AUGUST 4, 1977

CAREERS, PART 3: ENGINEERS DESCRIBE THE EE OF THE '80s/87

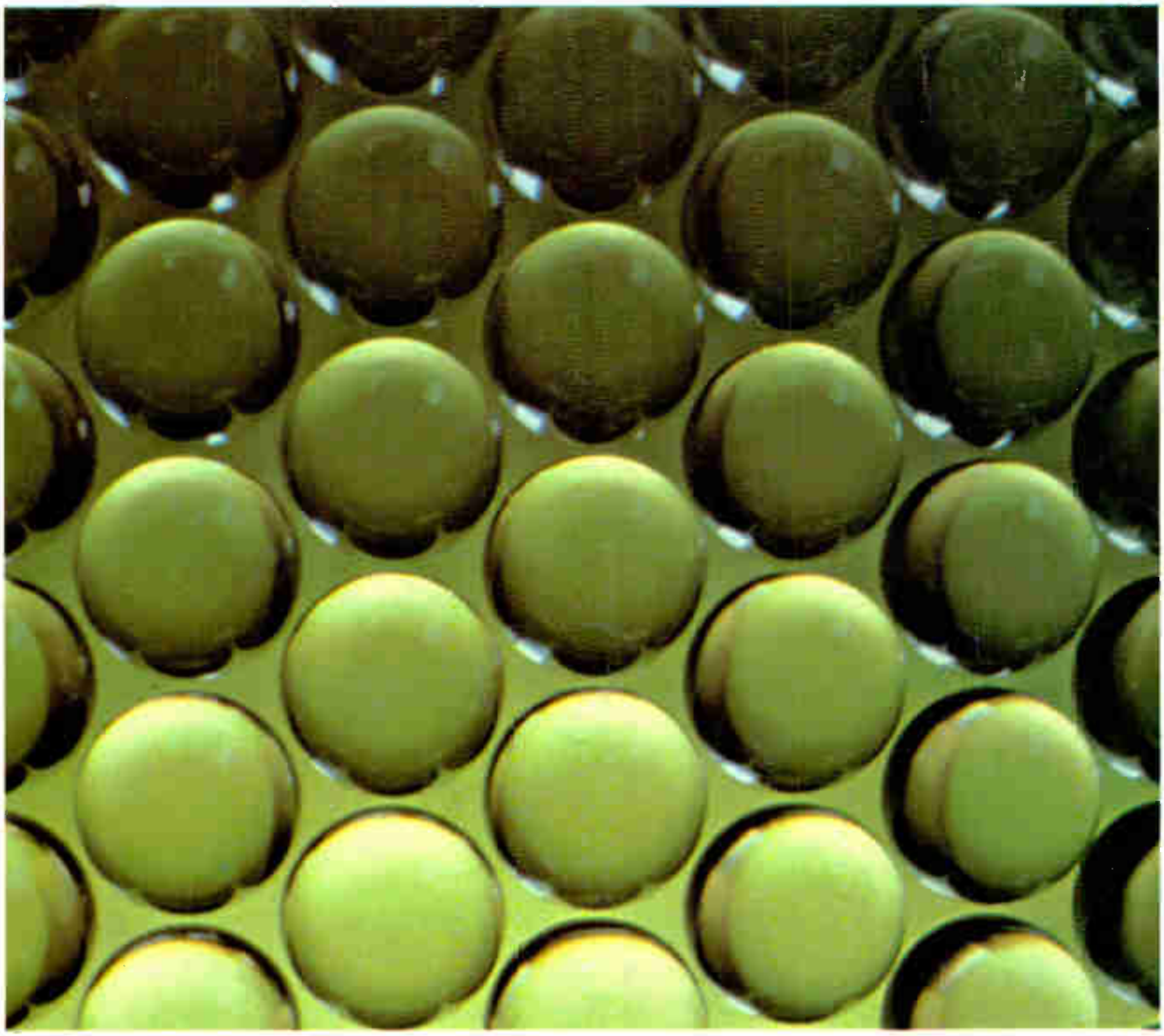
Poland's manufacturers turn to Western-style consumer products/67

Vibration analysis attacks circuit board fatigue/100

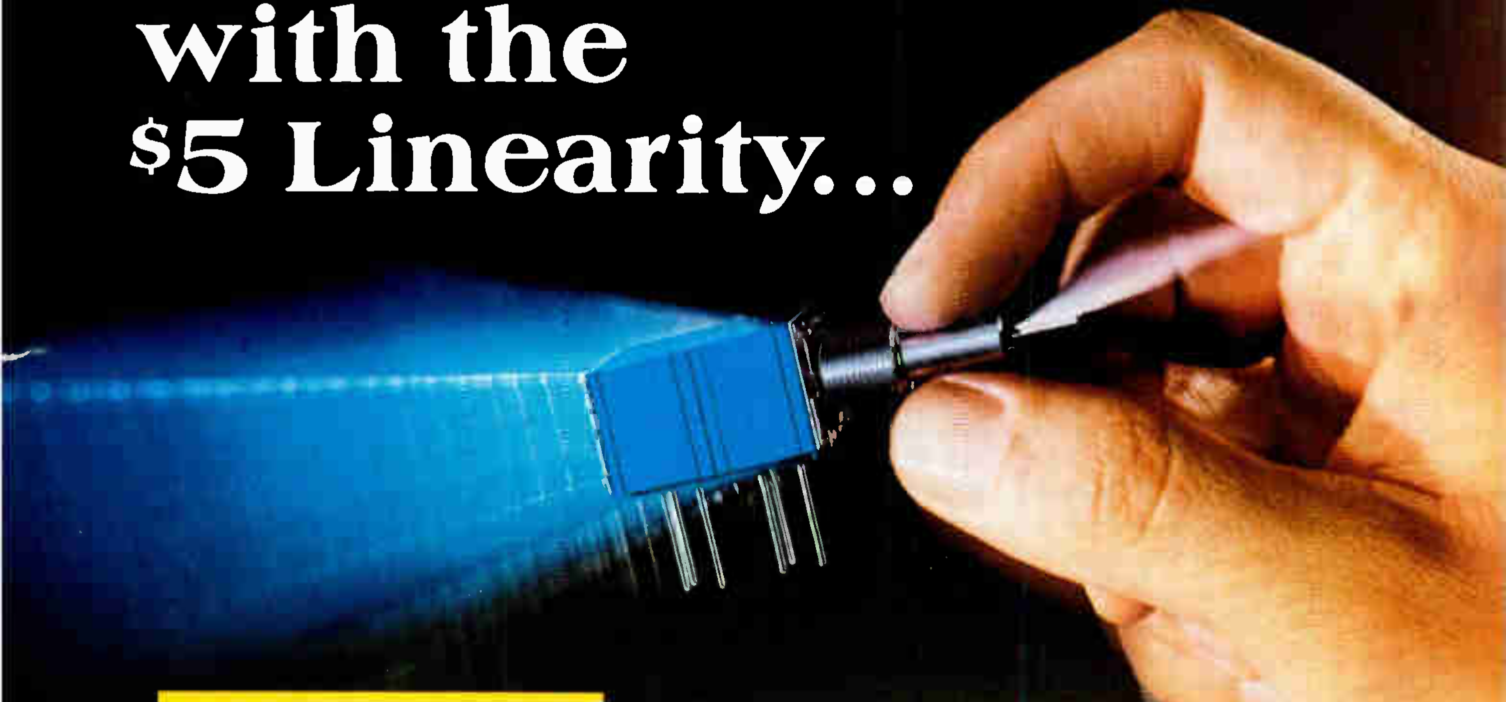
FOUR DOLLARS A McGRAW-HILL PUBLICATION

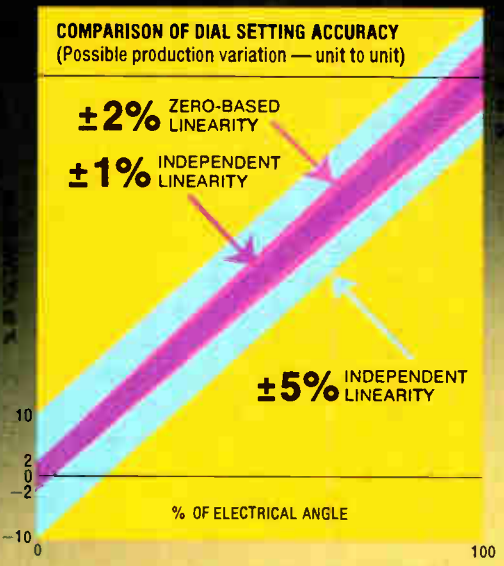
Electronics®

Bubble memories for microcomputers



The $2 Pot with the $5 Linearity...





PERFORMANCE/COST COMPARISON

Type	Element	Linearity	Approx. Cost
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BOURNS 87/88 SEMI-PRECISION POTENTIOMETERS	Conductive Plastic	±2% Zero-Based	$2.00
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HP's first general-purpose Logic State Analyzer designed for both controllable production testing and field service...and it's low cost.

Until now, production line testing of digital equipment has meant complex test gear, large sums for computerized equipment or time-consuming manual checks . . . perhaps all three. In the field, it's been traditional test gear without the measurement capabilities of logic state analyzers.

Now, with the low-cost 1602A, HP offers a general-purpose, Logic State Analyzer that's easy to use in a number of plant or field applications. Manufacturing can use it in automatic functional test systems or in board-level and incoming inspection testing. And its ease of use, light weight and portability makes it a natural for field service applications, too.

The 1602A, priced at $1800*, is compatible with many logic systems having data rates to 10 MHz. It monitors, stores and displays activity on system buses or control lines (up to 64, 16-bit words on a single instrument) to verify proper system function.

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This instrument minimizes chances of error two ways. Extensive messages tell the operator that the 1602A is being used properly. And internal diagnostics verify proper operation.

* Domestic U.S.A. price only.
** HP's implementation of IEEE Standard 488-1975.

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[illegible]

Circle 1 on reader service card

[illegible]

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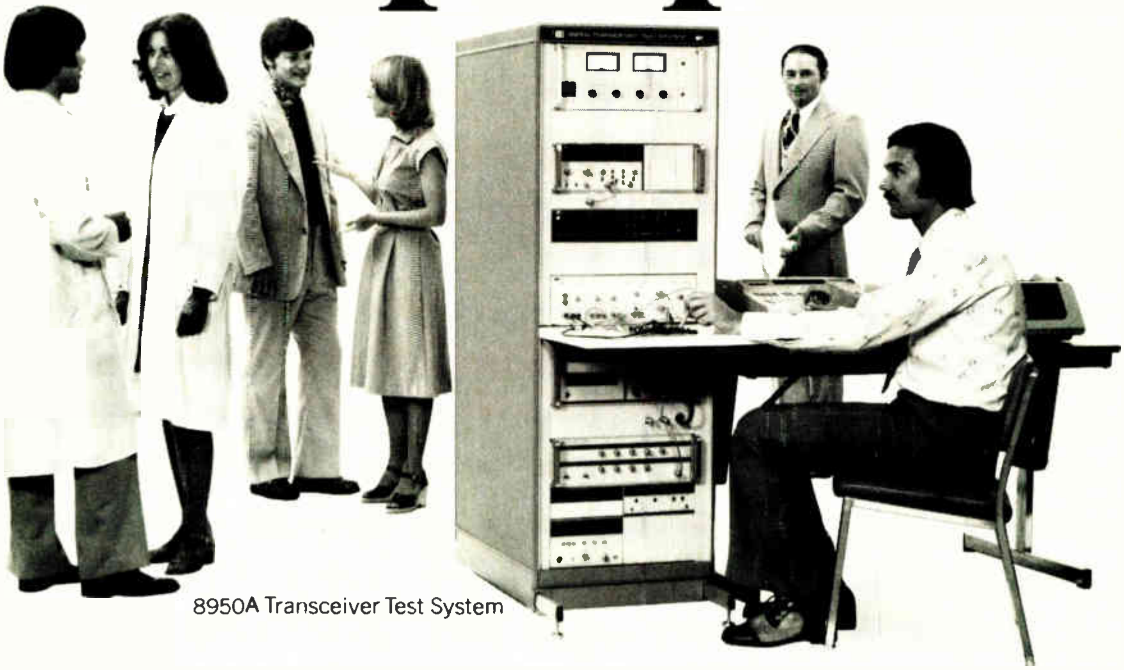

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What it is.

The HP 8950A Transceiver Test System is a rackful of powerful measuring instruments. It was designed for efficient transceiver testing, but it's finding applications in a wide range of general RF module testing as well.

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- 13 MHz Synthesized Oscillator.
- 4200 MHz Power Meter.
- 1100 MHz Counter.
- True RMS Digital Voltmeter.
- 30A DC Power Supply.
- Signal Switching Interface Panel.
- 9825A Desk Top Computer and modular software subroutines.

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Highlights

Cover: Bubbles blow into town, 81
Microcomputer storage of a few megabits is the initial application of commercially available magnetic-bubble memories. The 92,304-bit major-minor-loop chip allows storage capacity to be tailored to size, with no need to buy the excess memory of cassettes and floppy disks.

Cover illustrated by Art Director Fred Sklenar.

'Whither IEEE?' to be election issue, 70
The entry of Fairchild's C. Lester Hogan into the race for executive vice president of the Institute of Electrical and Electronics Engineers guarantees that the nature and extent of the professional activities program will be an issue in the upcoming election.

EEs foresee more career diversity, 87
The spread of electronics technology means greater career diversity, say engineers in a round of personal interviews. They express a wide range of views on how to press for professional gains.

Fast RAM runs cool in systems, 103
A higher-performance metal-oxide-semiconductor technology and circuit innovations permit a 4,096-bit random-access memory to blend high speed at the chip level with low power dissipation at the system level, making possible fast mainframe memories.

And in the next issue . . .
Technologies vie for very large-scale-integrated plum: a special report that includes articles on H-MOS, V-MOS, and I^3L.

Electronics

Publisher's letter

Magnetic-bubble memories have long promised some significant pluses over more conventional mass-storage media, such as compact packaging, low power consumption, nonvolatility, and elimination of mechanical and interconnection headaches. On page 81, you'll find the details on the design and operation of a 92,304-bit bubble memory from Texas Instruments that measures less than half of a cubic inch.

The team in charge of the development—authors J. Egil Juliussen, David M. Lee, and Gerald M. Cox—comes from two separate TI operations. Juliussen, who is responsible for market development and applications definition for bubbles, and Lee, who works on system design and interface-circuit design, are in the central research laboratories. Cox, on the other hand, is an applications engineer in the marketing operation of the semiconductor group, which shares responsibility for new bubble-device design.

Right now, the design effort is targeted on the supporting chip set, and the pace, says Cox, is hectic. "When you have a new product based on a new technology, you have to do everything," he says. "There is little learning curve to rely on, and you have many things to do. You have to do them serially, because if you try to do them in parallel, the job just doesn't get done."

Vibration is one of the many environmental hazards that beset the electronics designer. Yet, as David Steinberg, author of the article that starts on page 100, points out, basic vibration theory is not normally part of the electronics curriculum, so he describes the concepts involved and how to use them to develop design guidelines.

Steinberg finds that his specialty of vibration analysis keeps him hopping. Aside from his work at Singer Corp.'s Kearfott division on thermal and vibration aspects of electronic equipment, up until recently he was flying regularly to the Midwest to teach a weekend course in vibration theory at the University of Wisconsin. He also managed to find time for consulting work. This summer, he is teaching a short course in vibration analysis in Israel.

Electronic's packaging and production editor, Jerry Lyman, who worked with Steinberg on the article, has had his own encounters with the problems of vibration. Two events during the time he was an electronics engineer at a now-defunct Long Island electronics firm are still vivid in his memory. In one case, he says, "an avionics box composed of printed-circuit cards, a card cage, rotating components, and a chassis proved out fine until the vibration test. But it fell apart in that test because of an unplanned-for resonance peak in the chassis."

In a second case, a large radar-positioning system was theoretically stable, but proved violently unstable on the system prototype. "The instability was caused by a resonance in the antenna mount that was within the system's bandwidth. For a fix, it was easier to modify the servo system's parameters than to redesign the large pedestal."

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Readers' comments

We made it

To the Editor: In your special report on "The Gathering Wave of Japanese Technology" [June 9], you picture and describe an n-channel metal-oxide-semiconductor memory cell used in a 65,536-bit dynamic random-access memory project that is funded by the Nippon Telegraph and Telephone Public Corp. [pp. 116-17].

You say the complete chip, also shown, was fabricated by Fujitsu Ltd., but this statement is not in agreement with the facts. This large-scale-integrated memory was designed and fabricated in the Musashino Electrical Communication Laboratories of the NTT.

H. Toyoda
Musashino Laboratories
Tokyo, Japan

Remember the Boston tea party!

To the Editor: May I congratulate you on your excellent editorial on the new Government tax rulings that cuts the earned-income exclusion for U. S. engineers and other citizens working abroad to $15,000 from the former level of $20,000 or $25,000 and adds to the taxable list the cost of many cost-of-living benefits [June 23, p. 12].

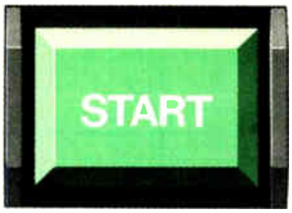
I hope that the Congressmen working on tax reform will heed your arguments and change the law to make those of us working overseas feel that taxation without representation is not going to become a reality again.

R. W. Nearhoof
Belo Horizonte, M.G., Brasil

Don't read-only this

To the Editor: The joint Army-Navy approval granted to Texas Instruments Inc. was for its TMS4050 and TMS4060 large-scale-integrated circuits, as you reported [July 7, p. 158]. However, the parts are 4,096-bit dynamic metal-oxide-semiconductor random-access memories, not read-only memories. These are the first dynamic RAMs to receive JAN approval.

Leo Lagere
Texas Instruments Inc.
East Syracuse, N. Y.



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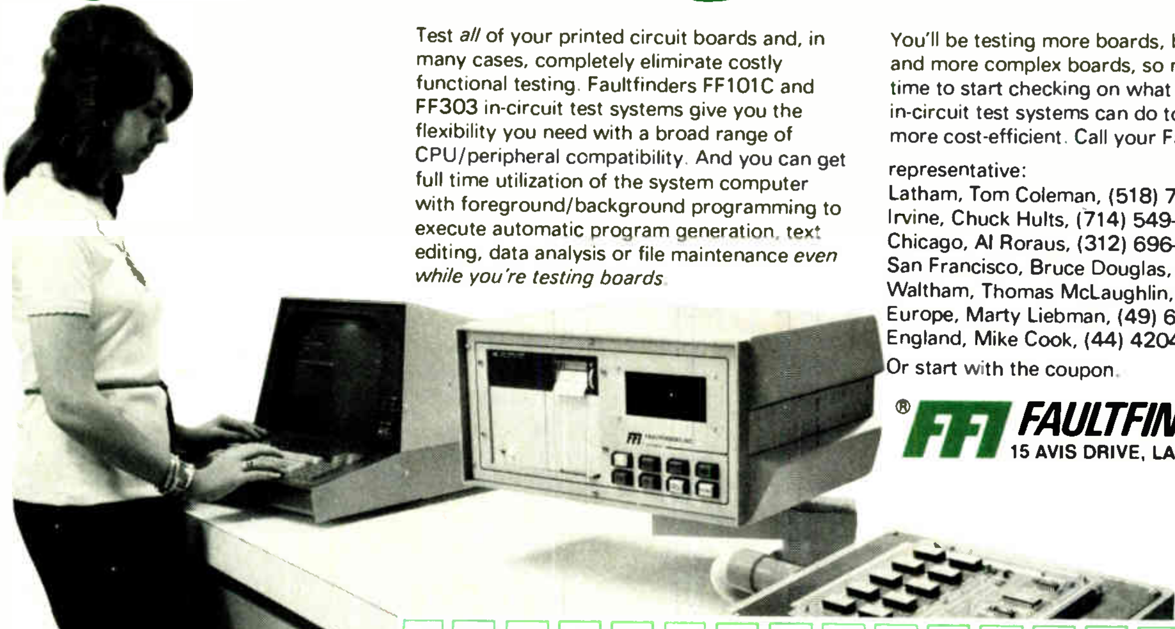

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News update

■ When the lights went out in the metropolitan New York City area on July 13, New York Power Pool officials in Schenectady got a clear picture of the situation, thanks to a complex network of computers. Installed several years earlier by International Business Machines Corp. [*Electronics*, July 5, 1971, p. 79], the system helped avoid a repetition of the big blackout of 1965. It was designed to give dispatchers a statewide picture of power generation, customer demand, reserve capacity, and transmission-line loads. Beyond permitting them to quickly spot abnormal conditions and initiate corrective actions over telephone lines, the system allows the dispatchers to continuously supervise power generation and transmission facility loading to meet regional demands and to coordinate and arrange for energy interchanges with pools in neighboring regions.

The night the blackout started, "the system worked as it was designed to," says John Koehler, supervisor of the computerized control center. "When the lightning hit, the change in status of some of the equipment and the changes in the flow of power in the line were detected, and we had an excellent picture of what was happening."

An IBM spokesman notes that "the equipment is not a control station and doesn't make decisions about where to switch off power or where to cut in a new line. Rather, it allowed the Power Pool's top management people to stay on top of the situation so that they could make the decisions."

The initial system, installed in 1971, consisted of two IBM System 360/50 processors, each with 256,000 bytes of core memory, and an array of control consoles, peripheral displays, disk memories, and drives. The 360/50s have since been replaced by two System 370/155 processors, with 1.5 megabytes of semiconductor memory each. "An expansion of the system including additions to the consoles and communications system is in the planning stage," says Koehler.

Bruce LeBoss

Hello, 25% Higher Current, 45 V @ 150°C, Switchmode Schottkys. Goodbye, TRW.

Meet the world's first power Schottky rectifiers to give top performance at high temperatures with no derating, backing off or baloney. Motorola Switchmode* Schottkys.

Switchmodes are full-rated at 150 A, 45 V, 150°C conditions *simultaneously*. You-know-who's aren't.

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The whole family has unique guard-ring construction providing *avalanche* characteristics for transient protection plus low leakage for added reliability.

Schottky Type	Peak Forward Current*** (Rated VR) (Amps)	Average Forward Current** (Rated VR) (Amps)	Max V_R @ T_J = 150°C (Volts)
MBR7545‡	150 (T_C = 90°C)	70 (T_C = 90°C)	45
SD51†	120 (TC = ?)	—	32
MBR6045‡	120 (T_C = 90°C)	50 (T_C = 90°C)	45
1N6098	—	50 (T_C = 70°C)	40
MBR3545‡	70 (T_C = 90°C)	30 (T_C = 90°C)	45
SD41†	—	30 (TC = ?)	32
1N6096	—	25 (T_C = 70°C)	40

†Yes, We've Got 'Em
‡Top-of-the-Line, lower voltages available
**60 Hz, 180° conduction angle
***Square wave, 50% duty cycle

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Say hello to our good buys. Send for Switchmode Schottky data sheets and get spec-by-spec, side-by-side comparison of these new DO-4s and DO-5s with outgoing standards. It's an eye-opener.

Write Motorola Semiconductors Inc., P.O. Box 20912, Phoenix, Arizona 85036.

