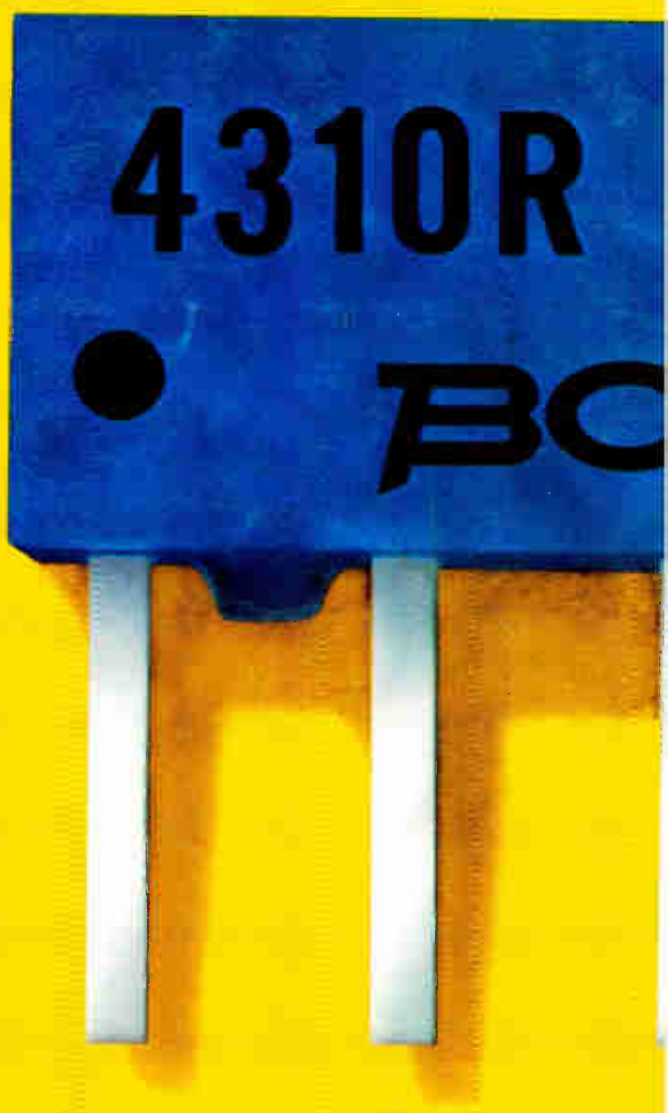
the DIP HIGH SIP



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