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MOTOROLA Semiconductors

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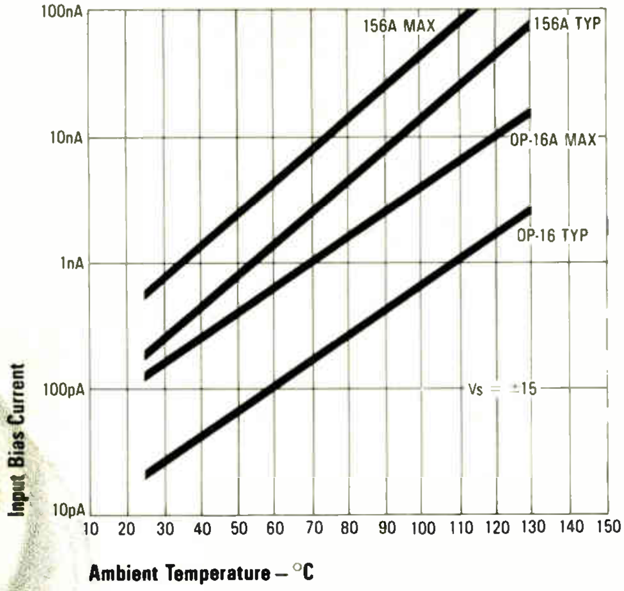
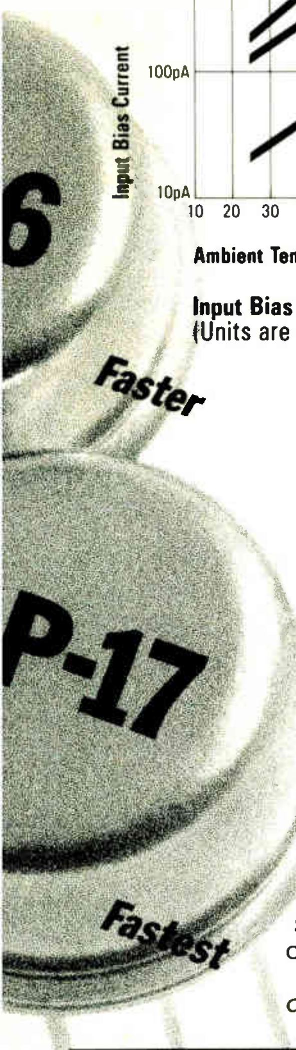


Input Bias Current vs. Ambient Temperature
(Units are warmed-up in free air)



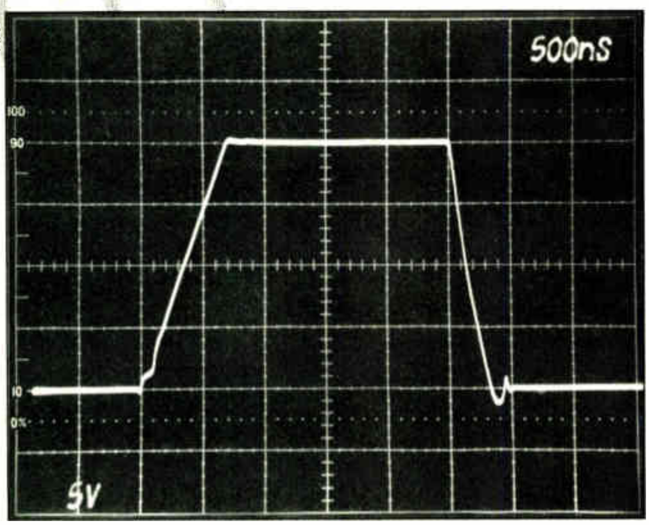
So what's the bottom line?

Offset voltage improved fourfold. Circuit balanced for low TCV_{OS}. Bias current over temperature reduced ten times. And the OP-15/16/17 fits all 155/156/157 sockets. Plus:

The **OP-15**'s supply current is low like the 155's, yet it gives you the speed of the 156.

The **OP-16** gives you the best power/speed compromise you can find—twice as fast as the 156, but with the same moderate power dissipation.

The **OP-17** gives you ultra-high speed (70v/μsec. typical in a gain of five)—high enough to challenge costly dielectrically-isolated devices.



OP-16 Typical Slew Rate

And cost. What about cost?

There's no basis for comparisons, since nobody else is delivering "A" grade bi-FETs anyway. For sure nobody is delivering anything that comes close to the OP-15/16/17 specifications. But we would like to make something clear:

We do not consider a bi-FET op amp to be a substitute for a 741. With its larger chip area and extra ion-implant step, the bi-FET will always cost more; and the OP-15, 16, and 17 are **precision**, high-speed, low-bias-current op amps designed to give you high performance and high speed over the full operating temperature range. They cost more than 741's.

On the other hand, they cost **less** than LF-155/6/7A's—even though they outperform them.

Model	Temp. Range	Price (100–999)
OP-15/16/17A	−55°C/+125°C	$18.00
OP-15/16/17B	−55°C/+125°C	$ 9.00
OP-15/16/17C	−55°C/+125°C	$ 6.00
OP-15/16/17E	0°C/+70°C	$10.00
OP-15/16/17F	0°C/+70°C	$ 3.50
OP-15/16/17G	0°C/+70°C	$ 2.50

Lower price. Better performance. And we actually deliver them.

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IEEE's most important election

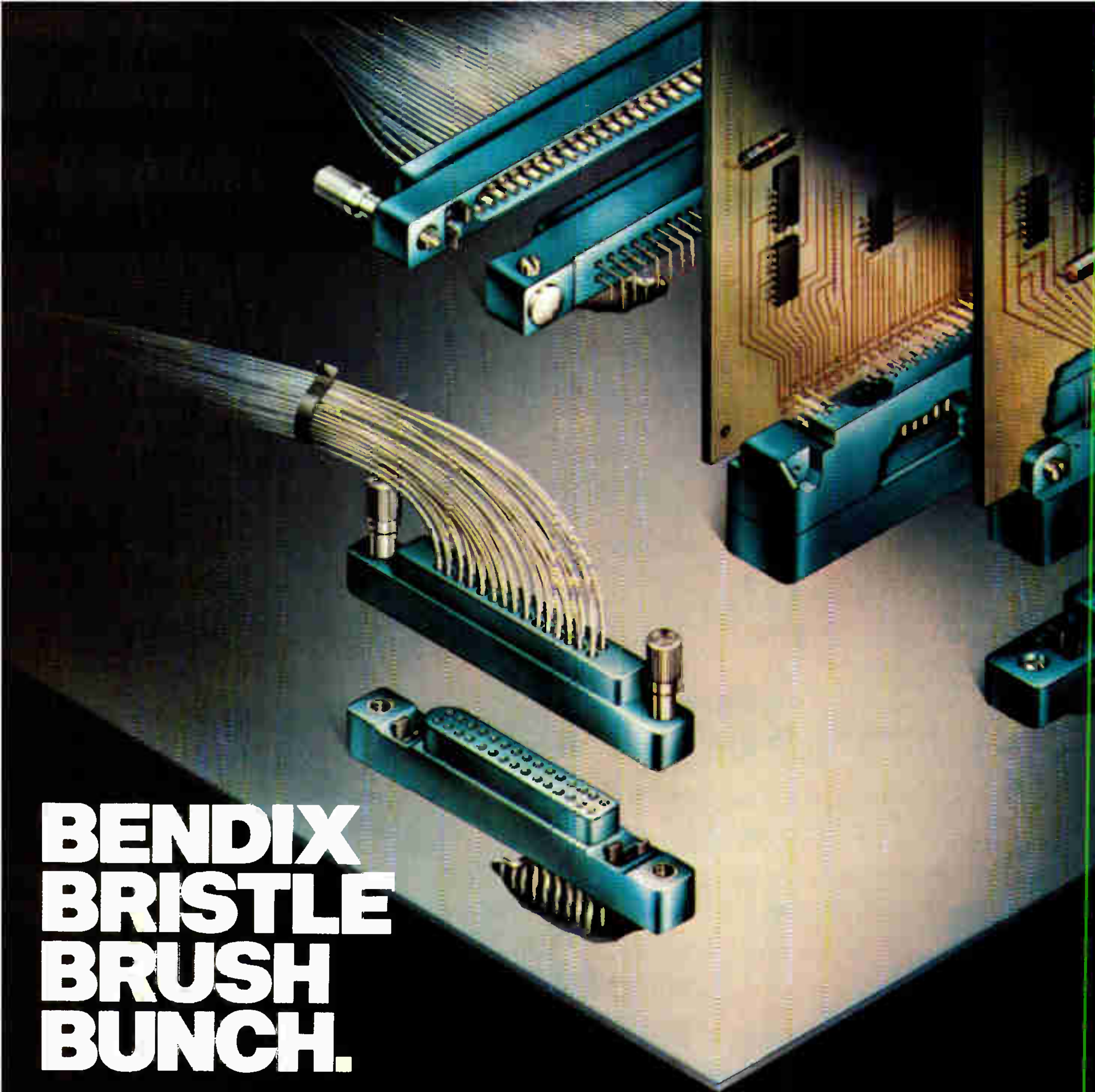
Perhaps at no other time will the apathy that members of the Institute of Electrical and Electronics Engineers usually display toward the annual election of officers be more dangerous and destructive to their organization. Make no mistake, the election is extremely important, because the outcome of this year's battle to decide the leadership of the institute will affect every member.

There is one overriding issue—the future direction of the IEEE in professional pursuits versus technical and educational activities—and to settle it, there must be a large turnout. The winners of the contests for president, executive vice president, and directors must receive a mandate. The losers must be convinced that the majority of voting members have expressed their wishes. Otherwise, the institute could become bogged down by factionalism, by lack of direction, and by internal power struggles.

Those campaigning for the major offices are striving to work for the best interests of the institute and its members. They differ, of course, in their definition of "best interests." What the voters must decide is whose vision of the future to support, what kind of leadership will do the most to advance the IEEE and benefit the membership.

In making this decision, every voter should keep some key guidelines in mind:

- Forget personalities. Vote for those who reflect your views, who will make policy decisions and spend your dues the way you would.
- Ignore nomination distinctions. While some people would try to argue otherwise, there are no inherent differences between those candidates nominated by the board of directors and those who are placed on the ballot by petition. By the same token, write-in votes have an equal status when the ballots are tallied.
- Become informed. The institute is trying to get each candidate's position before the members, within the limits imposed by its own regulations on election campaigning. Also, between now and ballot-counting time in November, some IEEE sections and societies will sponsor debates between the major candidates. These meetings should be helpful in sizing up the issues. Informal discussions with colleagues about the merits of the candidates should also aid decision-making. After all, it is going to be an interesting campaign, and it will be well worth following.
- Vote. As suggested above, the institute's greatest enemy right now is apathy. The easy way might appear to be to avoid making the effort. But for any member who takes the institute's work seriously, who believes that paying dues carries with it a right to a say in how that money is spent, now is the time to stand up and be heard.

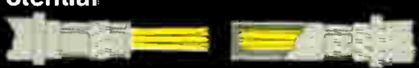


Opens new horizons for PCB design.

70%-90% Reduction in Mating and Unmating Forces

- simpler board support systems
- fewer damaged boards

Extended Circuit Count Potential

- up to 400 Bristle Brush  contacts per connector

Extensive Product Line

- mother board, daughter board, input/output, PC receptacle body styles
- 2-, 3-, and 4-row configurations
- 90° and straight PC, solderless wrap, crimp removable, willowy tail terminations

For complete information, contact The Bendix Corporation, Electrical Components Division, Sidney, New York 13838.

Bendix

Circle 13 on reader service card

People

Astrophysicist Robert Doyle invents electronic games

Can a man with a Ph.D. in astrophysics find happiness as a consultant on electronic games to a toy manufacturer? Yes, says Robert O. Doyle, who has a submarine pursuit game, "Code Name: Sector," going into production this month at Parker Brothers Inc. [*Electronics*, July 21, p. 32]. "Building games is fun," he explains. "I like the theorizing and hypothesizing that go with it."

Doyle is vice president of MicroCosmos Inc., a Cambridge, Mass., company formed in 1974 to explore the potential for electronics in games that are not played through television sets as are the popular video games. "We knew that eventually microprocesors would allow the games to be made cheaply enough for the marketplace," says the pleasant, low-key Harvard graduate.

This was not the only handwriting on the wall that Doyle, now a youthful-looking 41, espied. In 1972, after four years as an astronomer on the Skylab program, he chose to move on as the funds and programs of the National Aeronautics and Space Administration dwindled. He formed Super8 Sound Inc., to make sound equipment for schools to use with Super-8 movie projectors.

"That was my introduction to electronics," Doyle says. "Integrated circuits made our sound recorder possible." He also turned to electronic games, with which he admits to having toyed mentally since the early 1960s. "We developed six or seven, then chose four as our 'portfolio' and wrote to about 20 companies," he recalls. He built his prototypes with transistor-transistor logic and began educating himself about microprocessors, reading everything he could get his hands on.

Parker responded and began what has become for Doyle an exclusive relationship. "I guess you can say we're their electronics wing," he remarks. MicroCosmos has some 25 electronic games in various stages of development, he says.

"Parker's strength is in games that

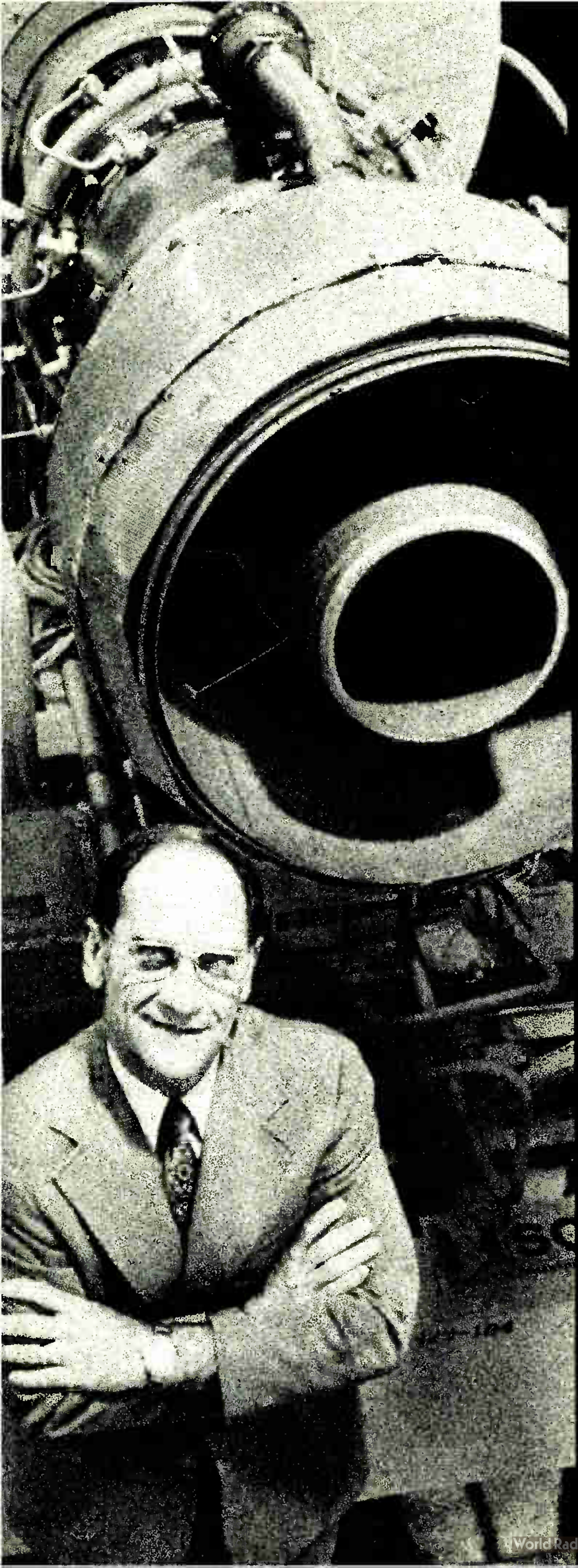
Gamesman. MicroCosmos' Robert Doyle has 25 electronic games in development.

require mental dexterity, are rich in imagery, and have extensive rules," states Doyle, pointing out that the firm developed the ever-popular board game of Monopoly. For the new games, rules of play can be stored in microcomputer memory, and with its logic capability, the microcomputer may become an intelligent and unpredictable player. Says Doyle: "I think the future for Parker will be to do more and more to implement rules with electronics and imaginative software."

Improved phosphors make Fred Walzer's CRTs look good

"We see our sales of color-penetration cathode-ray tubes in the military and industrial markets really starting to build now, and it's because of our breakthrough in bright phosphors," says Frederick Walzer, 54-year-old president of the DuMont Electron Tubes and Devices division of DuMont Electronics Corp., Clifton, N. J. One of his first decisions after being named president recently was to OK the initial production run of the tubes, which rely on a single electron gun and red and green phosphors to produce a limited number of colors.

His division is using phosphors developed by Thomson CSF, the



People

Vision. Walzer hopes the advantages of color will finally be appreciated.

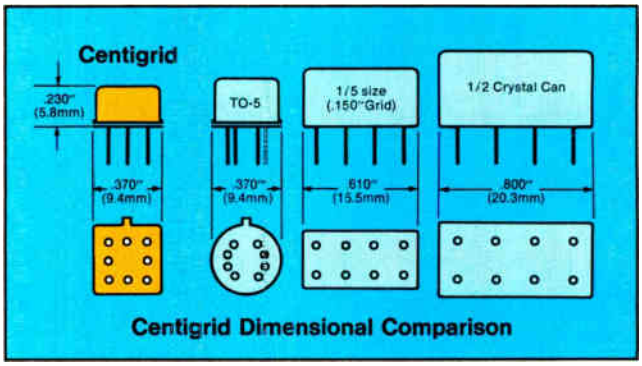
French electronics manufacturer that owns DuMont, a producer of both color-penetration and television-type CRTs and photomultiplier and storage tubes. Coupled to screens and electron guns designed by DuMont, the phosphors yield color tubes that Walzer claims have "up to three times the brightness and at least 1.5 times the life of what's been available on the market." Color definition is improved as well.

Walzer returns to DuMont after a five-year hiatus, most recently as head of Carter Semiconductor Ltd. in Hong Kong. Earlier, he spent 23 years at DuMont, starting in the quality control area in 1949 and working his way up to general manager. If there is one thing he knows, it is tubes.

Application for the color CRTs "will go all over, particularly in military and Federal Aviation Administration markets for cockpit displays, simulators, and command and control systems for air-traffic control and electronic warfare," he says. "People haven't appreciated what color can do here because of brightness and definition problems of earlier penetration phosphors." The CRTs and the few colors they produce are sufficient to enable operators to see data easily and quickly recognize when data is changing. Size of the tubes will cover a broad range—rectangular ones will be up to 25 inches measured diagonally, round ones up to 23 inches across.

TO-5 RELAY UPDATE

The Relay of Tomorrow is here today: the Centigrid.



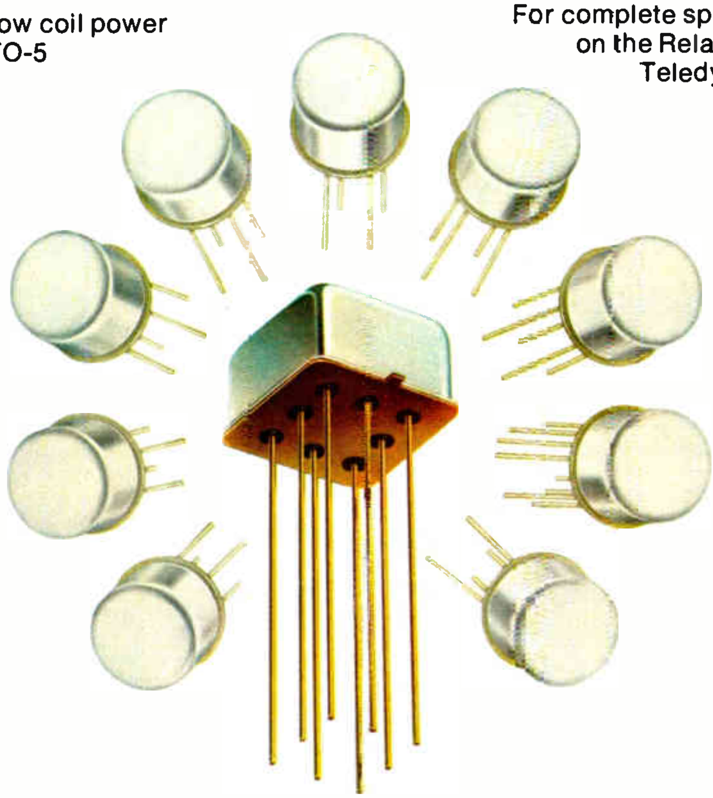
Centigrid Dimensional Comparison

Out of Teledyne's TO-5 relay technology has evolved the Centigrid® — the ultimate subminiature relay. It combines the proven TO-5 relay design concept and internal construction into an even more compact package. Low profile height — just .230" (5.84mm) — with terminals spaced on a .100" (2.54mm) grid permitting direct pc board mounting without the need for lead spreading.

Add to this the same low coil power consumption as the TO-5 relay, with obvious thermal and power supply advantages. And for RF switching, the Centigrid's low inter-contact capacitance and contact circuit losses provide high isolation and low insertion loss up through UHF frequencies.

To top it all off, the Centigrid is qualified to levels "L" and "M" of MIL-R-39016, including the internal diode suppressed versions.

For complete specification data on the Relay of Tomorrow, contact Teledyne Relays, the technology leader in the relay industry.



TELEDYNE RELAYS

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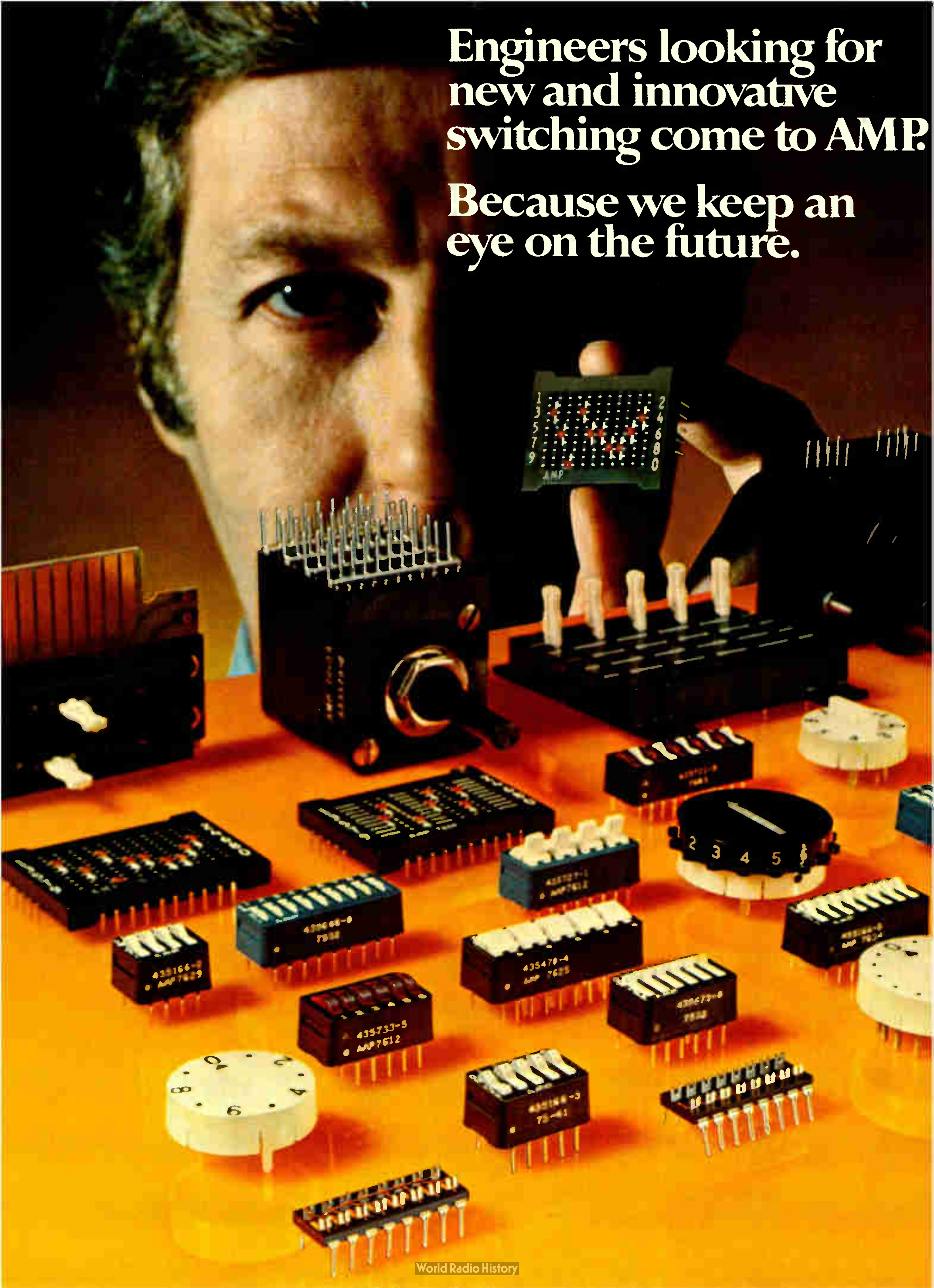
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Because we keep an eye on the future.

We started with the world's first miniature Dual In-line Package switch and now have types ranging from new mini-matrix slide switches and coded rotary switches to LED and side-actuated DIP types, to name a few.

And as we have from the beginning, we stand behind every one of them, new or old, with an offer of solid, technical support. Not because they need it. But because we believe you as an engineer, are entitled to it when you innovate. It's the kind of full support that says we're ready to work with you not only in product application and production but even earlier, in research and development, if you desire. And we think you'll find it a good way to keep an eye on the future of switching.

Among the most popular of our "future" switching innovations is the unique Mini-Matrix Slide Switch. It's especially useful for logic level matrix, switching applications. And our new programmable DIP Shunts offer another easy way to program manually. By simply opening or closing conductive straps.

But perhaps the most revolutionary switch of all is our unique, patented coded rotary switch. It switches the circuit instead of the contacts. Just as new, is our DIP Network Switch. It's designed for use with thick film capacitor and resistor chips for impedance switching and time delay functions.

As you can see, there are many more switching innovations, like our Standard Rotary switches and Pull-to-set types. For more information, just call AMP Customer Service at (717) 564-0100. Or write AMP Incorporated, Harrisburg, PA 17105.

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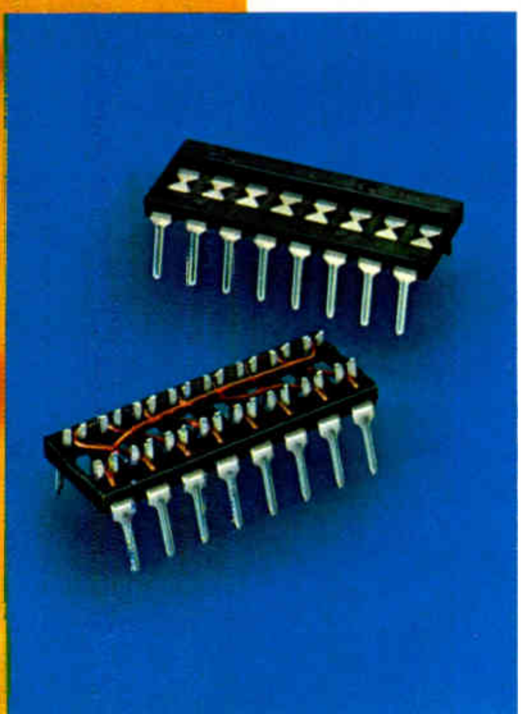

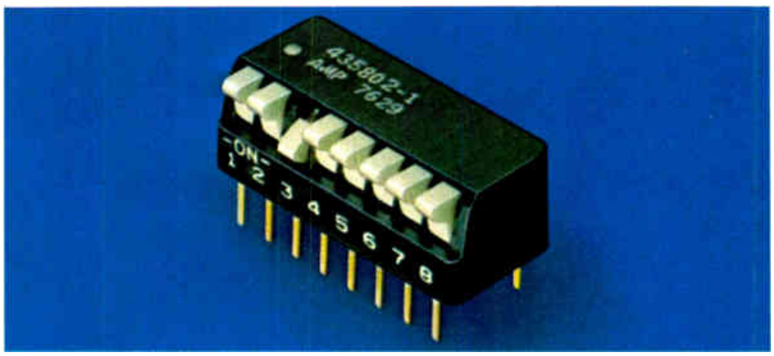

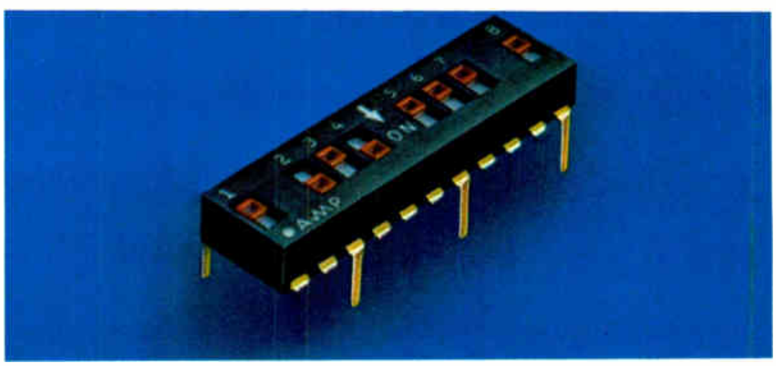

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Meetings

NBS Seminar on Time and Frequency: Standards, Measurements, and Usage, National Bureau of Standards, Boulder, Colo., Aug. 22–26.

21st International SPIE Symposium, Society of Photo-Optical Instrumentation Engineers (Bellingham, Wash.), Town and Country Hotel, San Diego, Aug. 22–26.

Product Liability Prevention Conference, IEEE, New Jersey Institute of Technology, Newark, New Jersey, Aug. 24–26.

Intrasociety Energy Conversion Engineering Conference, IEEE, Sheraton Park Hotel, Washington, D. C., Aug. 28–Sept. 3.

7th European Microwave Conference, Microwave Exhibitions & Publishers Ltd. (Sevenoaks, Kent, England), Bella Center, Copenhagen, Denmark, Sept. 5–8.

Compcon Fall, IEEE, Mayflower Hotel, Washington, D. C., Sept. 6–9.

Ineltec 77: Exhibition of Industrial Electronics and Electrical Engineering, Ineltec Exhibition Secretariat (Basel, Switzerland), Basel, Sept. 6–10.

Fall meeting of Electronics Division of American Ceramic Society, ACS (Columbus, Ohio), Queen Elizabeth Hotel, Montreal, Quebec, Canada, Sept. 18–21.

Wescon 77, IEEE, Brooks Hall and Civic Auditorium, San Francisco, Sept. 19–21.

13th Electrical/Electronics Insulation Conference, IEEE *et al.*, Palmer House Hotel, Chicago, Ill., Sept. 26–29.

Fifth Data Communications Symposium, IEEE and ACM, Snowbird, Utah, Sept. 27–29.

International Conference on Thin- and Thick-Film Technology, IEEE, Congress Center, Augsburg, West Germany, Sept. 28–30.

Did you know that you can save $1,005 by buying a Fluke 1953A Counter instead?

That's right.

Fluke's 1953A Universal Counter-Timer mainframe plus IEEE Programming option will cost you just $1,595.* Instead of the $2,600 or more you'd pay for comparable models.

And you'll get excellent systems performance plus extras you didn't count on.

Like "clean dropout." If the signal is too small, the 1953A will show zeros. Theirs can give you a wrong reading.

Our frequency range on Channel A is 125 MHz. Theirs is 100 MHz.

Our Z-axis time interval marker is standard. Theirs is optional.

Board access is better on the 1953A. We use one custom I.C. They use many.

Our input capacity on Channels A and B is 30 pF. Theirs is 40 pF. And our Channel B frequency response is 25 MHz. Theirs is 10 MHz.

The 1953A is half the weight, consumes one-fifth the power and makes no noise at all. On theirs you'll hear the fan and switching regulator.

Our switch and control "feel" is as good as theirs, and our front panel labeling is much less confusing.

Where the 1953A shows 9 digits all the time, theirs offers 9 digits only on Channel C.

And, if you need the option of Parallel BCD for both control and data out, we have it. They don't.

So, if you're in the market for a programmable counter, consider the Fluke 1953A.

And consider how much you'll save.

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.

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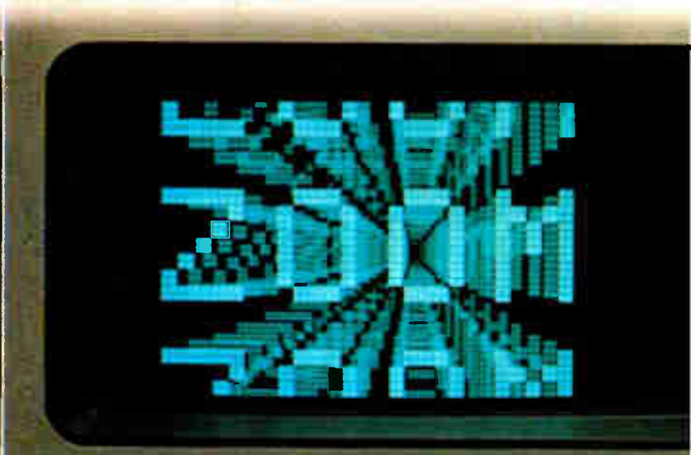
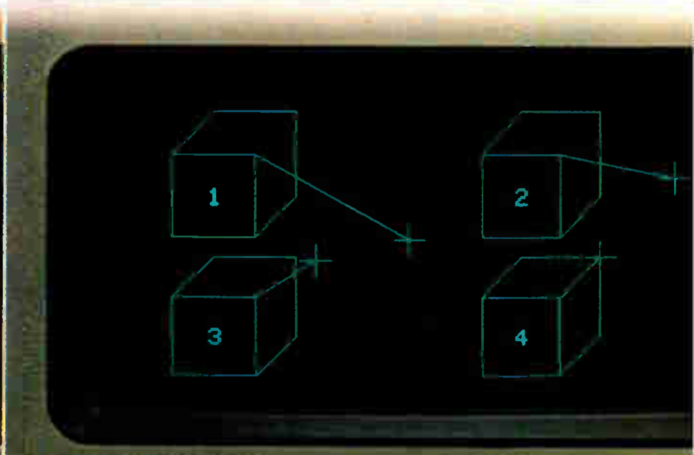
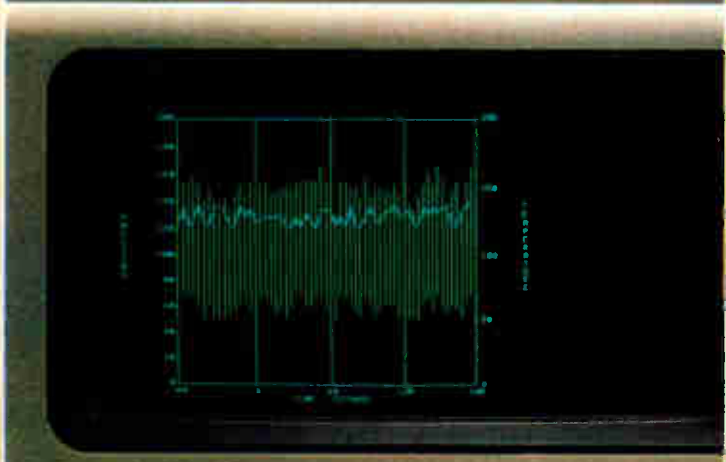


Zoom

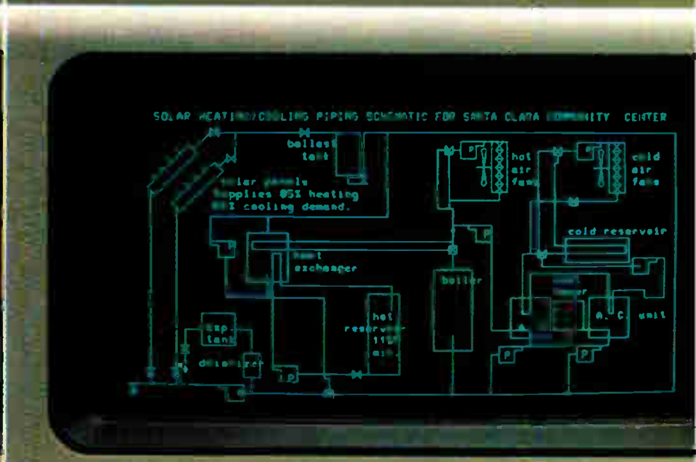
Area shading



Rubber-band line



Typical application: scientific plotting.



Typical application: process flow diagram

The new Hewlett-Packard Graphics Terminal uses a microprocessor and raster scan technology to combine high performance with low cost.

The HP 2648A introduces a whole range of bright ideas to graphics. There's so much power built into the terminal itself that you can perform everything from auto-plots to zoom without any CPU help at all.

Auto-Plot. You don't need to know programming or invest in costly software. Once you've entered your facts and figures from the alphanumeric keyboard, press a few keys and your tabular data is plotted instantly.

Raster Scan. No more pulling down the blind to make your plots visible. Our display is clear and easy to read even in bright light. And the raster scan technology permits selective erase, cutting down the time it takes to modify your picture also.

Zoom and Pan. This lets you magnify any area of the display up to 16 times. And you can pan in any direction for closeup investigation of complex designs, without having to reinitialize the data.

Area Shading and Pattern Definition. This makes it easy to distinguish areas with similar shapes, such as bar charts, mechanical parts and architectural drawings.

Rubber-band Line. You can draw trial sketches, such as architectural floor plans, with or without CPU connection. Think of the time and money you'll save by cutting down mistakes.

Independent Display Memories. Both alphanumeric and graphic data can be shown independently or at the same time. And you can carry on a dialogue with the CPU without disturbing the picture.

The HP 2648A also has all the advantages of our popular HP 2645A alphanumeric terminal. Specifically: mass-storage on 110K byte cartridges (you can store graphics as well as data); 'soft keys' to speed up repetitive jobs; one-button self-test; plug-in PC boards for easy maintenance; extensive data communication and off-line capabilities.

This bright new look in graphic terminals is designed for such applications as electrical, mechanical and architectural design. For process and control. For scientific plots. And for business planning. We'd like to give you a graphic demonstration of everything the HP 2648A can do. Send us the coupon and we'll set it up. Or contact the nearest Hewlett-Packard sales office listed in the White Pages. We're sure you'll get the picture.

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Yes, I'd like to take a closer look at your low-cost HP 2648A Graphics Terminal.

☐ Contact me to arrange a demonstration.
☐ Send me complete information.

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Mail to: Ed Hayes, Marketing Manager, Hewlett-Packard Data Terminals Division, 19400 Homestead Road, Dept. 607, Cupertino CA 95014.

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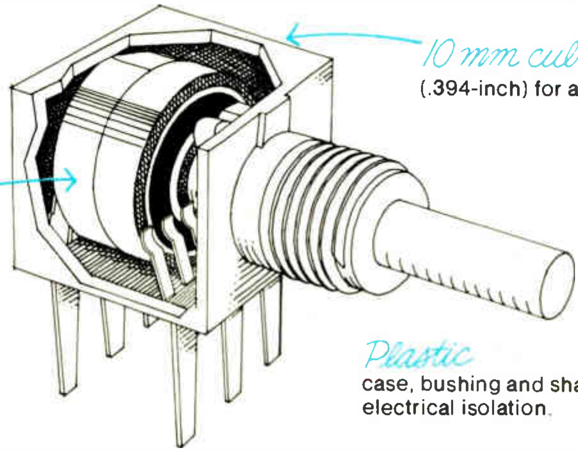
The one variable the world can standardize on.

Our new Type M conductive plastic variable resistor is hard metric. A 10 mm cube that's tiny, flexible and rugged. The MINI-METRIC is the smallest dual pot available today. Manufactured in the United States, it's dimensioned the way the rest of the world thinks. Allen-Bradley has what you need; or, it can be ordered through our distributors. Ask for Publication 5239.

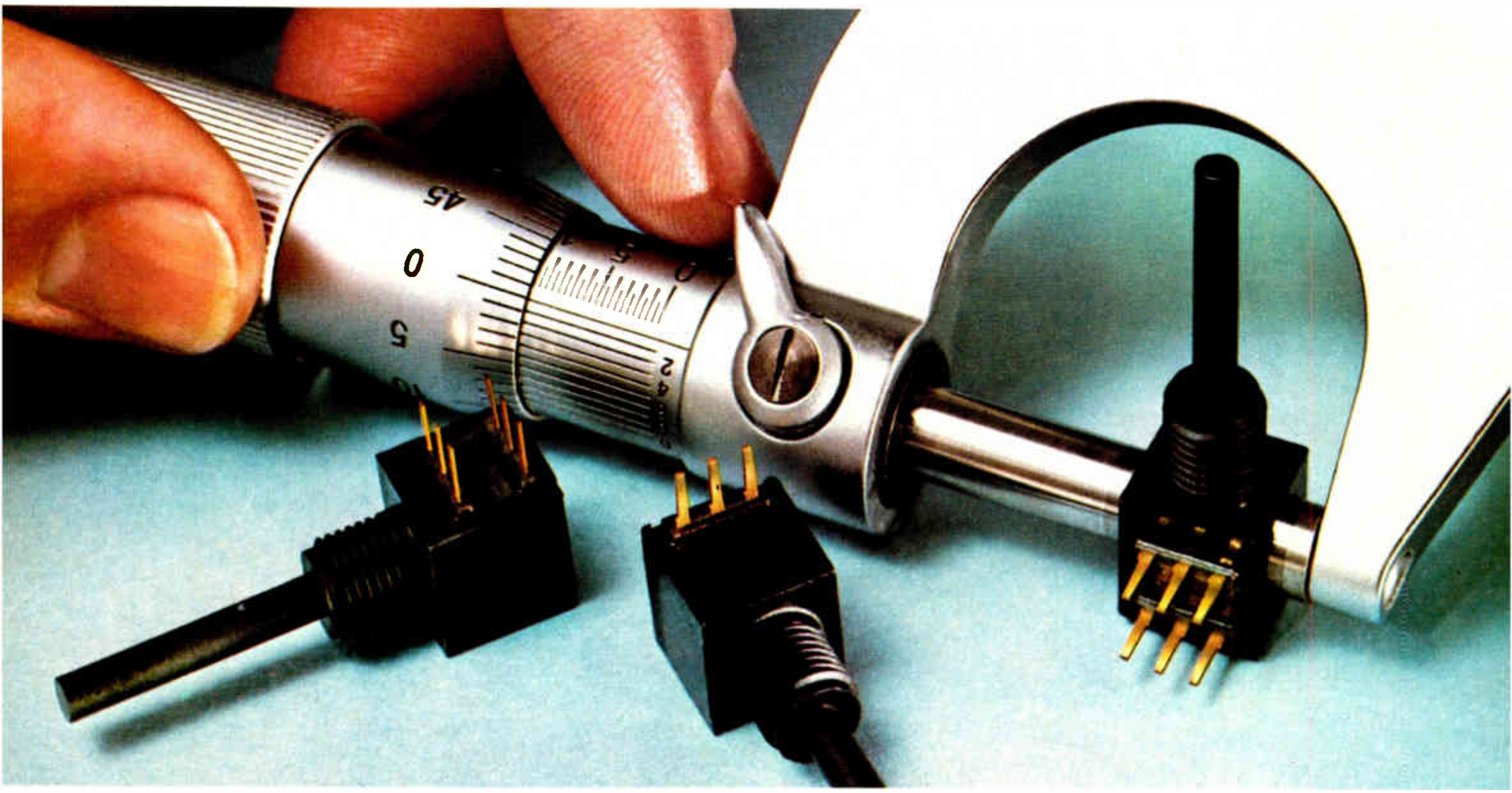
Choices
single or dual pot or pot/switch combinations

10 mm cube
(.394-inch) for all combinations.



100 ohms to 1 megohm
conductive plastic resistance elements, ±20% tolerance, standard resistance values conform to IEC.

Plastic
case, bushing and shaft for electrical isolation.



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EC131

Electronics newsletter

Digital-watch shake-out to continue

Electronics industry analysts on Wall Street forecast a continuing exodus from the digital-watch business by vertically integrated semiconductor firms. "They're taking a bloodbath, from a profits standpoint," says Sal Accardo, vice president and electronics analyst at Kidder, Peabody and Co. in New York. He suspects **the digital-watch market may be left to Texas Instruments, Fairchild Camera and Instrument, and Timex, as well as the Swiss and Japanese suppliers.** Among the semiconductor makers' failings, he says, are their lack of in-depth market research and inability to understand seasonality in terms of production planning.

Adds Kent Logan, research vice president at Goldman, Sachs and Co. in New York, "If you look at those that have bailed out, or those like National that may be about to, you'll find they generally aren't anteing up to put in place the necessary distribution network or to gain brand recognition." What's more, he says, "most semiconductor companies that entered the watch business had unclear marketing plans. They took a shotgun approach, unlike TI, which has a clear, rifled strategy."

Rockwell adds to n-channel line

With two members of its recently acquired 6500 microprocessor series going into high-volume production for Atari game applications, Rockwell International Corp.'s Microelectronics division will be expanding the line with several proprietary n-channel chips. **To be ready for sample distribution in September is a fully static 4,096-by-8-bit read-only memory with an access time of 200 to 250 nanoseconds.** An expanded peripheral chip, scheduled for December, features 12 to 24 input/output lines, depending on the package pin count, 2 kilobytes of ROM, 128 bytes of static random-access memory, and an interval/event counter. Also planned is a byte-oriented one-chip microcomputer that is compatible with the 6500 family software and contains 2 kilobytes of ROM, 64 bytes of RAM, four 8-bit bidirectional data ports, and an on-board clock—making it as powerful as other one-chippers already on the market. **The company is also working on a microprogrammable peripheral-control chip that can be programmed for a variety of functions including a floppy-disk controller, bubble-memory controller, and printer controller.**

AMD gears up to market a-d converter

To back up its claim to supply a full-family of microprocessor chips, Advanced Micro Devices Inc. will have samples ready by October of its first analog-to-digital converter with direct microprocessor-interfacing logic. **The AM 6080 consists of an 8-bit d-a converter, an 8-bit data latch, and latch control logic—making it usable with 8-bit microprocessor systems without any external logic required.** The part provides the chip-select input, write input, and data-enable input for device selection and latch-timing control. Another part being readied, the AM 6081, will provide all these functions plus two pairs of current outputs, a status-enable input, and an output-select port.

Japanese TV makers get export allocation

Japan's 10 color-TV manufacturers say they can live with the export allotments made by the Ministry of International Trade and Industry to fit the tightened 1,750,000-set limit imposed by the U. S. **Company quotas are based on previous exports, and for the largest five makers that means about half as much as they exported in the peak year of 1976.** Sanyo, Toshiba, and Sharp are cut to just over 200,000 sets each, while Matsushita and Sony, both with color manufacturing plants in the U. S., are cut to about 100,000 each. The five accounted for 2 million of the 2.9 million sets exported to U. S. last year. Quotas for Hitachi and Mitsubishi will be about 100,000 each, with General Corp., Victor of Japan, and New Nippon Electric ranging from 20,000 to 50,000 each.

The curtailment comes at an awkward time, because Japanese TV manufacturers may be heading for reduced profits as domestic consumers hold back. Total shipments of color TV sets for the first six months of 1977 lag behind those for the first six months of last year—4,659,000 vs 4,820,000. **June exports including chassis are down sharply compared with June a year ago**—358,437 vs 493,718—while those for the first six months are up slightly only because exports were high early in the year.

Raytheon ups ROM capacities

Responding to strong demand for its recently introduced 256-by-4-element programmable read-only memories with built-in power switches, Raytheon Co.'s Semiconductor division will introduce three larger-capacity parts by the end of the year. **Coming in September is a 512-by-8-element array to be followed by a 1,024-by-4-element and a 1,024-by-8-element array.** The company has also started production on a user-programmable multiplexer that contains four 8-line-to-1-line multiplexers and can be electrically programmed for a variety of configurations. The 29693 device uses the same bipolar technology as the switching PROM.

Microcomputers to handle cable-TV applications

With several types of cable-TV jobs in mind, United Feature Syndicate Inc. of New York has signed a $3.5 million-plus commitment for a minimum of 2,500 MicroMind II microcomputer systems from ECD Corp., Cambridge, Mass. Through its subsidiary, TV Data, United Feature will offer the microcomputer system to cable-television operators for such uses as **presenting daily scroll TV listings on subscribers' sets and for separating and routing newswire stories to specific local channels.**

TRW ups device speed-power performance

Already the supplier of the industry's highest-performing digital-LSI standard product line, TRW Inc. has improved the speed-power performance of its devices by a factor of three. **The improvement, which comes from a more abundant use of current-mode logic in a large-scale-integrated form,** means that, for example, the power dissipation of the MPY-16AJ 16-by-16-bit parallel multiplier is reduced from 5 to 3 watts and the multiplication time from 160 to 100 nanoseconds. Using the same technology, TRW is planning early next year a 24-by-24-bit multiplier on a 280-square-mil chip that will operate below 200 ns at 5 W dissipation.

Matsushita readies projection TV with 50-ft-L brightness

The Matsushita Electrical Industrial Co. is raising the stakes in the projection-TV game with a unit that has a 60-inch-diagonal, 50-foot-lambert viewing screen. **Sales of the $4,000 set probably will begin in Japan next spring, and exports are planned.** The unit is built around new projection tubes in which image-forming light, after passing from the electron gun to a convex phosphor-coated target, bounces off an internal spherical mirror. The light then passes through an external Schmitt correction lens and is reflected from a flat mirror to the screen. **The 50-ft-L brightness is at least 15 ft-L better than in other projection TV sets.**

Introducing the hungry ECLIPSE.

Data General's new ECLIPSE S/130 computer has a bigger appetite for work than any other mid-range mini. And enough speed and versatility to wolf down any kind of data you have to dish out.

The hungry ECLIPSE computer is built around the same powerful architecture as our super high-speed ECLIPSE S/230. Added to that is a host of special features that make the hungry ECLIPSE unique. Like our fast micro-coded floating point and efficient character string instruction sets. And our second-generation WCS general-purpose user microprogramming ability that results in unmatched throughput in demanding applications. To top it off it also includes AOS, our amazing new heuristic multi-programming advanced operating system, and of course the full range of Data General's economical big-computer peripherals, software and worldwide support.

Now, you don't have to skimp along with an undernourished mini that's too limited for your work. Or splurge on one that's too fat just to get the performance you need. Just order an ECLIPSE S/130 computer. It will make your work load a lot leaner. Want more food for thought? Send for our brochure.

☐ Send your S/130 brochure.
☐ Send your S/130 brochure and have your sales representative call.

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Circle 27 on reader service card

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Data General Europe, 15 Rue Le Sueur, Paris 75116, France. Data General Australia, Melbourne (03) 82-1361.

If this ad doesn't don't know what

A/D Converters		
	Motorola's MC14433	National's ADD3501 (MM74C935-1)
Accuracy: 0° to +70°C	No spec	± 1 count max
Power Supplies Required	2	1 (+5V)
External Active Components Required	4	2
System Cost	Higher	Lower
Price @ 100 pcs.	$9.97	$9.95

National introduces its answer to the Motorola MC14433. The ADD3501 3½-digit A/D converter...manufactured using National's standard MM74C Series CMOS process.

As you can see from the chart, it offers more performance and requires fewer external components than Motorola.

Fewer components means lower system cost and greater reliability.

The ADD3501 uses pulse width modulation as a conversion technique, rather than dual slope. Which means inherently better temperature and long term stability.

And our out-of-range indication is "OFL," not just a blink.

The ADD3501 is available now from National distributors. Pick up a few samples and give us a lock-see.

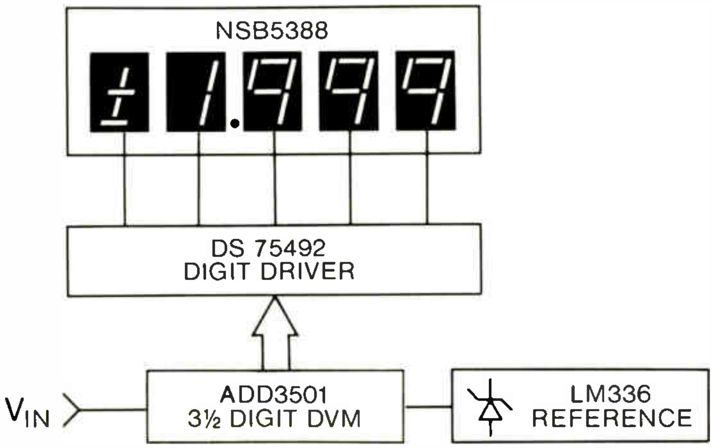
One-stop shopping for digital panel meter and digital multi-meter components.

Another nice thing.

You can fill your whole shopping list from National.

convert you, we will.

The LM336 Reference, plus the other external components you might need for your panel meters and digital



DVM BLOCK DIAGRAM

multimeters: Regulators, Digit Drivers…NSB & NSN Series Seven Segment displays…and Resistor Arrays.

Other ways to convert you.

The ADD3700. A 3¾ digit device instead of 3½. With twice the resolution of the ADD3501, and twice the accuracy (0.025%).

And the bipolar ADD2500. A complete converter on a chip, including the reference. All it needs are a few passive external elements and a display, $7.95.

The new monolithic A/D Converters from National.

Hello more reliability.
Hello less cost.
Goodbye Motorola.

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Gentlemen:

Please try converting me. Send technical literature on your new converters and associated digital panel meter components.

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Our PROM Programmer travels light.

Retire your wheelbarrow.

Our microprocessor-based PROM Programmer is fully portable. It weighs less than 15 pounds and comes in an attache case making it as easy to use in field service as it is on the production line or on an engineer's bench.

Using our field proven plug-in PROM Personality Modules, the stand-alone Series 90 PROM Programmer programs, lists, duplicates and verifies every major MOS and bipolar PROM. Its master control unit costs only $1,800.

The single-button Series 92 Peripheral PROM Programmer/Duplicator control unit, including a TTY interface, is $995.

PROM Personality Modules cost from $360 to $450 and plug into either control unit.

Pro-Log routinely submits PROM Programmers and PROM Personality Modules to PROM manufacturers for evaluation and approval. Contact us for approval status on the PROM Personality Module you want.

PROM Programmer options include TTY, paper tape reader, parallel I/O, RS232 and CMOS RAM buffer.

For a demonstration of PROM Programmers "to go," or for the latest version of our 48-page PROM User's Guide, contact Pro-Log Corporation, 2411 Garden Road, Monterey, CA 93940. Phone (408) 372-4593.

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Circle 30 on reader service card

Clinical analyzer tells users how to make repairs

Microprocessor-based instrument from Beckman comes with own probe and built-in digital voltmeter

Aghast at the soaring cost of sending a field service engineer to make even minor repairs on its equipment, Beckman Instruments Inc. is designing clinical laboratory gear so that users—nonelectronic medical technicians—can do much of the repair work themselves.

That should help the Fullerton, Calif., firm's Clinical Instruments division keep its prices down in the competitive clinical market. It also gives Beckman's customers the means to cut equipment downtime to almost nil—an important feature for clinical equipment, which often serves hospital emergency rooms and intensive-care units.

Though the firm started its customer repair program with the introduction of relatively simple glucose and blood-urea nitrogen analyzers earlier this year, the most startling example will come when Beckman starts shipping a sophisticated immunochemistry analyzer in October. Built around Intel Corp.'s SBC8010 microcomputer board, the $10,000 instrument analyzes scattered light to determine the concentration of specific proteins in body fluids, alerting physicians to kidney damage, susceptibility to infection, and such critical diseases as multiple myeloma, a bone-marrow cancer.

The unit's 8080 microprocessor runs the machine: it controls an optical card reader that helps program the machine for the specific protein it is looking for, prompts the operator through manual parts of the test sequence, performs multiple curve-fitting calculations, scales the results into the proper units, and displays them on a 14-character gas-discharge display.

Self-test. The microprocessor also is key to the machine's self-test capability. It can generate a signal that simulates an analysis, exercising the instrument's logic to determine whether it is working. Beckman has liberally sprinkled its printed-circuit cards with light-emitting diodes, fault indicators that can be interpreted with the aid of the operator's manual to help isolate problems to any of six circuit boards or a pair of card-reader and optics modules. The user replaces a faulty unit and sends it back for repair in a postage-paid mailer Beckman provides; the spare comes from a $3,290 repair kit it encourages users to buy. Repair charges are generally minimal for those who have the kit. When Beckman sends a new replacement board, it charges only for the cost of repairing the board it receives.

"We expect the LED to pinpoint 90% of any problems," explains John E. Lillig, the Beckman engineer who designed the instrument's electronics. But what makes the Beckman analyzer unique is a built-in digital voltmeter used with a hand-held probe. "Flipping a toggle switch turns the display into a voltmeter that gives a readout of test points in the system as they are probed," he

Twin functions. Gas-discharge display on the immunochemistry analyzer can be turned into the display for a digital voltmeter when faults must be located in the equipment.

Microprocessor makes adding a DVM easy

The fault-diagnostic capability that Beckman has built into its new immunochemistry analyzer is indicative of the extra uses to which microprocessors designed into equipment can be applied. "Since we have the microprocessor in the instrument and we already have an analog-to-digital converter in there to handle the inputs, it's no trouble at all to build in the digital-voltmeter function," says engineer John Lillig. "All it takes is one extra line on our analog multiplexer plus some software."

According to Lillig, the instrument has a four-channel analog multiplexer—two channels sense overrange signals, and one senses the optical scatter from the medical sample, leaving the fourth for the DVM function. Lillig says the instrument multiplexes all four readings every 20 milliseconds. Thus, it is possible to take a measurement on a sample and at the same time check voltages with the DVM without losing any information. Accuracy of the three-digit DVM is ±4%, Lillig says, which is adequate for the functions it must perform, even though the third digit may not always be meaningful.

says. Most of the test points have their correct voltages printed next to them on their pc boards.

"One of the LEDs works with the DVM as a logic probe," Lillig adds, and the DVM will make easier any potentiometer adjustments the instrument may need, as, for example, to normalize the electronics of a replacement optics module.

Pulls apart. The entire instrument, except for shielded high-voltage sections, can be taken apart without a screwdriver, and the operator's manual has been beefed up with extensive troubleshooting and repair sections. Moreover, the firm has installed a toll-free "hotline" so that its engineers can help customers step through unfamiliar diagnosis and repair problems, and to hasten replacement parts orders.

The immunochemistry analyzer got an unplanned public trial last month in Chicago, where it was introduced at the national meeting of the American Association for Clinical Chemistry. "Our prototype crapped out with a half-dozen customers standing around," recalls Richard Sawyer, product manager for the Clinical Instruments division. "We found an LED on the analog interface board that was not lit; it told us to replace the optics module. We did, and were up and running within 15 minutes. We impressed even ourselves." □

Photovoltaics

Report by Congressional committee favors small power installations

Solar energy got a big boost in Congress in July with the report that photovoltaics and related technologies should be given serious consideration as a source of electricity as well as heat for homes, apartment buildings, and offices. The report by the congressional Office of Technology Assessment also finds that Federal research and development programs for energy have consistently overemphasized large, central solar facilities at the expense of smaller installations—a trend that OTA believes should be reversed.

To spur development of small, on-site systems, the report calls for major revisions in Federal energy policies to provide incentives for manufacturers, prizes of $50,000 to $100,000 for inventors, and a 20% investment tax credit for users. For technologists, the study urges achievement of several "breakthroughs," including the ability to produce a silicon solar cell "without the need to grow an expensive single crystal" and development of much more efficient cells, programs already being supported by the Energy Research and Development Administration.

Military boost. The development of small photovoltaic systems could get a significant boost if the U.S. military pushes R&D on small, and even portable, solar-energy installations for its own use, says Lionel S. Johns, manager of OTA's energy program and holder of a Ph.D. in physics. A study this year for the Federal Energy Administration by BDM Corp., Vienna, Va., indicates there could be a total requirement for 50 to 100 megawatts in such military applications as power for navigation aids, communications relays, and mobile systems. "The feasibility of expanding the photovoltaic market in the near future and the potential for cost reductions will depend critically on these markets," says the OTA study.

Small solar equipment should be able to provide electricity at a price of 5 to 15 cents per kilowatt-hour, compared with existing residential rates of 3 to 4 cents, the report says. "Therefore if electricity rates increase by factors of 1.5 to 2 over the next few decades, there could be large areas of the country where small solar electric facilities would be attractive. . . . These areas would be increased if the owners of solar electric devices were given tax credits." Alternatively, OTA suggests that electric utilities could install and own on-site equipment.

Overseas. The two-volume study, totaling more than 1,300 pages, also looks at foreign markets and concludes that the solar-electric-equipment market could run to "several hundred millions of dollars in annual sales, particularly if the market in nonindustrialized countries is fully developed." Some countries without ready access to power-generating plants already pay up to 45 cents per kilowatt-hour for electricity, the report points out.

After an effort of nearly 18 months involving 28 staffers, OTA's Johns is optimistic about the promise

What happens next?

Whether Congress will move to accelerate Federal research and development on photovoltaic and other solar-energy systems on the basis of Office of Technology Assessment recommendations is uncertain. "That is up to our client," as OTA energy program chief Lionel S. Johns collectively labels the 100 Senators and 435 House members for whom he works. Most members of the Senate and House have yet to wade through the solar-energy study's 1,311 pages. Yet Sen. Edward M. Kennedy (D., Mass.), chairman of Congress's Technology Assessment Board, says in a statement included with a draft of the study that, "as the cost of conventional energy sources continues to increase, solar energy is going to become highly competitive and constitute a growing share of the nation's heating, cooling, and on-site electrical generation." The assessment was undertaken at the request of Sen. Barry Goldwater (R., Ariz.), with the support of Sen. Clifford Case (R., N. J.), because they contend that many members of Congress might be seriously underestimating the potential of small-scale solar energy.

The Energy Research and Development Administration, meanwhile, is moving to accelerate its photovoltaics programs, "because the field is moving more rapidly than we anticipated," according to Morton B. Prince, chief of the Photovoltaics branch. "We are developing a more aggressive program," says Prince of the restructured photovoltaics effort his group will present in early August to Henry H. Marvin, director of ERDA's Solar Energy division. Beyond saying that the changes could lead to "larger photovoltaic applications at an earlier date—and perhaps funding them in a different mode," Prince was reluctant to discuss the draft effort until it had been cleared through the agency. But Prince did make the point that the plan to accelerate the program was undertaken before publication of the OTA study and that any correlation between ERDA's effort and OTA's recommendations is coincidental.

of solar energy. The study's view developed, he points out, "because we weren't coming from anywhere. We had no biases one way or another, but were raising questions from outside" the solar field.

The cost of silicon for photovoltaic devices can be reduced in two ways, Johns and his staff believe. One is the development of less wasteful crystal growing, slicing, and other procedures that now lose nearly 80% of the silicon input in the manufacturing process. Texas Instruments and Varian Associates are now both developing less wasteful slicing techniques under contract to ERDA. The other is by using a lower-quality, "solar-grade" silicon. Silicon costs, OTA says, represent about $2 of the $17/kw charged for typical cells in 1976. ERDA's goal is 10¢/kw. □

Solid state

Texas Instruments battles for linear market with two new series of bi-FET op amps

Semiconductor leader Texas Instruments Inc. is going all out to become No. 1 in linear integrated circuits. The top spot has belonged to National Semiconductor Corp. for several years. But TI intends to change that with the introduction of two new series of bi-FET operational amplifiers aimed at the broad industrial-market customer base.

Mixed-process bi-FET op amps, which combine the high input impedance of junction field-effect transistors at the front end with the linearity of bipolar transistors at the output, have been shaping up as the battleground since last year.

In 1975, National introduced the first viable bi-FET op amps, the LF355 and LF356 series, for about $2.10 apiece. Last fall, TI retaliated, both second-sourcing National and introducing a lower-cost design of its own, the TL081 series. This offers lower current drain than the LF355/356 devices but higher input offset voltage and input bias current, although its bandwidth is narrower than the LF356 and the slew rate is identical. National responded in March by cutting LF355/356 prices to 75 cents and by coming up with a new low-cost LF351 series that outperforms TI's TL081 devices, yet sells for only 50 cents each in hundreds. Meanwhile, TI has geared up for its two new low-cost bi-FET series and has just slashed the price of its TL081 units to a low 33 cents.

This means that TI is going after the sockets traditionally held by straight bipolar devices, like the ubiquitous 741, the recognized industry standard now selling for only 25 cents. In fact, predicts Delbert Whitaker, linear marketing manager at TI, bi-FET products will capture 50% of the op-amp market by 1980.

Like the TL081 parts, the new TL071 and TL061 bi-FET units from TI will be offered in single, dual, and quad versions. The pricing is aggressive—units in both new series will range in price from 47 cents for singles to $1.60 for quads. With the new parts, Whitaker expects to catch more specialized and higher-performance applications than the general-purpose TL081 series addresses.

The TL071 series, intended for audio equipment and other low-noise applications, has a low input noise of 18 nanovolts per square-root hertz. These parts will probably compete directly with National's LF351 devices, which hold input noise to 16 $nV/Hz^{1/2}$ and offer broader bandwidth at slightly higher current drain.

The TL061 series provides ac and dc characteristics superior to existing bipolar devices, yet it draws less than a tenth the current. Maximum supply current for the TL061 is 200 microamperes.

National has no low-power bi-FET products now, but the firm is strongly responding to TI's challenge by cutting the price of its LF351 devices to 39 cents and the price of its bi-FET version of the 741 op amp (the LF13741) to 30 cents. Moreover, says Jim Solomon, National's manager of research and development for industrial linear ICs, "We have no intention of losing any significant share of the bi-FET market, and we'll do whatever it takes to accomplish this." □

Communications

Digital switch serves 500-line office

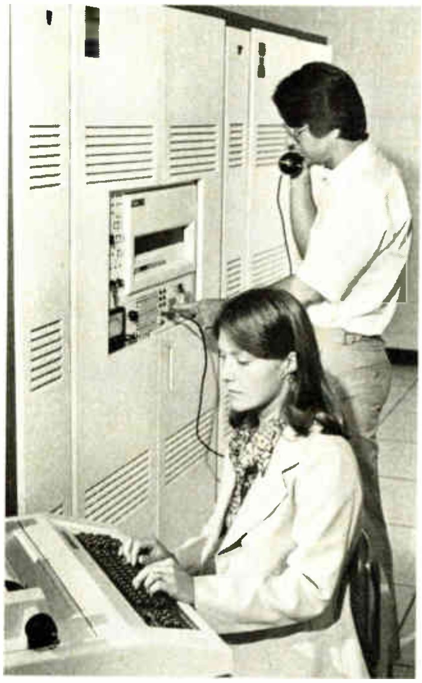
The phone equipment was installed at a little-known town in Georgia by an even more obscure telephone company, but it marks a major step forward in the implementation of digital switching in the nation's phone network. Coastal Utilities Inc. in Richmond Hill is the first to install a computer-controlled digital switch at the smallest phone company office—one that accommodates 500 phone lines at most [*Electronics*, July 21, p. 27].

Heretofore, the advantages of digital over analog switching—smaller and less costly hardware and the ability to handle a far greater number of lines—have been limited to much larger installations. Thanks to large-scale-integrated technology and the availability of circuit-board-sized processors, small telephone companies will now be able to keep up with the rising volume of calls and the increasing amount of digital data. With electronic mail, electronic funds transfer, credit-card verification, and facsimile transmission on the horizon, digital switching is the only way to keep up with the spiraling demands of such services. So the installation in Georgia is only the first of many for such switches as the System Century line from the Stromberg-Carlson Corp., Rochester, N.Y.

Unlike analog switches, which basically set up an electrical path between two telephone circuits and require huge amounts of hardware, digital switches simply keep track of each bit, once the voice signal is converted to a digital bit stream by a coder-decoder. A computer routes each bit to different registers and then controls the delivery of these bits to the right destination.

The System Century line of digital switches relies on Digital Equipment Corp.'s PDP-11 family of processors. Five processors are used in the 500-line switch: three LSI-11s and two preprocessors developed by Stromberg. Dual LSI-11s handle call-processing chores, while the third provides routine maintenance and administrative functions. The two preprocessors are scanned by the dual processors and receive instructions from them to perform such tasks as detecting off-hook signals and collecting digits as they are dialed. The larger PDP-11/34 processors would be needed for about 4,000 lines or when many features must be supplied.

Leonard A. Muller, president and chief executive officer of Stromberg-Carlson, the telecommunications subsidiary of General Dynamics Corp., says the use of multiple processors was key in keeping costs down. "Sharing the tasks among several processors instead of using one large processor to handle everything cuts memory size and greatly reduces the amount of software needed." He claims the number of instructions drops an order of magnitude to 16,000.



New switch. Phone company employees monitor operation of Stromberg-Carlson digital switch, first in nation to be installed in small, local telephone exchange.

Hybrid codec. Besides exploiting commercially available processors with their wealth of software, Stromberg developed its own hybrid codec that it claims is cost-effective for use on a one-per-line basis—which is necessary to meet the stringent requirements of the smaller central offices. The hybrid codec combines five integrated circuits housed in a package about the size of a 22-pin dual in-line package.

The first digital switch installed—American Telephone & Telegraph's No. 4 ESS (for electronic switching system) in Chicago in January 1976—can handle some 90,000 lines at long-distance switching centers. The only other computer-controlled digital switch now in operation is the ITS4, which the Vidar division of TRW Inc. first installed in March 1976. It handles 1,000 lines or more.

Other companies plan to install smaller digital switches. In October, Canada's Northern Telecom Ltd. will begin installing its DMS-10 400-line unit. In the U.S., Vidar and the Collins Commercial Telecommunications group of Rockwell International Corp. have recently added small switches to their lines. □

Changes mulled in White House plan

Congressional discontent is surfacing over the White House reorganization plan that would fold the Office of Telecommunications Policy into the Department of Commerce under a new assistant secretary for communications and information. Alternate plans for an independent administration for telecommunications within the Department of Commerce are being weighed by the chairmen of the Senate and House subcommittees for communications, Sen. Ernest Hollings (D., S.C.) and Rep.

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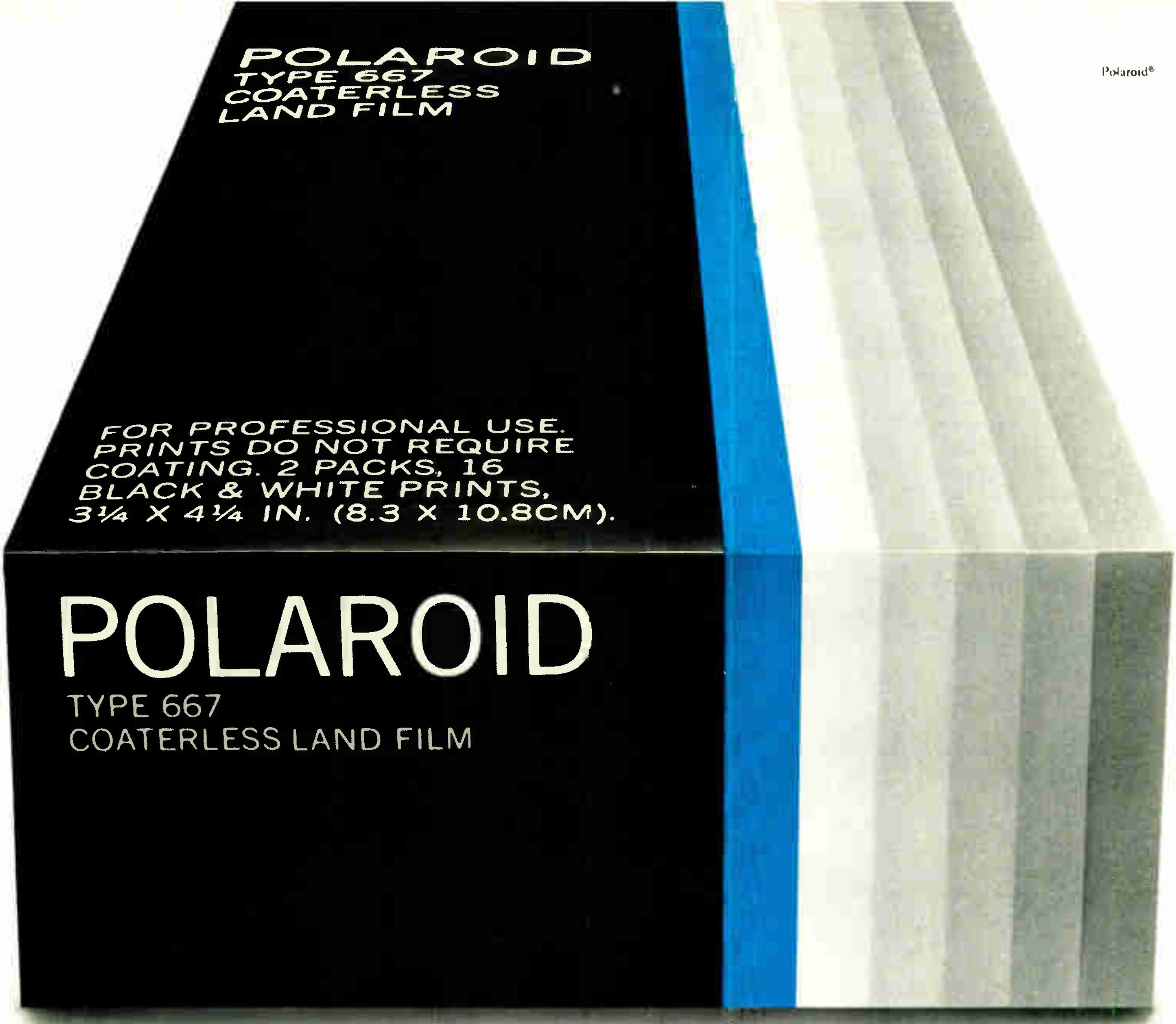

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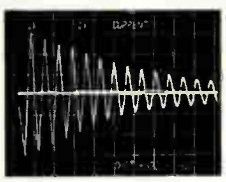

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Subcommittee staff members say the chairmen are concerned that the proposed downgrading will cut White House interest in critical communications policy issues. These include the ongoing rewrite of the telecommunications laws to encourage limited competition with the Bell System and the development of rules for electronic funds transfers and to insure the privacy of computer data.

"The White House admits that the new assistant secretary would have a staff of about 200, so there really is no great savings in jobs," points out one committee staff member. But a separate administration or agency for communications within the Department of Commerce—like the Department of Transportation's Federal Aviation Administration—would have greater authority and recognition within Government and industry, as opposed to adding one more asistant secretary to the five already in place, staff members hold.

A congressional proposal, if one comes, is expected before the end of August. Unless a substitute plan is introduced before Sept. 15, the Carter plan—aimed at reducing the White House staff—becomes effective automatically.

The plan. Carter's 10-page reorganization plan calls for combining the remnants of the telecommunications office with the existing Office of Telecommunications in the Commerce Department, now directed by Jordan Baruch, assistant secretary for science and technology. The plan would leave the White House with a telecommunications policy staff of four persons under the direction of the Domestic Policy Staff.

Functions relating to Government communications, including resolution of appeals on frequency allocations, would be taken over by the Office of Management and Budget under the Carter proposal. That office would also oversee Federal telecommunications procurement policy, a role now held by the General Services Administration.

These moves would leave the proposed Commerce Department organization with responsibility for development of general policy and policy analyses, initial assignment of frequencies to Federal users, and management of U. S. participation in international telecommunications meetings and negotiations.

The small White House staff will handle three areas: preparation of national security, emergency, and other policy options; final disposition of appeals from the Office of Management and Budget; and procurement and management of Federal telecommunications systems. Critics contend the White House plan "leaves a lot of people at Commerce with relatively little to do, and damn few people at the White House with more than they probably will be able to handle." □

Microprocessors

National readies broad product push, including extension of the 8080A

Look for a major push during the fourth quarter by National Semiconductor Corp. in metal-oxide-semiconductor and bipolar microprocessors. The Santa Clara, Calif., firm will introduce low-, middle-, and high-end 8-bit designs, single-chip devices, and 16-bit systems in MOS and bipolar bit slices and 8-bit microprocessor peripherals.

Eight-bit 8080A. Surprisingly, however, National's Microprocessor group, under its director, Bill Baker, is sticking with the 8080A in the general-purpose 8-bit area, rather than go to so-called third-generation designs like the Intel 8085 or the Zilog Z-80. "The 8080A is a viable and very high-volume market for at least another two to four years," says Howard Raphael, microprocessor marketing manager at National, "and it will remain the industry standard until a true third-generation system comes along, something with at least an order of magnitude improvement in speed. Nothing less, we believe, will make it economically and technically attractive for users to give up designs they already have in place based on the 8080A."

The company plans higher-speed versions of the 8-bit microprocessor, as well as more than 40 peripheral chips designed specifically to operate with the 8080A. These peripheral devices will include not only most of Intel's 825X and 827X series but proprietary devices from National itself and redesigns of peripherals from other microcomputer families.

At the low end, National plans to meet Intel's 8048 family head on with a one-chip version of its n-channel MOS SC/MP II microprocessor. Designated the 8050, it will be the first of a series of one-chip devices, says Raphael. First samples are expected by the end of this year.

In the 16-bit area, National will introduce a high-speed n-MOS minimum-chip 16-bit microcomputer system, the 8900, before the end of the third quarter. It will be similar to the 8085, consisting of a sophisticated 16-bit central processing unit and two peripheral chips, one combining random-access memory with input/output functions and the other combining read-only memory and I/O. Moreover, says Raphael, the 8900 will be completely software-compatible with National's present p-channel MOS 16-bit microprocessor, the PACE.

Software aids. A major effort will also be made in the area of high-level languages as a microprocessor software development aid, he continues. "Semiconductor firms have reduced the cost of computing in every area except software," he says. National is planning a family of software-preprogrammed 65,536-bit, 131,072-bit, and 262,144-bit maxi-ROMs aimed at reducing costs in this key area. The first of these units, the INS8298, is a 65-k ROM with a modified 8080 Basic interpreter and hex debugger package on one chip. A later 65-k ROM will incorporate a software utility package using Na-

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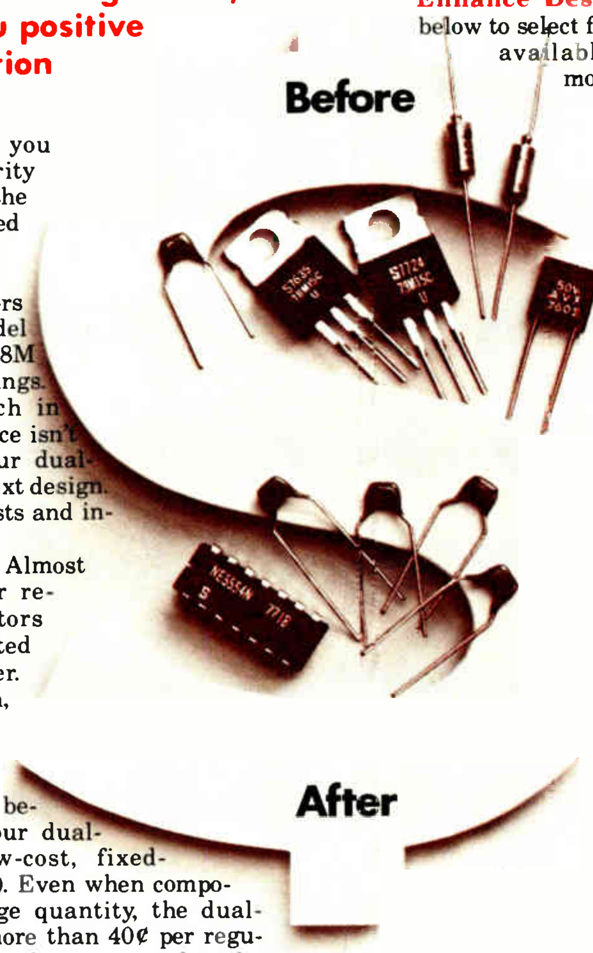

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tional's SC/MP-oriented Basic language, NIBL (for National Industrial Basic Language). Still later, an enhanced Basic software package for the PACE microcomputer family will be introduced on two 65-k ROMs and then on a single 131-k ROM now in development.

In the bipolar area, National has developed a high-speed 4-bit-slice family with a 120-to-150-nanosecond microcycle time that is 30% to 50% faster than the industry standard 2900 family. National's new INS2900 family will include all parts now on the market, says Raphael, and eventually add new proprietary circuits as well. In addition, all of them will be fabricated with a new process combining the high speed of emitter-coupled logic with the advantages of low-power Schottky bipolar processing. □

Two-chip design hits low end of market

Semiconductor manufacturers will be serving the low-price controller end of the microcomputer market with one-chip designs, but Signetics Corp. thinks these are much too limited. That is why its new entry into the low-end market is a two-chip affair, one that Signetics' Gary Summers points out is easy to expand when users want to add extra features to their basic equipment designs.

"It not only handles simple controller jobs for such things as microwave ovens, vending machines, and printer controllers, but it also is easily expandable into more powerful, byte-oriented data-processing systems at a cost much lower than other multichip designs," says the marketing manager for metal-oxide-semiconductor microprocessors at the Santa Clara, Calif., company.

Interface. Key to its two-chip approach is Signetics' new combination memory, input/output, and timing chip called the system memory interface. The 2656 can hook up directly to the company's well-established, general-purpose 2650A mi-

News briefs

Wema relinquishes semiconductor statistics

The recently formed Semiconductor Industry Association, Cupertino, Calif., has taken over the 18-month-old statistical program that Wema, the electronics trade association, had organized for the semiconductor industry. According to Bernard T. Marren, SIA president, the transfer occurred "because we're better suited to serve the needs of the semiconductor industry." SIA was formed early this year by five major semiconductor manufacturers seeking stronger representation on trade matters in state and Federal legislatures [*Electronics* April 14, p. 50].

The program has 45 subscribers who pay from $400 to $700 for the monthly reports. According to Marren, it will provide the same statistics as before, with an independent accounting firm gathering the data on shipments from 42 companies.

CB license applications rise 10% in first half

Citizens' band radio license applications to the Federal Communications Commission rose to 3.25 million in the first half of 1977, up more than 10% from the 2.93 million filed in the first half of 1976, a record year for CB radio sales and license applications. Approximately 11 million licenses have been granted by the FCC since it began licensing CB radios in 1958, over half of them in the last 18 months, says the Electronic Industries Association. EIA staff vice president John Sodolski estimates that "by 1980 there will be more than 50 million mobile citizens' radios in use in the U. S.—approximately one in every other car—in addition to 15 million to 20 million base stations."

Philco, RCA recalling more than 21,000 TV sets

Routine quality control inspections at Philco Consumer Electronics Corp. in Batavia, N. Y., and RCA Corp.'s Consumer Electronics division in Indianapolis, have led to the recall of over 21,000 recently produced television sets following the discovery of potential shock hazards. Philco is recalling 3,132 15- and 19-inch color TV sets, while RCA is doing the same for about 18,000 black-and-white 19-in. receivers.

A Philco spokesman says that the inspections indicated that the color correction button on two models and the autolock channel-tuning button on another "might give users a 120-volt shock." This could occur if the spring-loaded button on the front control panel is fully depressed, the user is grounded, and the electrical wall plug lacks voltage polarization protection. An RCA spokesman says rough handling in shipping might damage its receiver and loosen the picture tube, "providing a potential for a 60-volt electrical shock."

Electronic Arrays loses its president

W. Donald Bell resigned as president and chief executive officer of Electronic Arrays Inc., Mountain View, Calif., nudged in part by the company's poor performance over the last 18 months. Although Electronic Arrays had an ambitious technology development program, including an intensive V-groove metal-oxide-semiconductor development, few new products from this costly effort reached the market. For its fiscal year ending March 31, the company reported a $3.4 million loss.

Bell Laboratories checks out a new photovoltaic cell

A new type of photovoltaic solar cell being worked on by researchers at Bell Laboratories, Murray Hill, N. J., relies on a pair of electrodes immersed in a water-based solution. Light-conversion efficiency of 7.5% was attained with one electrode of single-crystal cadmium selenide and the other of carbon. With lower-cost polycrystalline cadmium selenide, the efficiency was 5.1%. According to Bell Labs, the cells, with their easy-to-make junctions, are much cheaper to build than conventional photovoltaic cells using single-crystal silicon. The efficiency of silicon cells used terrestrially generally runs between 12% and 14%.

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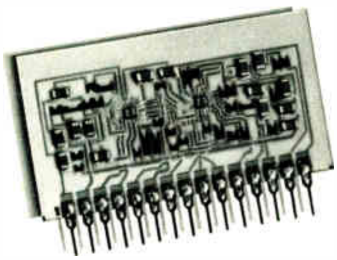

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croprocessor to offer a system with a full 2,000 bytes of program memory, 128 bytes of random-access memory, and an 8-bit I/O port. This is as powerful as the most powerful of the single-chip designs.

Because it works directly with the full line of 2650 microcomputer peripheral and memory components, the interface chip can be used to design upward. Its range extends from simple controller applications costing less than $20 to full-performance, multichip data-processing jobs that may require larger memory and additional peripherals, according to Summers.

He concedes his two-chip system will not be as cheap as competing one-chip microcomputers such as the Intel 8048 and the Mostek 3870, but he is after users who plan ahead. "Neither the 8048 nor the 3870 can easily be expanded into multichip processor families," he maintains. "To do that, a user would require a new software development program. With our two-chip set, no additional software is required."

He reckons that for $20, an expanded three-chip set that includes the 2650A, the 2656, and the 2655 programmable peripheral interface chip provides 26 more I/O lines. All three chips are in a single 5-volt supply format using less than 1.5 watts of power. Such a combination of features would cost $40 with a three-chip set such as the 8085, he asserts.

On the chip. The 2656 is a complex n-channel LSI chip. It has a 2,048-by-8-bit mask-programmable ROM for program storage, a 128-by-8-bit static RAM for data storage, eight multipurpose pins for chip-enable or I/O bits, and an 8-bit latch for I/O or central-processing-unit storage. It also has an internal clock generator with a crystal, resistor/capacitor, or external timing source. The chip contains an 18-by-11 programmable gate array that manages the data flow and serves to make the architecture one of the most efficient for low-end applications.

Also available with the 2656 system memory interface is a circuit emulation board for helping to program the chip. The emulator allows a user to formulate specific RAM and programmable gate-array patterns that can then be easily transferred to code for ROM instructions. Samples of the chip are available this month. □

Memory

65-k V-MOS ROM attains high speed

If there is one parameter at least as important as density in the next generation of metal-oxide-semiconductor read-only memories, it is speed: specifically, read access times that are compatible with the cycle times of the newest generation of microprocessors.

American Microsystems Inc. attains such speed, as well as high density, in a 65,536-bit read-only memory fabricated with its new V-groove MOS process [*Electronics*, June 23, p. 29]. The Santa Clara, Calif., integrated-circuit maker will begin supplying samples in September and expects to reach production by the end of the year. Access time of the device, designated the S4262, is in the 225-to-300-nanosecond range, about 100 to 150 ns faster than the only other 65-k ROM now commercially available, National Semiconductor Corp.'s MM4235 [*Electronics*, April 14, p. 42].

What is more, the 5-volt, silicon-gate V-MOS ROM incorporates the 65 kilobits of the central array and 4,096 bits of peripheral circuitry on a chip only 29,000 square mils in area. This is roughly 7,000 square mils smaller than ROMs with half the bit capacity (such as General Instrument's 32,768-bit device, which measures 36,000 mil^2). Power required for the S4262 is only 500 milliwatts, says Robert Yu, the circuit's designer.

Structure. Key to the high density is, of course, the V-MOS structure, a vertical n-channel MOS transistor having a gate that is formed on the slope of a V groove, with the result

COMMUNICATIONS

THE REMARKABLE 3843 USART: IT HELPS SMART CONTROLLERS SPEAK FLUENT SERIAL.

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The 3843 is a full duplex Universal Synchronous/Asynchronous Receiver Transmitter (hence, USART) designed to interface the bus-oriented format of a controller with the serial format of peripherals.

It converts parallel data to formatted serial data and assembles formatted serial data for parallel use by the controller.

The new Fairchild device provides programmable control of the transmitting and receiving mode, character length, framing format, parity mode and baud rate. Inputs and outputs are TTL-compatible. Three-state outputs can be combined to form a TTL-compatible output bus.

A FEW MEANINGFUL SPECS.

The 3843 provides 5, 6, 7 or 8-bit selectable character length. Odd or even parity generation and checking. Selectable number of stop bits (1, 1½, 2) in asynchronous mode. Selectable clock rates (16X, 32X, or 64X-baud rate). Maximum baud rates (synchronous mode): 1X clock, 256K; 16X clock, 16K; 32X clock, 8K; and 64X clock, 4K. Error flags include over run, parity and framing error. Requires + 12V, + 5V supply voltage.

On one low-cost programmable chip, requiring minimal power and pin-count, you get essentially all the functions necessary to interface a parallel data environment with a serial communications link. It is ideal for use with any 8-bit microcomputer system, including Fairchild's F8 and F6800 families.

The 3843 is manufactured with the N-channel Isoplanar™ silicon gate process. It's available in both plastic and ceramic 28-pin DIPs.

THE FIRST OF MANY.

The new USART is the first device in a new line of telecommunications products from Fairchild. The 3843 is available right now, in quantity. Call your Fairchild distributor, sales office or representative today for parts and specs. For a quicker response, use the direct line at the bottom of this ad. Fairchild Camera and Instrument Corporation, 464 Ellis Street, Mountain View, Calif. 94042. Tel: (415) 962-3941. TWX: 910-373-1227.

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SCIENCE/SCOPE

Survival odds have increased for US Army tank crews, thanks to a remarkable new fire-suppression system to be incorporated in the US Army's new XM1 main battle tank . . . scheduled for use during the 1980's. The system will detect and suppress a fuel explosion inside the tank, extinguishing it within 1/10 of a second which is less than half the time it takes to blink an eye.

Similar devices in the past have triggered false alarms due to signals as common as the energy reflected from colored shirts. So combat crews simply turned them off. In contrast, the Hughes dual-spectrum sensor can detect a mini-explosion even in direct sunlight. Yet, it will not false-alarm even when pointed directly at the sun or other light sources such as gunfire, rockets, lightning, matches or other vehicles. Infrared sensors and related electronics for the fire-protection system will be built by Santa Barbara Research Center, a Hughes subsidiary, for the XM1's prime contractor, Chrysler Corporation.

Improved forecasting of major crop yields, a step in the battle against world famine, is among the benefits predicted from an advanced space instrument called Thematic Mapper. Scheduled for launch in early 1981, it will be installed on Landsat-D, fourth in the NASA Goddard Space Flight Center's series of Earth Resources Technology Satellites. Hughes, with its Santa Barbara Research Center subsidiary, will design and develop the instrument's basic structure, telescope, calibrating system, detector arrays and processing electronics.

The new sensing instrument, with a ground resolution expectation 2½ times greater than present sensors, should also contribute to improvements in agricultural land use, forest and water resource management, land use mapping and mineral exploration. Launched in a low-altitude north-south orbit that carries them over both poles, Landsat satellites provide full coverage of the earth's surface.

Hughes Aircraft Company has openings for experienced engineers and scientists in its Culver City, California laboratories. Radar Systems Group needs are for electronic circuit engineers to design microwave transmitters, power supplies, and RF, IF and video frequency analog circuits; mechanical engineers to design airborne microwave antenna structures; engineers to develop hybrid microcircuitry; systems analysts to apply modern control theory to tracking systems, and signal theory for radar system detection and acquisition functions; signature technology engineers to analyze and simulate target return digital processing for target identification.

Use of the laser as a high-speed cutting tool has been envisioned since the first laser was demonstrated at Hughes more than 15 years ago. Since 1971, when the first lasercutter was used to cut cloth in apparel manufacture, its advantages in speed, accuracy, material saving, response to design change, and adaptability to computer control have been applied to other industries. Systems have been used in the US and abroad for such applications as cutting patterns for footwear and cutting sheets of boron epoxy broadgoods used in aircraft part manufacture.

Now, the first, large-scale, metal-lasercutting system is being built for Garrett AiResearch to cut corrugated steel. The system eliminates the need for costly dies, provides for more efficient use of materials, and permits quick, economical response to special engineering changes.

Creating a new world with electronics

HUGHES

HUGHES AIRCRAFT COMPANY

that it is geometrically more efficient than present planar n-channel MOS devices. The fabrication process features double selective oxidation and uses seven masks—only one more than in depletion-load MOS processing, says Yu. The extra mask is used for the V grooves, while surface MOS structures are defined conventionally by the other six masks in the set.

"Resistors are chosen as load elements over depletion loads on the V-MOS transistors," adds Yu, "because they have lower temperature dependence and therefore give better worst-case power-speed values."

More unusual is the internal organization of AMI's 65-k ROM. Externally, says Yu, the S4262 looks as if it were organized as an 8,192-by-8-bit device, and it is compatible with byte-oriented microprocessor designs. Internally, however, the array is organized in four 16,384-bit blocks and, unlike present devices, uses three levels of decode—one to access the block, another to access the word line, and a third to access the bit line and transfer a particular bit out to one of a common set of eight bit-sense lines running down the center of the device. "But at the same time as a particular block is accessed," says Yu, "the other three are automatically put on a standby mode. This allows us to reduce the read access time without substantially increasing the power."

Family. A fully static part that requires no clocks to operate, the S4262 is the first in a family of high-speed super-dense ROMs that American Microsystems is planning to bring to the marketplace, according to Yu. "Simply altering the value of the load resistors in the V-MOS structures will allow us to reduce the speeds of later 65-k ROM designs to much below 200 ns," he says.

Yu goes on to predict that with the addition of such techniques as substrate bias generation and scaling, it should be possible to build 131,072-bit devices in approximately the same area as the S4262, and 262,144-bit ROMs in about the same area as some 32-k ROMs now available. □

Communications

Comsat shows digital TV link

A digital color-television link from Chicago to Clarksburg, Md., was in operation for a short while recently, courtesy of Communications Satellite Corp. The developmental system, demonstrated at the International Communications Conference in Chicago, uses differential-pulse-code modulation (DPCM) to achieve an approximate 2:1 video data reduction. It also multiplexes the program audio, 60 telephone voice channels, and a dedicated digital channel onto the same 43-megabit-per-second serial data stream that carries the video signal.

"We think that the future of TV will be digital," says Allen G. Gatfield, manager of the image processing department at Comsat's Clarksburg laboratories. "So we're working on a technique for digital coding that is simple enough to be reasonably priced if produced in commercial quantities." There are strong signs of a trend toward digital video processing in TV studios [*Electronics*, June 23, p. 94]. Moreover, TV transmissions will need to be digital to be handled efficiently by satellite and terrestrial communications, which are moving to digital as well.

Low price. Gatfield estimates that the Comsat equipment, with time-division-multiplexing gear for adding external data streams, could be sold for \$10,000 to \$15,000. Other implementations have aimed at squeezing the video into smaller bandwidths, but at a hefty cost premium. For example, Nippon Electric Co.'s Netec-22 coder—which uses interframe DPCM techniques to pare the bandwidth to 22 Mb/s—requires two racks of equipment that the Japanese firm estimates would cost \$120,000 in production.

Besides the operators of the systems that now distribute analog TV signals, potential buyers of digital TV systems include firms that may want them for internal communications. AT&T has been pushing this concept for years, without too much success, with its Picturephone service, and such teleconferencing is also a pet project of the National Aeronautics and Space Administration. NASA, in fact, provided the impetus for Comsat's first demonstration. Using a vehicle-mounted earth terminal from NASA-Lewis Research Center, Comsat beamed full-duplex digital color-TV video and audio signals between Chicago and its Clarksburg facility via the U.S.-Canadian Communications Technology Satellite.

Comsat treats the composite video signal without breaking it into its component parts, as others do in trying to achieve higher compression ratios. Amplitude (brightness) information is converted into 256 levels. The signal's phase, conveying color information, is preserved by sampling the analog video at 10.7 megahertz, which is about three times the color subcarrier frequency. The 8-bit samples are fed to the transmitter, which determines the difference between the actual and predicted values of the sample and quantizes that difference with one of 16 4-bit codes—achieving 2:1 reduction.

Same frame. Instead of using data from earlier frames to help predict what the next sample will be, Comsat relies entirely on picture elements in the frame being transmitted. This technique eliminates a costly frame storage memory. "From a hardware standpoint, the difficulty is in getting the prediction from one sample around the loop before the next sample comes along," Gatfield says. "That involves a table-look-up operation (quantizing and coding) and a number of arithmetic operations within 93 nanoseconds." Comsat builds its transmitter and receiver with high-speed emitter-coupled logic.

A buffer and multiplex unit formats the data, inserts unique words for line and frame synchronization, and multiplexes the program audio with the video by bursting it during the horizontal sync portion of the signal. □

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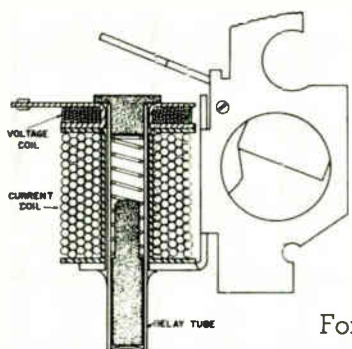

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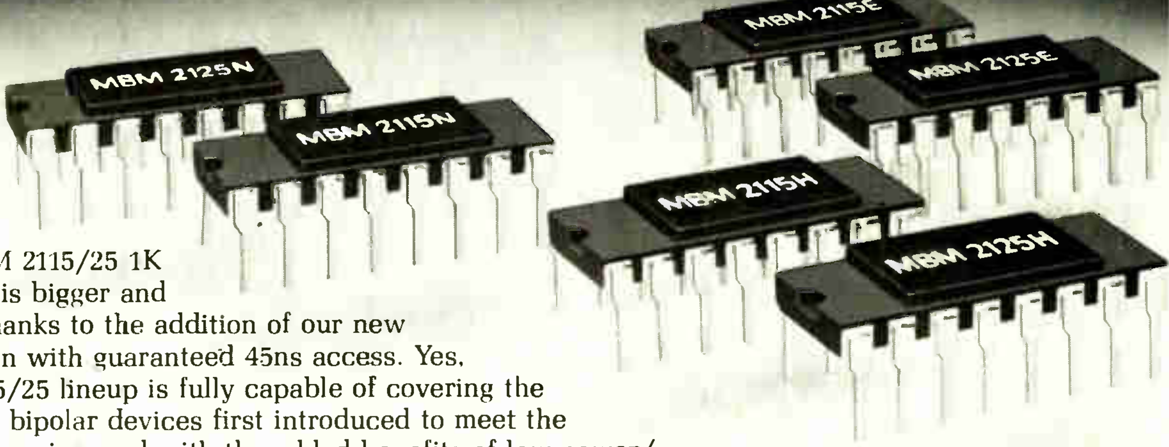
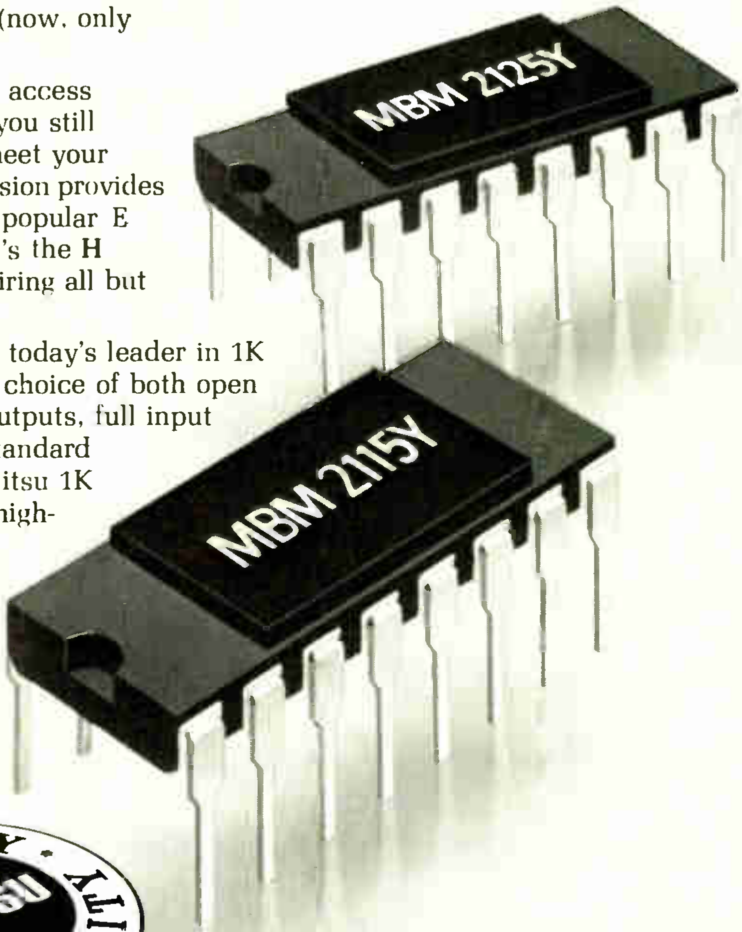


The Fujitsu MBM 2115/25 1K static RAM lineup is bigger and better than ever thanks to the addition of our new super-fast Y version with guaranteed 45ns access. Yes, now the MBM 2115/25 lineup is fully capable of covering the speed range of the bipolar devices first introduced to meet the needs of cache memories, and with the added benefits of low-power/low-cost MOS technology. And improved performance with the MBM 2115Y/25Y doesn't stop just with faster access time. You also get a 5ns reduction in chip select time (now, only 30ns max.) that's the best in the industry.

Of course, if you find the 45ns max./30ns typ. access time of the all-new Y version too hot to handle, you still have a choice of three other speed versions to meet your needs. Our "slowest" and most economical N version provides you with a guaranteed 120ns access time, our popular E version offers 95ns access, and, of course, there's the H version with 70ns max./55ns typ. for those requiring all but the fastest access.



Remember, the Fujitsu MBM 2115/25 lineup is today's leader in 1K static memories. Offering four speed versions, a choice of both open drain (MBM 2115) and three-state (MBM 2125) outputs, full input protection against the effects of static charge, standard pin-outs* and a wealth of other features, the Fujitsu 1K static RAM is your best choice for dependable, high-speed 1K performance.

Write or call right now for more information about these high-performance Fujitsu static memories, or any of the other Fujitsu-superior memory products. Contact Fujitsu America, Inc., 2945 Oakmead Village Court, Santa Clara, California 95051, phone: 408-985-2300, telex: 357402, twx: 910-338-0047.

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Circle 48 on reader service card

Washington newsletter

China tour set by seven U.S. satcom companies

A team of seven U. S. electronics companies specializing in satellite communications and headed by Scientific-Atlanta Inc.'s Sidney Topol will visit the Peoples Republic of China for nine days beginning Aug. 8. Also represented will be California Microwave Inc., Collins Radio Group of Rockwell International Corp., GTE International Inc., Hughes Aircraft Co., International Telephone and Telegraph Corp., and RCA Corp. Included on the group's schedule is a one-day briefing in Peking for the China Machinery Import and Export Corp., the official trading company for high technology.

Despite the fact that satellite communications are on the U. S. control list of items barred from export, the visit—put together by the Electronic Industries Association—has been approved by the White House, which overruled opposition by the State Department. "It's an exploratory trip," explains John Sodolski, EIA communications division vice president. China has applications on file with the International Telecommunications Union for two satellite orbital positions and has two America-made ground stations installed by GTE Sylvania and RCA.

Fogarty tops list for FCC chairman

Federal Communications Commissioner Joseph Fogarty, Democrat and former counsel to a congressional telecommunications subcommittee, is the **leading candidate to succeed chairman Richard E. Wiley.** Possible appointees to vacancies caused by his elevation and the resignation of Benjamin L. Hooks to head the NAACP include Charles D. Ferris, legal counsel to House Speaker Thomas P. O'Neill, and Henry Geller, former FCC general counsel.

NASA to name Lockheed, Perkin-Elmer for space telescope . . .

Two six-year contracts for development of key parts of the space telescope totaling more than $131 million plus fees are scheduled to be awarded in October to Lockheed Missiles and Space Co., Sunnyvale, Calif., and Perkin-Elmer Corp.'s optical technology division, Danbury, Conn., by the National Aeronautics and Space Administration. The 2.4-meter-diameter telescope, capable of accommodating up to five different instruments in its focal plane, is due to be placed in orbit in late 1983.

Lockheed will design, develop, and build the telescope's support systems module at a proposed cost of $72.8 million, while Perkin-Elmer will receive approximately $58.5 million to perform the same tasks for the optical telescope assembly. **NASA says that the telescope will provide immense improvements in resolution, light sensitivity, and wavelength coverage** that will permit astronomers to investigate problems that could never be approached from observatories below the Earth's atmospheric veil. In the competition, Lockheed defeated Martin Marietta Aerospace's Denver division, and Boeing Aerospace Co., Seattle, while Perkin-Elmer won in competition with Eastman Kodak Co., Rochester, N. Y.

. . . as Ball Bros. beats Hughes for IR satellite pact

Ball Brothers Research Corp., Boulder, Colo., has been chosen by NASA to negotiate a contract for $13.8 million plus fee to design, develop, and build a large, cryogenically cooled infrared telescope to be flown on the infrared astronomy satellite. **IRAS, a cooperative U. S.-Netherlands program, is scheduled for early 1981 launch into polar orbit using a Dutch spacecraft.** Ball Brothers defeated Hughes Aircraft Co., Culver City, Calif., in the competition.

EIA's limited vision on arms export controls

Carter Administration proposals that would set a $9 billion annual limit on U. S. arms exports to countries other than its NATO allies, Japan, and Israel are disturbing the Electronic Industries Association's Government division—so much so that EIA is circulating a new 150-page study, in which it identifies a cumulative seven-year loss through 1983 of $56.6 billion and 1.53 million man-years of employment in the military electronics and transportation equipment industries through "sales not realized" if the Carter limit is upheld.

Bearing a straightforward title, "The Impact on U. S. Industry of a Restricted Arms Control Policy," the study is clearly aimed at members of the House and Senate whose districts include makers of military electronics and transportation equipment—e.g., aircraft, missiles, ships, tanks and their components. To make it easier to lobby against the Carter proposals, much of the study is devoted to a statistical breakdown of the impact that arms export controls would have on jobs and sales dollars in each of 36 industrial states.

Awacs an aberration?

Recent events involving the Carter Administration's drive to sell Iran seven of Boeing Co.'s E-3A Advanced Warning and Control Systems for $1.2 billion, despite requests for reconsideration by the leaders of both the Senate and House, suggest that the arms control ceiling may be honored more in the breach than in application. But the EIA had no way of knowing that when it assembled its study. It may even turn out that the Iranian Awacs sale is merely a one-time White House move to offset the economic loss produced by NATO's recent rejection of Awacs.

To get its data on exports, EIA used the U. S. Standard Industrial Classification for communications-electronics equipment (SIC-36) and transportation equipment (SIC-37), breaking out the estimated electronics content in the latter category. Total electronics exports of these two industries in 1977 could run to $27.3 billion if uncontrolled. But if Carter's $9 billion ceiling on military hardware is invoked, they would be cut to $22 billion, EIA claims, resulting in the loss of some 100,000 jobs.

That near-term impact is as nothing, EIA says, compared to its projection of what a $9 billion annual export ceiling would do to military electronics exports in 1983. In that year, SIC-36 and -37 exports would be held to $35.2 billion, generating only 825,000 jobs, rather than the $49.1 billion and the 1,162,000 jobs those extra military sales would produce. The unrealized export potential of $13.9 billion in sales and 337,000 jobs evidently distresses EIA.

The larger issue

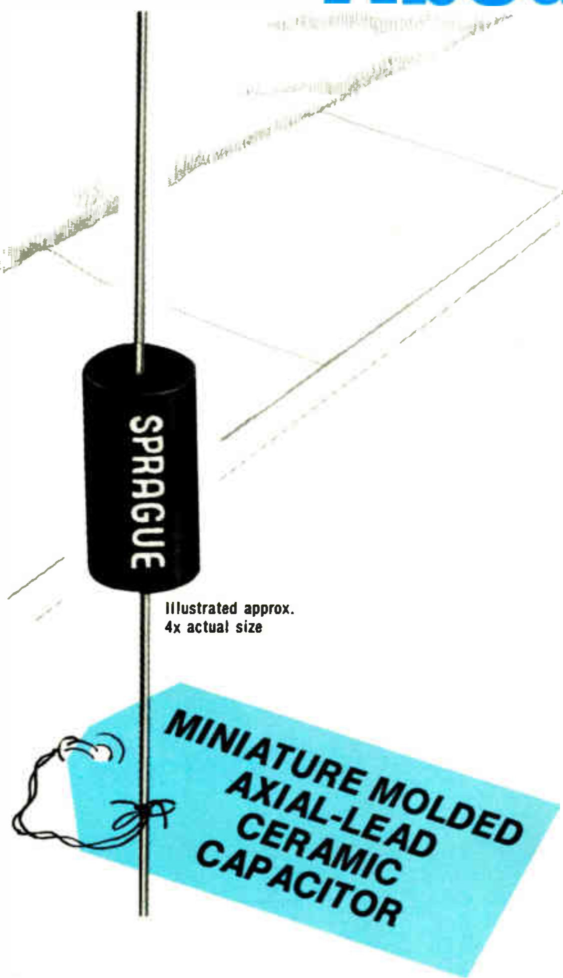
Beyond the impressive massing of statistics—regardless of how soft they may be—lies an issue for the electronics industries that is larger than the dollars and manhours that might be lost if exports of military electronics are controlled. How long will some of America's leading electronics companies let their economic success or failure depend on the uncertainty of foreign wars? They have already put themselves partially into an economic box by leaping at the opportunity of sharply increased foreign arms sales, promoted by Richard Nixon as President seeking to counter massive price increases for Middle East oil in the early 1970s.

To say that the United States cannot successfully divert its electronics technology to nonmilitary applications—and create sales and jobs in the process—has been proved wrong time and time again. It has been proved by the National Aeronautics and Space Administration's lunar landing program, by the many-sided computer industry with its macro, micro, and mini machines, and by semiconductor producers who have developed enough new markets to push small military orders near the bottom of their lists of priority business. Then, of course, there is the example of Japan—limited constitutionally to spending no more than 1% of its national budget on military systems. That constraint hardly prevented Japan from developing its electronics industries—as American manufacturers of home entertainment electronics are painfully aware.

The world's undeveloped markets for telecommunications equipment alone are enormous, as American Telephone & Telegraph Co. has discovered. While the Carter White House pushes to capitalize on the sale of seven Awacs to Iran for more than $1 billion, AT&T's Iranian subsidiary, American Bell International, has turned up a telecommunications market in that country with a business potential 10 times that of Awacs [*Electronics*, June 9, p. 40]. And that is by no means the limit to opportunities for American electronics manufacturers abroad provided they raise their sights beyond the level of weapons. EIA needs to take a second, longer look at its subject.

Ray Connolly

About that 'new' kid on the block...



Illustrated approx.
4x actual size

Actually, he's not that new. He's been around for quite a while now. Other vendors keep announcing miniature cylindrical ceramic capacitor 'innovations', but Sprague Electric, the pioneer in layer-built ceramics, can state with pride that this type of capacitor was introduced by Sprague more than ten years ago.

Sprague Type 292C MONOLYTHIC® Capacitors are the industry's best-constructed axial-lead capacitors, thanks to MFT*, a closely-monitored material modification of electrode metal and ceramic reacted with glass. The result—less capacitance change with temperature change, improved stability with life, and improved impedance with frequency characteristic.

These low-cost miniature capacitors feature a dimensionally-precise molded construction and can be ordered taped and reeled for automatic insertion. They are available in body formulations to meet characteristics Z5U (general-application), X7R (semi-stable), and C0G (NP0).

For complete technical data, write for Engineering Bulletin 6250B to: Technical Literature Service, Sprague Electric Co., 35 Marshall St., North Adams, Mass. 01247.

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First D-MOS static memory hits Japanese market

Sharp Corp. is bringing Japan's first double-diffused MOS part to market in the form of the LH-2102A2, a 1,024-bit static random-access memory pin-compatible with Intel's 2102A2. **Minimum access time is 120 nanoseconds; maximum is 250 ns.** These speeds do not fulfill the potential of the process, but they have been achieved on a production line that does not make fast parts. The company plans to use the devices with the Z-80 microprocessors that it expects to have in sample quantities this autumn.

The firm has also announced the LH-5010 and LH-5102, which are 1-k and 2,048-bit static complementary-MOS RAMs with metal gates that have typical access times of 400 ns. Sharp and Rockwell International Corp. will be using these chips in microcomputer applications requiring battery backup to prevent loss of memory contents.

BBC buy buoys Marconi export hopes for transmitters

A British Broadcasting Corporation purchase of 24 50-kilowatt radio transmitters of a new type from Marconi Communication Systems Ltd. should help the British manufacturer in the highly competitive export market for that type of receiver. Marconi executives say the $3.4 million contract will give them a production run to quote lower unit prices against worldwide competitors—Thomson CSF in France and the Broadcast Products division of Harris Corp. and the Continental Electric Manufacturing Co. in the U. S.

Due to enter operation by May 1979, **the compact B6034 has only four vacuum tubes in the high-power stages.** It features solid-state (including large-scale-integrated) circuits especially in the control and drive sections, an improved Doherty-type modulation system, and a noteworthy 60% efficiency rating. Transmitting between 525 and 1,605 kilohertz, the automatically operating units may be assembled in 100- and 150-kw versions.

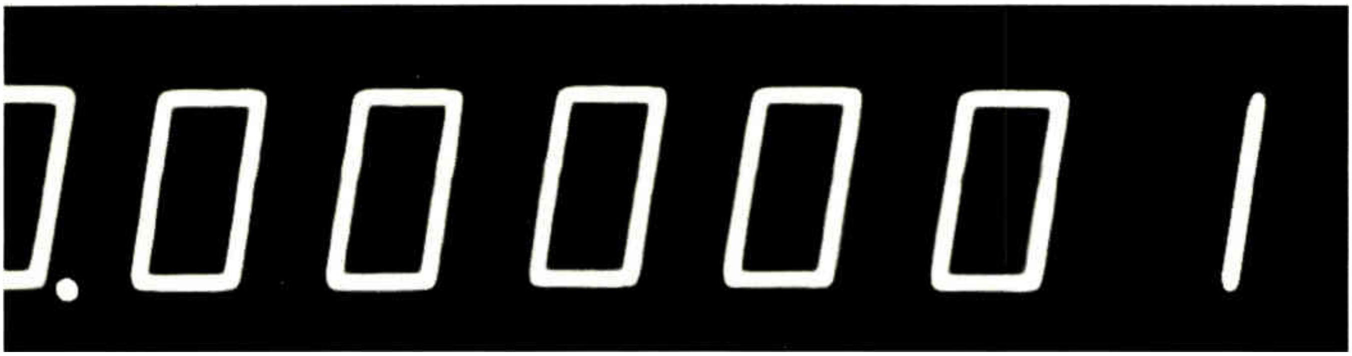
Sales mounting for 21,000-line/min. laser printer

Best-seller status is fast approaching for the high-speed laser printer that Siemens AG announced last year. During the past five months, the German company **received orders and options for more than 100 of its model 3352 laser printers** from original-equipment manufacturers around the world. Besides what the Munich-based firm terms a favorable price-performance ratio, a major selling point for the system is its printing rate of about 21,000 lines a minute—a speed claimed to be the highest yet attained for a commercial nonimpact printer.

Export blues hit Japan's CB makers

Citizens' band radio exports from Japan to the U. S. in June were slightly down compared with May—575,661 vs 580,622. **But exports to the U. S. for the first six months of 1977 are down sharply**—2,773,521 vs 3,566,851 for the same period last year. Exports to the European market were more than double those of last June—60,423 vs 22,080—but that hardly makes up for the U. S. falloff.

Linearity



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For the most significant decades we replaced the conventional resistor network with an inductive divider system. For the remaining decades we went to integrating dual ramp technology. The result is the best of both worlds. Standards room accuracy and outstanding noise rejection.

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EMI

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Circle 54 on reader service card

Charge-coupled-device delay lines are exorcising TV ghosts

Automatic cancellation of multiple images, called ghosts, may be a built-in feature in many color television sets in a couple of years once a Japanese project succeeds in developing a large-scale-integrated chip for this purpose. Two firms are cooperating in the development of a weighted-feedback system using charge-coupled-device delay lines to cancel the ghosts.

One partner in the project is the Technical Research Laboratories of NHK, Japan's public service broadcasting system. The other partner is Tokyo Shibaura Electric Co., which is among the leaders in both television and semiconductor technology. Toshiba sells semiconductors and picture tubes both to its own equipment divisions and to others in Japan and abroad.

Picture degradation. Ghosts may be the largest remaining cause of picture degradation, as improved devices and circuits have eliminated synchronization instability and other eyesores of earlier days. Even the best antennas are not always adequate to remove ghosts, which can vary with channel, meteorological conditions, and other factors. Manually adjustable cancellation systems are unattractive because they must be readjusted for each channel and, for that matter, for the same channel over a period of time.

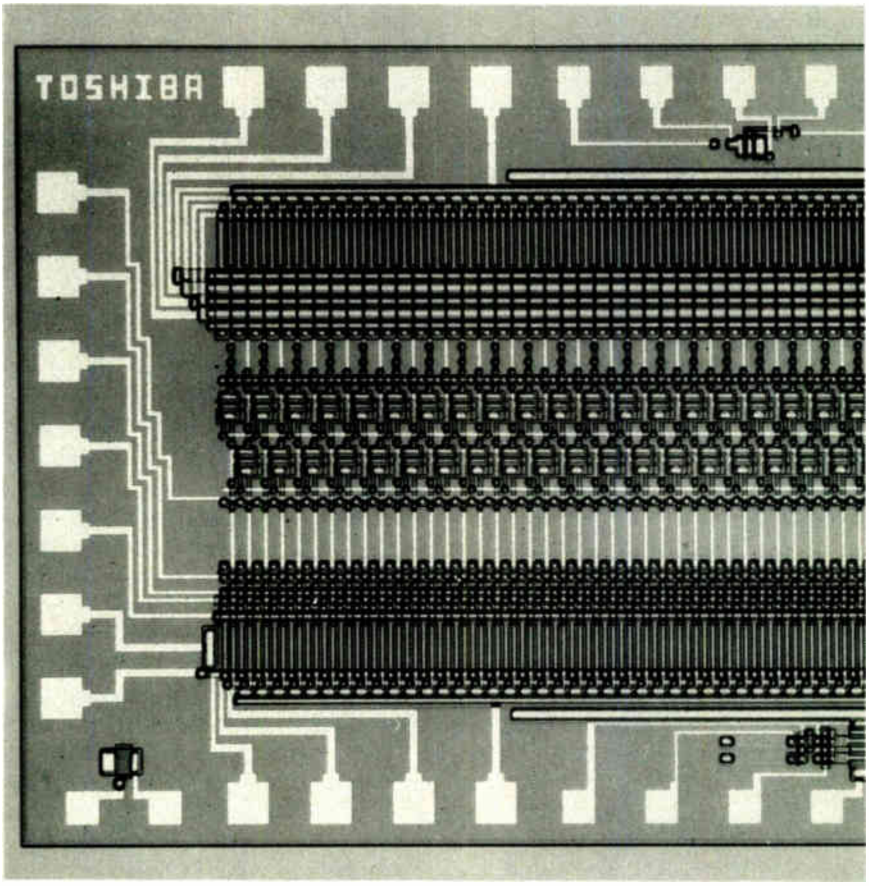
Researchers at NHK hit upon the idea of using the transition between equalizing pulses and vertical sync pulses at the bottom of the picture to control an automatic cancellation circuit. This transition occurs during the middle of a line, and ghosts present in the received signal show up as smaller pulses riding on a steady-state signal following the transition. Timing and amplitude of these pulses accurately define the ghosts. This scheme will work for ghosts delayed by up to about 27 microseconds, which covers most of these multiple images.

Ghosts are cancelled by a weighted-feedback system using a CCD delay line as a transversal filter. A feedback circuit can never provide 100% cancellation, but experimental circuits provide a reduction of 30 decibels, which cuts ghosts to negligible proportions.

The video signal is sampled at three times the color subcarrier frequency before it is fed in parallel to all stages of the delay line. Weighting circuits on same chip as the CCD line consist of gain-controlled, dual-gate, metal-oxide-semiconductor field-effect transistors. They vary the gain of the signal fed to a stage. Thus, it is proportional to the amplitude of the ghost having the same delay as that stage. Individual stages of the delay line act as adders, and the feedback signal has the proper configuration to cancel ghosts.

In initial tests, discrete circuits were used to control weighting of

Chasing ghosts. Top row of devices on LSI ghost canceller are CCD delay lines; middle row is weighting circuits. Bottom row has demultiplexing and analog-memory circuits.



individual stages. Adding to the complexity of the control circuits, is the need for an individual lead for each stage. Even in the original experiments with only 64 stages for somewhat less than 6-μs delay, the number of leads was too many for a single chip, and two separate delay circuits were used.

In the latest designs, demultiplexer and analog memory functions are added to the chip. The demultiplexer is an additional CCD delay line that is driven by a burst clock pulse to read in ghost information at the predetermined transition at the bottom of each field. Charge at each stage is then transferred perpendicularly to a separate floating diffusion that forms an analog memory. A source-follower circuit is a buffer between individual analog memory stores and weighting circuits.

Thus, gain-control lines of individual stages are on the chip, eliminating the need for external leads. The experimental 64-stage device using these techniques requires only 24 pins, and no additional leads would be needed.

Chip size for the 64-stage device is 2 by 3.6 millimeters. A device with twice as many stages would not require double the area because a large part of the basic chip is set aside for bonding pads. A practical device is still about two years off. With a delay in the order of 24 μs, it should fit on a chip comparable to those used for calculators. □

Great Britain

Army ADP system reports unit moves

The British Army could be first into the field with a tactical automatic-data-processing system that will quickly store and forward new unit locations to corps, divisional, and task force headquarters. Such a system could drastically cut the time spent in manually logging, verifying, and relaying changing unit locations.

Called Wavell, the project will enter field trials early next year with parts of the British Army on the Rhine's First Corps in West Germany. If the trials are successful, Wavell will be installed throughout the whole First Corps in the early 1980s. Britain hopes that this will give it a good shot at having Wavell adopted as the standard for the North Atlantic Treaty Organization. For supplier Plessey Radar Ltd., Ilford, Essex, it means potentially good export business in NATO and elsewhere.

Benefits. For the British Army, Wavell promises such tangible benefits as eliminating redundant staff at each headquarters, transferring data automatically, and providing immediate access to a common set of up-to-date information, according to Lt. Col. A. J. Sammes, Ministry of Defence procurement executive. He estimates that about 50% of current tactical trunk traffic is jammed up by the present manual logging.

Each Wavell ADP center will be built around a ruggedly packaged Digital Equipment Corp. PDP-11/34 minicomputer using 128,000 words of core memory backed up with a 40-megabit disk, plus line driver and printer, according to R. J. Fairchild, Wavell project manager. Headquarters staff will use visual display terminals or printers to transmit or receive information. A communications multiplexer relays the data from the center onto the tactical trunk network.

Because Wavell is a data system only, it can ride piggyback on any suitable trunk network, Fairchild claims. Currently it uses Bruin, a multichannel digital communications network employing directional ultrahigh-frequency and very-high-frequency links, but it will be able to use the British Army's more sophisticated Ptarmigan automatic dialing network expected to be out in the field in the 1980s [*Electronics*, Aug. 19, 1976, p. 73]. Later on, Wavell could transfer logistical information, as well operational moves.

The Wavell units will operate in armored command vehicles, trucks, and Land Rovers. The field trials, which end the $3.4 million first phase, will use nine vehicles. □

West Germany

Computers switch freight cars

Assembling more than 10,000 freight cars a day into as many as 270 trains will be the job of the electronic equipment in Europe's biggest switchyard in Maschen, just south of Hamburg. The electronics, which includes 14 Siemens computers, and the signaling equipment will account for 10% of the total construction costs of $350 million once the facility is fully operational sometime in 1979.

If the nearly-3-square-kilometer yard is not the world's biggest, "it certainly is one of the world's most highly automated switchyards," says Martin Lang, a project manager at the Braunschweig-based signaling equipment division of Siemens AG. His firm is the main supplier of the electronic systems and devices for the federal railway facility. The 14 computers handle the operations involved in freight-car classifying and routing for train assembly, as well as other control and monitoring functions. A similar system is already in operation at Mannheim.

At work. As in other switchyards, the switch engine pushes a train onto a hump, or inclined plane. As the cars roll down the other side, two computers throw track switches to route them according to their destinations onto 290 kilometers of switchyard track for assembly into a train.

The Maschen yard will have 112 assembly tracks and six switching towers. From the towers, the track switching and related operations handled by other Siemens process-control computers are initiated and monitored. Using data on car position, speed, and weight from the trackside sensors, radars, and other electronic devices, computers also control the car retarders—shoe-type brakes on the rails—and the mechanical mules—transport mechanisms between the rails. □

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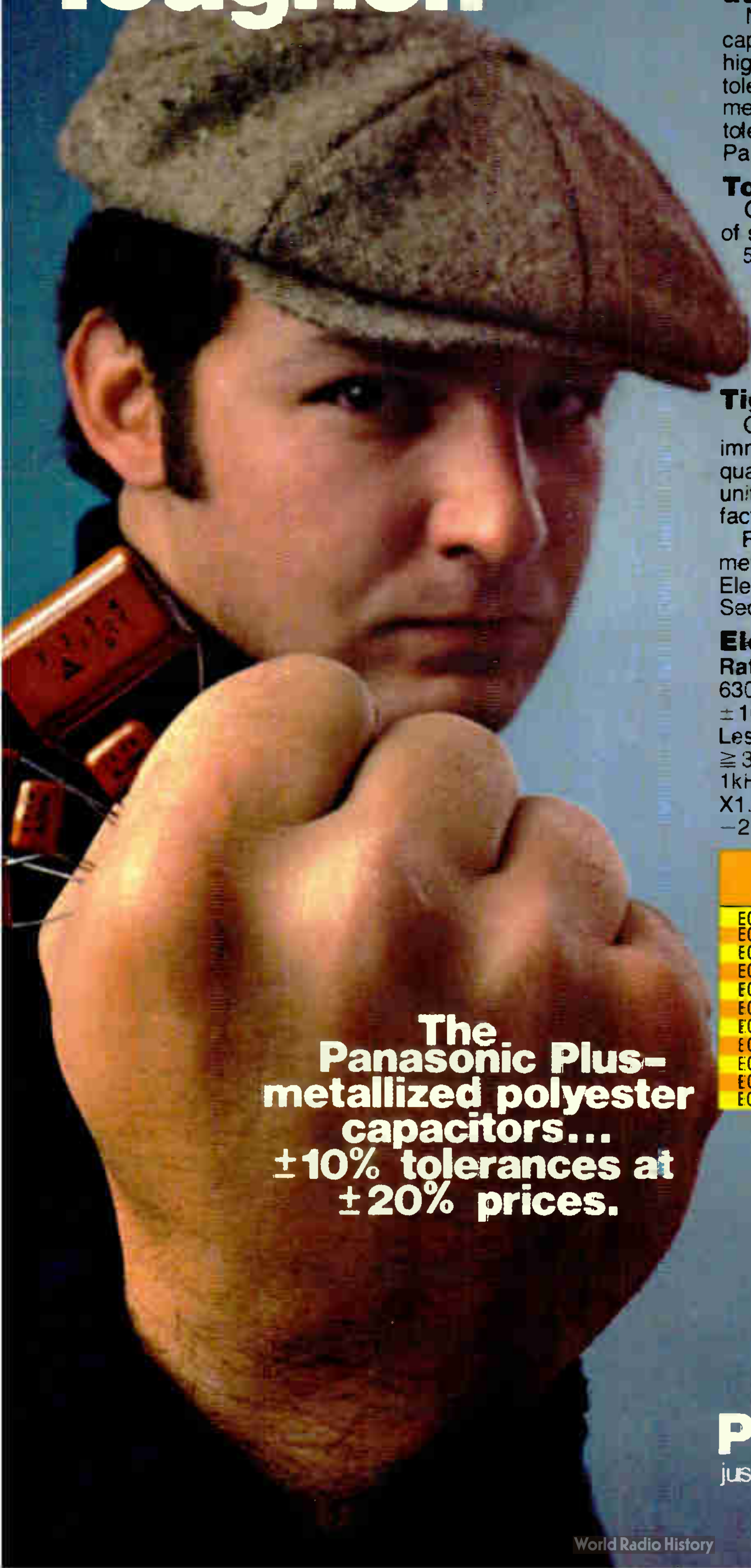

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Part No.	Capacitance ±10%(K) Rated (μF)	Part No.	Capacitance ±10%(K) Rated (μF)
ECQ-E2473(K)ZS	0.047	ECQ-E2394(K)ZS	0.39
ECQ-E2563(K)ZS	0.056	ECQ-E2474(K)ZS	0.47
ECQ-E2683(K)ZS	0.068	ECQ-E2564(K)ZS	0.56
ECQ-E2823(K)ZS	0.082	ECQ-E2684(K)ZS	0.68
ECQ-E2104(K)ZS	0.10	ECQ-E2824(K)ZS	0.82
ECQ-E2124(K)ZS	0.12	ECQ-E2105(K)ZS	1.0
ECQ-E2154(K)ZS	0.15	ECQ-E2125(K)ZS	1.2
ECQ-E2184(K)ZS	0.18	ECQ-E2155(K)ZS	1.5
ECQ-E2224(K)ZS	0.22	ECQ-E2185(K)ZS	1.8
ECQ-E2274(K)ZS	0.27	ECQ-E2225(K)ZS	2.2
ECQ-E2334(K)ZS	0.33		

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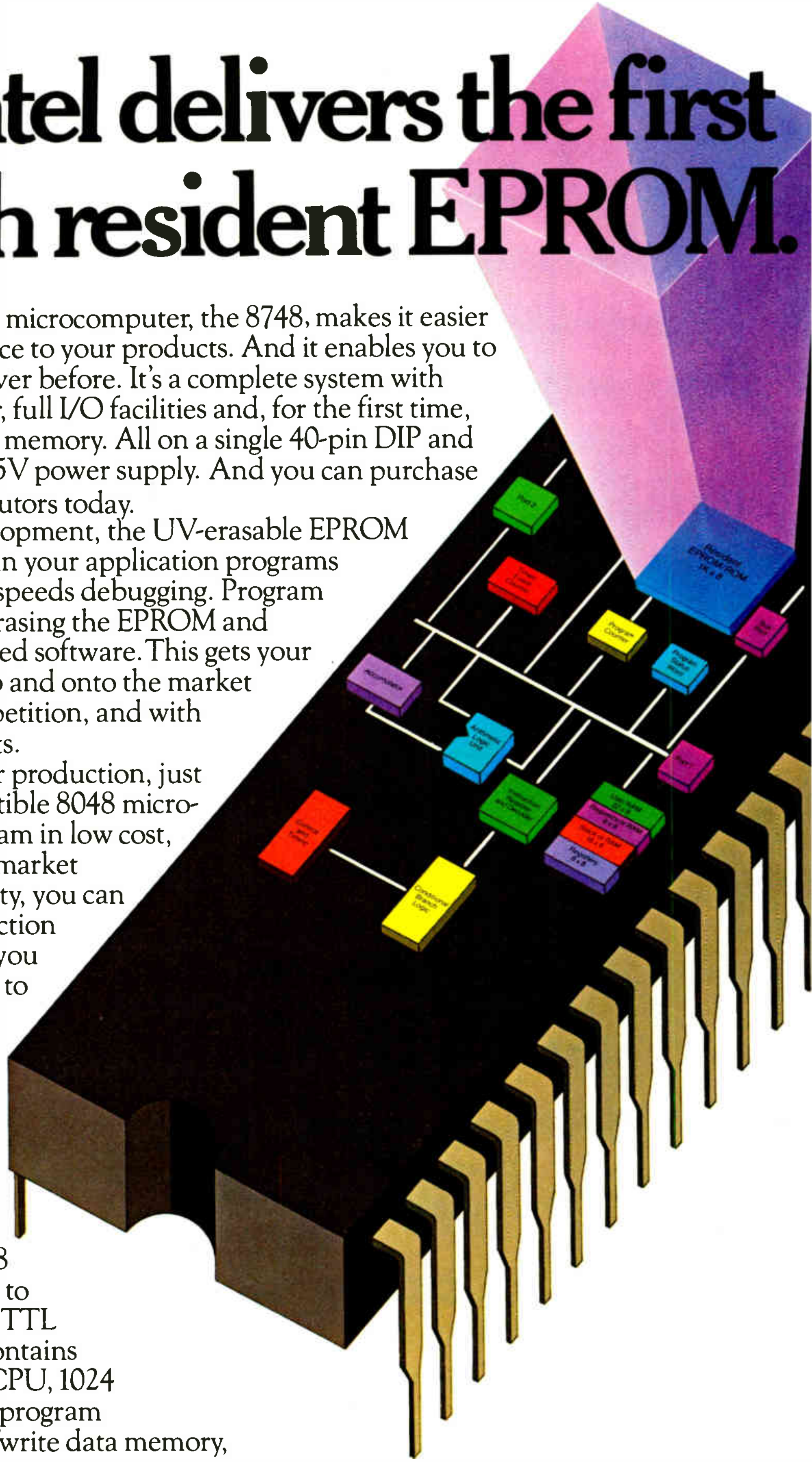
Circle 57 on reader service card

Intel delivers the first with resident EPROM.



Intel's new single chip microcomputer, the 8748, makes it easier than ever to add intelligence to your products. And it enables you to do it at a lower cost than ever before. It's a complete system with powerful central processor, full I/O facilities and, for the first time, resident EPROM program memory. All on a single 40-pin DIP and operating from a single +5V power supply. And you can purchase the 8748 from Intel distributors today.

During product development, the UV-erasable EPROM enables you to load and run your application programs in minutes. The 8748 also speeds debugging. Program changes can be made by erasing the EPROM and reloading with your updated software. This gets your new product out of the lab and onto the market months ahead of the competition, and with reduced development costs.

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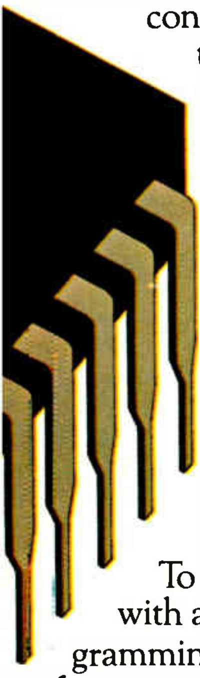
Intel's advanced MOS/LSI process technology allows a single 8748 or 8048 chip to replace up to 100 or more conventional TTL devices. The 8748/8048 contains an 8-bit general purpose CPU, 1024 bytes of EPROM or ROM program memory, 64 bytes of read/write data memory,

single chip microcomputer The 8748.



three programmable 8-bit I/O ports, 8 additional control/timing lines, programmable interval timer/event counter, priority interrupts, system clock generator and a full set of system controls. It's a single chip solution to a wide variety of applications, yet it's fully expandable by adding compatible MCS-80™/MCS-85™ I/O chips and Intel® standard memories.

There's also a new 8035 microcomputer that is exactly like the 8748/8048 but without resident program memory. It enables you to precisely match system memory size to your needs, using external ROM or EPROM.

Part No.	Description	Availability
	MCS-48 Components	
8748	Single chip μC with 1K bytes EPROM	NOW
8048	Single chip μC with 1K bytes masked ROM	NOW
8035	Single chip μC without resident program memory	NOW
8243	I/O Expander with 16 high current drive I/O lines	NOW
8355	ROM, 2K bytes, 16 I/O lines	NOW
8155	RAM, 256 bytes, 22 I/O lines and timer	NOW
	Compatible MCS-80/85 Components	
2316E	Standard ROM, 2K × 8, 450 ns	NOW
2708	Standard EPROM, 1K × 8, 450 ns, light erasable	NOW
2716	Standard EPROM, 2K × 8, 450 ns, light erasable	NOW
2111A-4	Standard RAM, 256 × 4, 450 ns, common I/O	NOW
2101A-4	Standard RAM, 256 × 4, 450 ns, standard I/O	NOW
5101	Standard RAM, 256 × 4, 650 ns CMOS	NOW
8255A	Programmable Peripheral Interface	NOW
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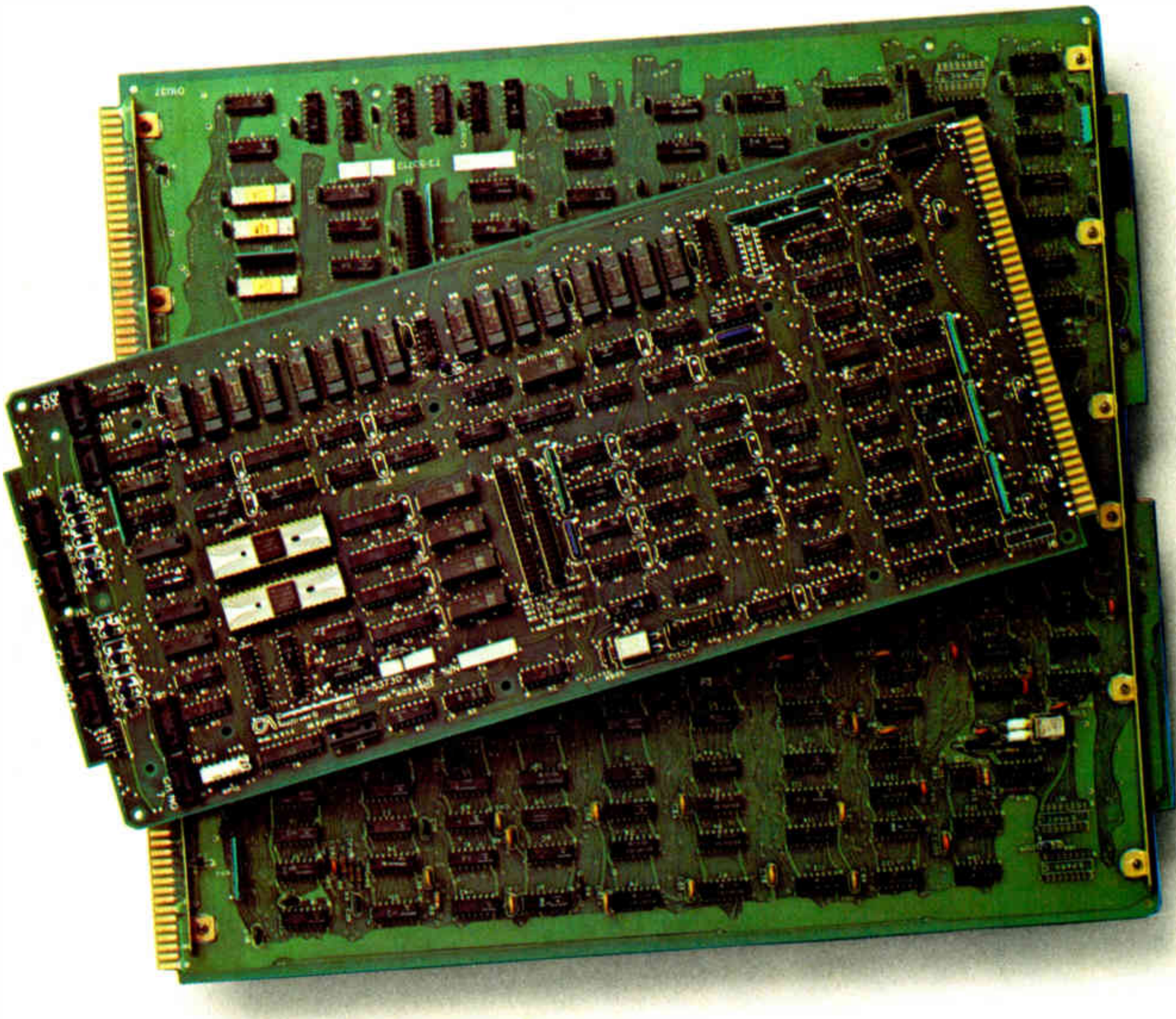

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Introducing a software development system that supports a variety of microprocessors: currently the 8080, 6800, Z-80, and 9900, with a wide selection to follow. Assembler software for two microprocessors is provided from those available at the time of purchase, and software for each additional microprocessor may be purchased as an option with a minimum of added expense.

This feature alone means that you can *change* direction without having to make a major investment in a new design aid. Choose a component on the basis of its suitability for a particular project, then, if it seems desirable, switch to another for the next project.

It also means that you don't have to relearn your software development system each time you use a different microprocessor chip. And that can save valuable time.

The 8002 offers several other time-saving features to ease the task of program creation: a text editor that simplifies software entry and revisions, an assembler with macro capability, and dynamic trace for software debugging.

Since microprocessor-based program creation and prototype design typically go hand in hand, the 8002 also offers three progressive option levels for program emulation and debugging, prototype emulation and debugging, and real-time prototype analysis.

The 8002 Program Emulation and Debugging System, which adds an emulator processor and software for a selected microprocessor, enables the developmental software to be run, tested, changed, traced, and debugged on the desired microprocessor. The

THE TEKTRONIX 8002 MICROPROCESSOR LAB

emulator microprocessor is identical to the microprocessor in the designer's prototype; if the software is to be executed on an 8080 in the prototype, for example, an 8080 microprocessor chip is used in the emulator processor.

The 8002 Interactive Prototype Emulation and Debugging System adds a Prototype Control Probe for a selected microprocessor. With the probe inserted into the prototype, developmental software and hardware may be tested, traced, and debugged together.

The 8002 Real-Time Prototype Analyzer System adds real-time trace and an 8-channel Analyzer Probe. At this level bus transactions and events external to the microprocessor may both be monitored.

One final advantage: the Tektronix name. Tektronix has always been responsive to the instrumentation needs of the design engineer . . . and the 8002 Microprocessor Lab is no exception. Its ability to deal with a number of different microprocessors, its many convenience features for software development, and its capabilities for software/hardware debugging, make it a unique design tool.

As a leading electronics instrument company, Tektronix offers you a full line of options and peripherals, from the three 8002 option levels . . . to PROM programming facilities for the 1702 or the 2704/2708 MOS PROMs . . . to a line printer and choice of system terminals.

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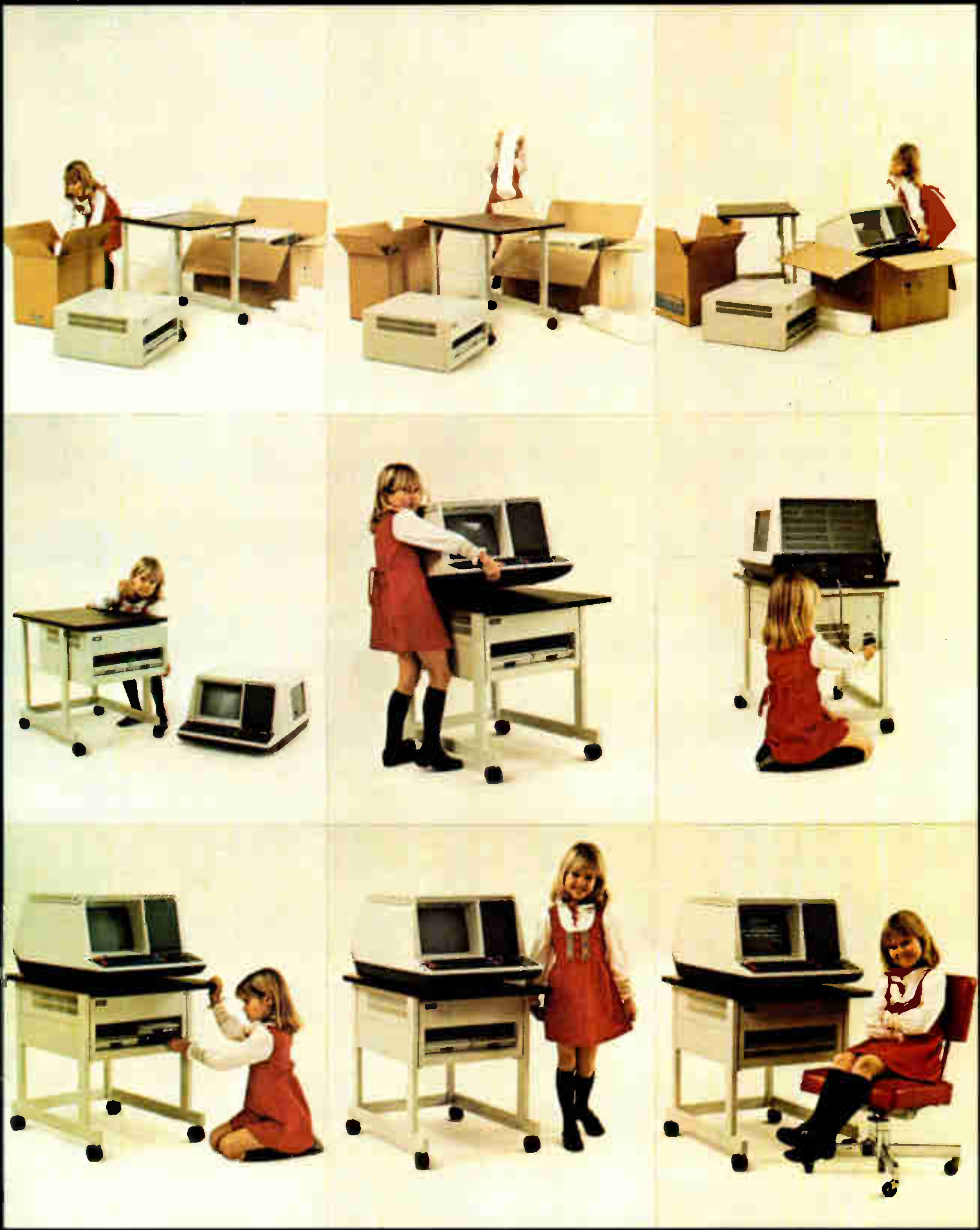

Digital introduces DECstation. A big computer system that's small enough for anyone.

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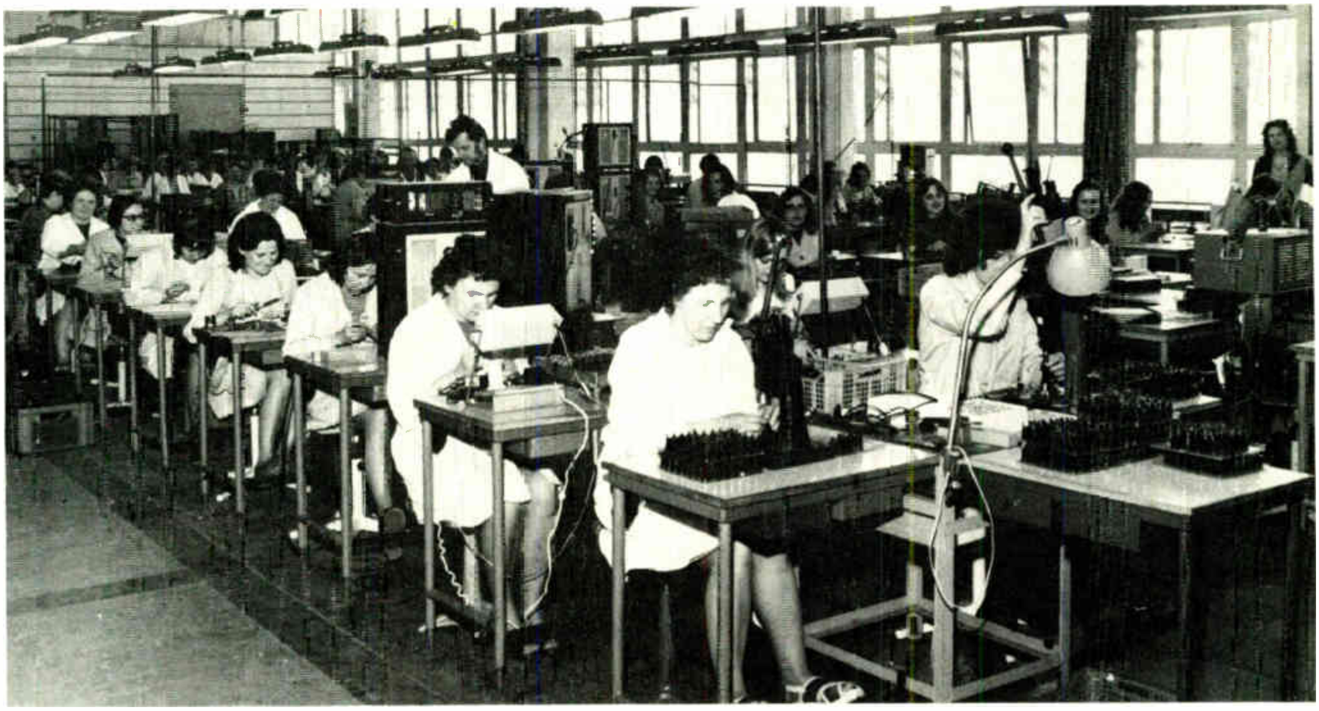


Poland pursues Western habits

by John Gosch, Frankfurt bureau manager

The setting could be the U. S. or Western Europe: long-haired, jeans-clad teen-agers crowded around a television set to watch two of their companions play video games on the screen. Is it New York, Frankfurt, Paris, or London? No, in this case it is Poznan, a city deep inside Poland.

The scene typifies Poland's transformation into a Western-style consumer society, a change that is felt deeply in the nation's electronics industries. "If there is anything distinguishing Polish electronics, it is the advanced level of consumer equipment design," says Horst F. Jenisch, international marketing manager at the ITT Semiconductor group's Intermetall GmbH in West Germany and a negotiator of East-West licensing deals.

Poland's emphasis on consumer products stems in part from the government's pledge to raise the country's standard of living. In the 1976–80 economic plan, consumer-oriented services are to increase 70% and the supply of consumer goods is to go up 60% over the 1975 level. These rates compare with 40% and 42% for overall services and industrial production, respectively.

As always, Polish planners are giving top priority to the electrical and electronics industries, calling for a 67% spurt in output for the five-year period. Specifically, the plan calls for delivery of about 3.5 million tape and cassette recorders and some 10 million radios. Further, the Warsaw Television Works is to be enlarged and a new TV tube plant completed. Under a license with RCA Corp., the plant will start up toward the end of next year and eventually produce several hundred thousand color tubes a year.

Despite the planned increases, Western firms should not expect to do the same kind of business in Poland that they did in previous years. At least for the short term, Western sales will, in fact, drop sharply. The reason: much of the industrial expansion and plant modernization of 1970–75 was financed by credits from the West. That, together with the need to import grain, has resulted in a highly negative balance of trade. Now, to even up the scales, the Poles are determined to sharply step up exports and at the same time drastically curtail imports.

Much of the task of reaching the goals set for Poland's electronics industries falls on Unitra Union, the Warsaw-based group of some 23 state-owned enterprises. These firms manufacture consumer electronics and production equipment, navigational and radio communications systems, and a wide variety of

Communicating. Workers put together subassemblies for communications equipment. Poles are well advanced in radar design, especially in marine-radar systems passive and active components, including semiconductors.

With a volume of slightly more than $1 billion last year, the 80-plant Unitra conglomerate, with its 100,000 employees, accounted for nearly half of Poland's electronics output. Technical director Jerzy Bilip says the group's production this year will climb to $1.2 billion, a 16% increase over the 1976 volume.

The bulk of Unitra's 1977 output will again be consumer goods, with roughly $580 million worth of entertainment electronics. Janusz Jablonski, commercial director for consumer and professional equipment, gives these figures to be reached this year: 700,000 record players, 1.25 million tape and cassette recorders, and 1.05 million black-and-white and color receivers.

In Poland, as in many other countries, black-and-white sets are becoming increasingly harder to sell, Jablonski notes. "What people are now clamoring for are color receivers and portable black-and-whites," he says. Production of color television sets, which began in Poland five years ago, climbed to 100,000 units in 1976 and will pass the 120,000 mark this year.

Thus far, between 500,000 and 600,000 color receivers have been installed, with a sizable number imported from the Soviet Union. According to Bilip, there are now about 8.5 million TV sets (monochrome and color) for a population of 34.6 million.

Sophisticated. But numbers are only part of Poland's entertainment electronics story. The other is the high technological level of the equipment. Integrated circuits are well established in TV sets, and so are varactor diodes for electronic tuning. Video games are now coming on the market, and sets featuring infrared and ultrasonic remote control will follow in 1978, Jablonski says.

Unitra officials also point proudly to other products that have found customers in the West. One is an X-band marine-radar system designed for motor boats, fishing vessels, and other small craft. Attracted by the system's advanced

Checkout. Components for communications gear and instruments undergoing tests.

design and low cost, West Germany's Krupp Atlas-Elektronik will buy several hundred such systems for distribution in Western markets.

Design know-how is evident in still other fields. "In the instrument sector, the Poles are tops in the Comecon area," comments Klaus Stockreiter, Eastern European sales engineer for Tektronix Inc. and for West Germany's Rohde & Schwarz.

Poland's metamorphosis into an industrial society during the past 25 years has spawned a computer industry ranked third in Eastern Europe (behind the Soviet Union's and East Germany's) in terms of both production potential and the number of systems delivered. The Poles have been helped by computer technology from the West, particularly from Britain.

For computers. Data-processing equipment and related gear are handled by the 55,000-employee Mera Union, 18 manufacturing organizations supported by nine research labs and two development institutes. Mera's product line includes simple multimeters, automation and control equipment, peripherals, electronic office machines, and computer systems. Production is concentrated at Mera-Elwro, a facility in Wroclaw with 5,000 workers and an output last year of about $150 million.

There are about 3,000 standard systems, not counting minis, in operation in Poland, says Andrzej Lejczak, an export executive at Mera-Elwro. Between 65% and 70% of them were made in Poland. The rest come primarily from firms in the West such as ICL in Britain and IBM in the U. S.

Like other East European countries, Poland participates in the Eastern Bloc's computer program [*Electronics*, July 7, p. 66]. Each of six Eastern Bloc countries makes a specific system, and Poland has been assigned the EC1032, a medium-sized TTL-based machine. The size of its core memory extends from 128 to 1,024 kilobytes, and the cycle and access times are 1.2 microseconds and 0.5μs, respectively.

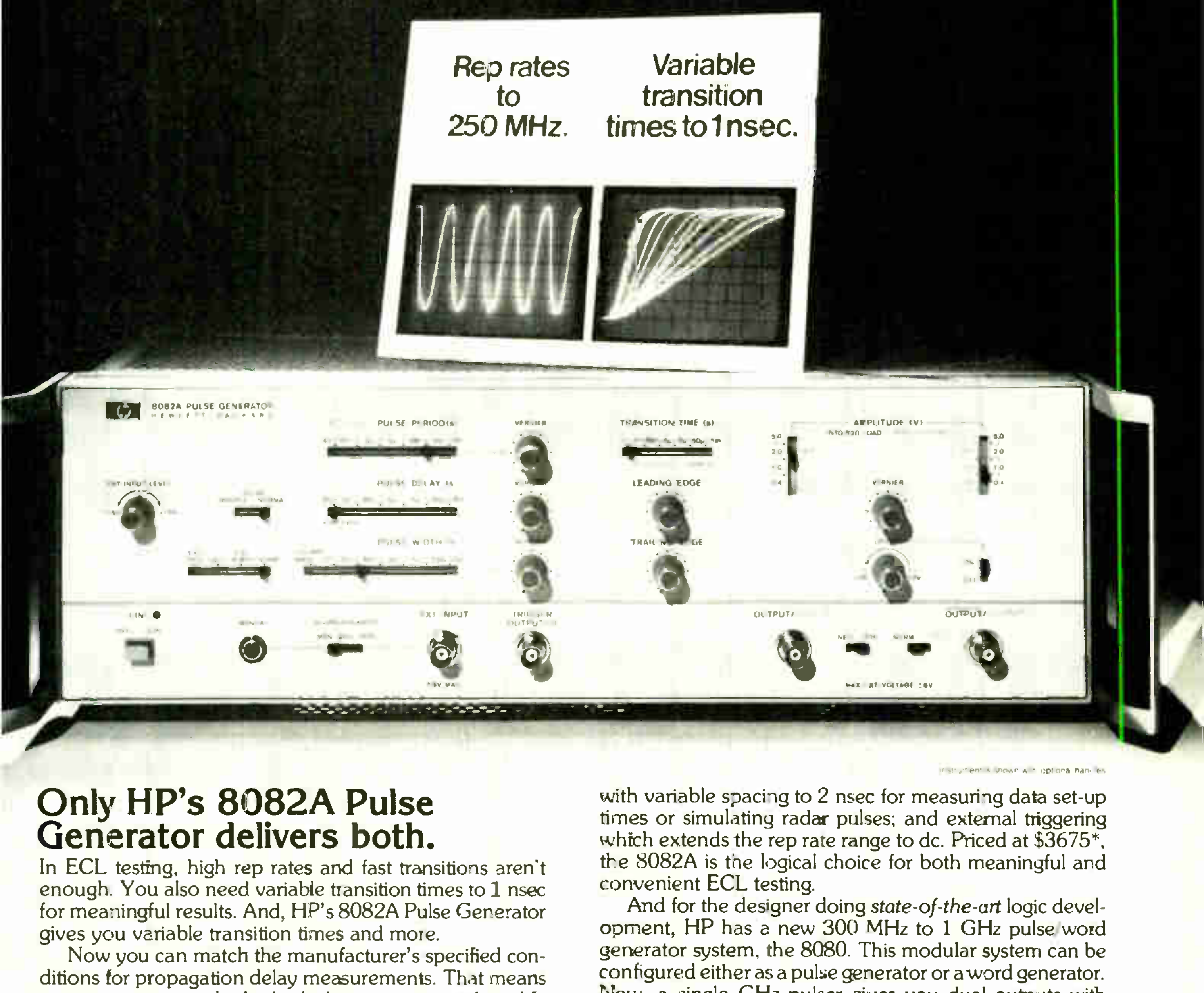
Although the 1032 captures most of the limelight in Poland's computer arena, the workhorse machine is the Odra 1305, a general-purpose central processor introduced about five years ago and still in production. Some 500 of this medium-sized system, which is compatible with Britain's ICL 1900 series, have been delivered inside and outside of Poland.

At the low end is the Mera 300 minicomputer series. About 30% of the semiconductors in the series comes from the West, Mera officials say. This figure points up the industry's heavy dependence on Western component technology, made evident also by a sizable number of licensing agreements with firms in the U. S., Japan, and Western Europe.

Imported ideas. As for semiconductors, well over half of what Unitra produces is based on outside technology. "We are just too small a country to develop everything on our own," a Unitra offical says. "Besides," he adds, "we don't want to rediscover America."

With all the licensed production, the Poles are striving to become less dependent on foreign component technology. Typical of these efforts is the new CEMI scientific manufacturing center for semiconductors on the outskirts of Warsaw. There—some observers call the complex Poland's Silicon Valley—the current five-year plan focuses on the development of advanced analog ICs, digital TTL and MOS circuits, optoelectronic devices, and other sophisticated solid-state components. Already well along in development are microprocessors and integrated-injection-logic devices. □

Meaningful ECL testing demands both:



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You and your career

IEEE election is a free-for-all

Hogan's entry pits variety of styles and philosophies in battle over whether body will emphasize technical or professional activities

by Gerald M. Walker, Senior Editor

The rift in the Institute of Electrical and Electronics Engineers over the priorities and management of its professional and technical activities has reached a critical point with the entry of C. Lester Hogan, vice chairman of Fairchild Camera and Instrument Corp., as an office seeker.

Hogan, supported by a phalanx of top industry executives and academics calling themselves the IEEE/Good Government Group, is out to capture control of the institute, which, in his view, has wandered in unwise directions under incompetent leadership.

As a result, when the ballots for IEEE officers go out at the end of this month, members will find a somewhat muddled lineup. Ivan Getting, president of Aerospace Corp., the nominee of the board of directors for institute president, will be opposed by perennial petition candidate Irwin Feerst. Carlton Bayless, who won the seat of executive vice president as a petition candidate last year, has been renominated for the post by the board of directors this year. But he will be opposed this time by Hogan, a petition candidate.

Why is Hogan running? "All of us have emotions toward our institute," he states. "It has done a great deal for us in providing the best in technical communications. And we all have an obligation to preserve it for other electronics engineers. For many years I have not been active, but for most of that period the institute has been under fine management, the best leadership in the U.S., a who's who of American engineering. But in the last few years the institute has been off on a bad track. In fact, Karl Willenbrock was the last good president the institute had [he served in 1969]."

Why is Hogan not running for the top spot? Earlier in the year, when those who eventually coalesced into the Good Government Group urged the Fairchild executive to run for IEEE president, he advised waiting until after the board of directors announced its nominations. Since Getting is acceptable to Hogan, he decided to seek the executive vice president's job in order to gain a position on the board of directors.

The IEEE/GGG is a blue-ribbon group that includes four former institute presidents and two former presidential science advisors. Sixteen have university affiliations, and 13 are corporation executives. But none has been connected with the professional activities gradually initiated by the institute since 1972.

In fact, dissatisfaction with the way professional activities have been going impelled the group to organize, though its formal goal is to improve the leadership of the IEEE "by identifying, endorsing, and actively supporting the best available candidates for president, vice presidents, and directors."

Upset. Because of its makeup and general leanings, the IEEE/GGG has been branded as a reactionary movement intent on scuttling the U.S. Professional Activities Board, which works with an annual budget of about $1.5 million. Both Hogan and the IEEE/GGG's spokesman, Willenbrock, who is dean of the Southern Methodist University School of Engineering, deny that they are out to get USAB. However, both are upset by USAB's programs, especially by what they see as an ineffectual and expensive lobbying operation in Washington, D. C.

Hogan: "I can support social issues, and I think I can win them as well as anyone."

Comments Hogan: "They [USAB] get $1.5 million and worry about how to spend it rather than selecting useful goals that would help the welfare of members of the institute. I can support social issues, such as a portable pension plan, that engineers have a right to ask about. And I think I could win them, whereas the institute people in Washington have done a very bad job."

This stand does not wash with consultant Irwin Feerst, who as a presidential candidate has a significant following among working-level institute members and has been extremely articulate in outlining IEEE reforms. He says, "I'm glad that this IEEE/GGG has come out into the open. We have finally uncovered the hard core of the institute power structure and find them to be the true Neanderthals of the IEEE. Where were they in the early 1970s when the members needed them? No, they had their chance in the leadership roles, and they blew it. Now there is a different institute, the members have changed, and the hard core does not understand these changes. I think the members will see through this strategy."

Caught in the middle, and facing a head-to-head contest with a well-known industry executive, Bayless sees the vote as a test of the constitutional change that in 1972 permitted the institute to pursue both technical and professional and social programs. "Pure and simple, this election allows members to decide if they want the post-1972 IEEE or an IEEE totally a learned group," he remarks. "This is not a personal issue, but a vote on two philosophies."

Bayless, who is division manager for Pacific Telephone and Telegraph Co., believes that the IEEE/GGG is dissatisfied with IEEE involvement in registration of engineers, its stand on the energy crisis, and its lobbying to amend the Service Contracts Act to prevent wage busting.

For his part, Getting sees the candidacy of Hogan as "part of the polarization in reaction to 'Feerst activism.'" The politically and economically oriented moves of Feerst and his supporters were bound to evoke a counterresponse.

Bayless: "This election allows members to decide if they want the post-1972 IEEE."

If elected president, Getting hopes to be a "mediator," who will preserve an atmosphere conducive to "rational consideration" of the issues. However, he does have opinions on a number of the current issues. For example, he is strongly against the IEEE's becoming a collective bargaining agent for EEs. He is concerned that potential Government regulation concerning wage busting in service contracts could be oversimplified, causing more problems than it solves.

The Aerospace Corp. president favors a portable pension plan and has instituted what he considers to be a liberal plan for engineers at his company. "I can claim I've done more for the working engineer than almost anybody," Getting states.

Change. No matter who wins when the ballots are finally tallied in November, the institute will be in for a major change. Hogan feels that he has begun the process of bringing the leading engineers in the country into active participation in the institute to preserve its technical leadership and reorganize the professional activities. Bayless emphasizes that he is the only candidate with experience in institute operations and with a commitment to professional activities.

Getting sees his role as healing the divisions in the institute's house. Feerst wants a number of sweeping changes, but insists that he would keep technical, educational, and professional activities in balance.

If Feerst wins, there is bound to be tension in the running of the institute, depending on the final makeup of the board of directors. "It would be a serious problem if Feerst is elected and cannot be controlled." Hogan frets. "I hope we don't have to find out."

Adds Bayless, "I would stick it out and hope to be constructive, but it would be rough. Often, after people are elected, they modify their extreme views when they get up close to the real problems."

Feerst is moderate. "We would have to work together. I would have to work with whoever is elected but they would have to work with me, for the IEEE of 1978, not the IEEE of 10 or 12 years ago." □

Companies

Patents and products are 1-2 punch

Six-year-old Standard Microsystems makes MOS ICs and avoids highly competitive device markets as it looks to more growth

by Bruce LeBoss, New York bureau manager

Although a continent away from the fertile soil of California's Silicon Valley, six-year-old Standard Microsystems Corp. is flourishing, thanks in part to a solid patent position. And the small but growing manufacturer of metal-oxide-semiconductor integrated circuits has set its sights on getting bigger even faster.

Founded in 1971 by three former members of General Telephone & Electronics Corp.'s MOS Product Development group, the Hauppauge, N.Y., company has found its niche as a supplier of standard and custom large-scale MOS ICs that perform specialized functions, particularly for data-communications systems and computer peripheral and terminal equipment. But, notes co-founder and president Paul Richman, perhaps equally important is what Standard Microsystems does not make: microprocessors, random-access memories, shift registers, or devices for other highly competitive markets.

Has a good seat. SMC president Paul Richman is talking with several n-MOS makers about patent-licensing deals.

"We're trying to shy away from head-to-head competition with companies having a much greater capacity," he says. This strategy is already helping SMC reap dividends. In fiscal 1977, ended Feb. 28, sales increased 55% to $5.1 million and pretax profits more than quadrupled, exceeding $1 million.

"A common misconception is that our profits primarily are generated by patent licensing," the 34-year-old president says, referring to the firm's patented Coplamos technology for fabricating high-speed, high-density n-channel MOS ICs. "In reality, more than 80% of our profits during the past fiscal year were generated by manufacturing operations."

Even more impressive, SMC operated at 20% pretax profit margin while the bulk of its production was on 2-inch wafers. Having recently made the transition to 3-inch wafers, "we've more than doubled our yields, our die costs have dropped accordingly, and for this fiscal year, we're looking at projected sales in the $8 million range and perhaps a pretax profit margin on the order of 25%, or $2 million," says Richman. He expects the following year's sales to be even better, somewhere between $12 million and $20 million.

Likely to be heavy contributors to that growth are two recently introduced n-MOS chips now in volume production. One, the COM 5025, was developed jointly with minicomputer-maker Digital Equipment Corp. and contains the new synchronous data-link control (SDLC) protocol functions [*Electronics*, March 3, p. 8]. The second, the CRT 5027, generates all the timing and control signals for presenting and formatting video data on a cathode-ray-tube terminal [*Electronics*, Feb. 17, p. 119].

The CRT controller, or vertical timing and control chip, is expected to have a major impact on sales from midyear on, since it is being designed in by many data-communications-terminal manufacturers, says Richman. As for the SDLC chip, "it has huge long-term potential," he adds. "But its market is developing more slowly because of the industry's timetable for using the IBM protocol." Still, DEC and many others in data communications are buying it.

Patent base. Nevertheless, the financial impact of SMC's patent-licensing program is a substantial factor in its growth. Armed with its Coplamos patent, SMC has already licensed five major companies: International Business Machines Corp., General Motors Corp.'s Delco division, and American Microsystems Inc., as well as Texas Instruments Inc. and International Telephone & Telegraph Corp.

The TI license [*Electronics*, Oct. 14, 1976, p. 25] "was a precedent-shattering agreement," he notes, in that TI has one of the largest and best-respected semiconductor patent portfolios. "But due to the strength

Probing the news

of our n-channel patent portfolio, we were successful in arranging a total cross-license on a worldwide basis," plus a $150,000 TI payment.

SMC is discussing additional Coplamos licenses with "a number of companies," whom Richman will not identify. The possibles include Fairchild Camera and Instrument Corp. and Intel Corp., since both have strong n-MOS RAM and microprocessor programs that use the isolated MOS process.

Richman believes the Coplamos patent is fundamental in fabricating high-speed, high-density n-MOS ICs and "is of particular interest in 4,096-, 16,384- and 65,536-bit dynamic RAMs, particularly 65-k because the advantages of the field-doped, locally oxidized structure become more and more apparent as device density increases."

Further, Richman expects SMC's patent portfolio also to affect device scaling, a direction in which semiconductor makers are moving to make chips smaller, more manufacturable, and lower in cost. But to maintain device reproducibility and to get away from parasitic space-charge-limited flow, it is also necessary to increase the doping concentration in the substrate, even at the cost of degrading the overall speed of the scaled-down structure, Richman explains.

On-chip bias. A reverse substrate bias eliminates this degrading effect, provided the bias can be prevented from affecting the system level. The solution, says Richman, is its generation on chip, a technique for which SMC also owns a basic patent. "We believe this and the Coplamos patents are fundamental to the evolution and growth of the $1-billion-a-year n-channel IC market that will develop by 1980," he adds.

Richman expects SMC to be issued important additional patents this year. One pertains to a technology, called Clasp, that is just out of R&D. It is for a new type of structure that, Richman claims, will have a fundamental impact in the microprocessor, read-only-memory, and custom random-logic markets. □

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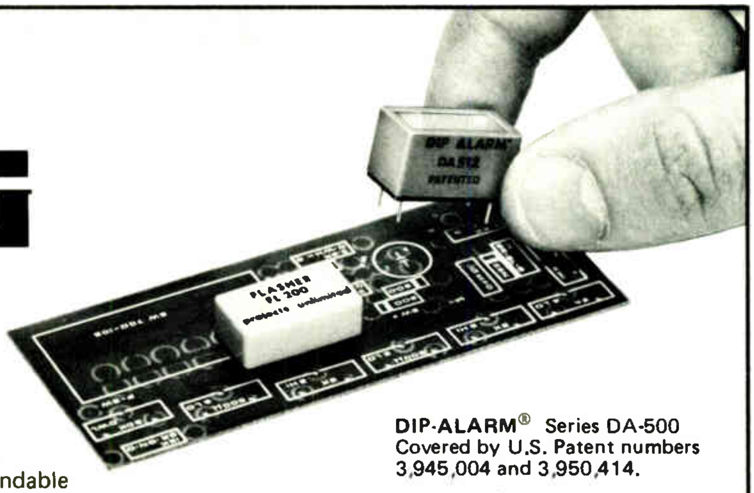

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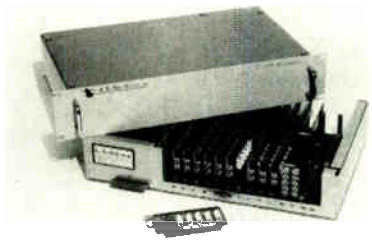

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Commercial electronics

Travel agents want a better way

Honeywell, Tymshare, and Incoterm are testing systems to link agencies directly with airlines' computerized reservation systems

by Pamela Leven, Boston bureau

Most of the nation's 13,000 travel agents make airline reservations for customers the same way you make them for yourself: by picking up a phone and calling the airline. So they, too, are subjected to interminable taped messages repeating, "I'm sorry. All our lines are busy. Please hold on. . . . "

To eliminate that step, the American Society of Travel Agents, American Express Co., and 12 major airlines have embarked on a joint venture to eventually develop a communications network linking travel agencies directly to airlines' flight reservation systems via display terminals. The 14 sponsors chipped in $25,000 each for the "automated pilot reservation program." In June, three computer companies were given the go-ahead by ASTA and about $100,000 to test their versions of a multiaccess reservation system at working travel agencies. Honeywell Information Systems of Waltham, Mass., will be installing its test systems in travel agencies in Seattle. Tymshare Inc. of Cupertino, Calif., is using Chicago travel offices, and Incoterm Corp. of Wellesley, Mass., has set up its trial in New York City.

The threads of commonality for a multiaccess reservation system in the airline industry have existed for years. Fare structures are set by law, and tickets are similar enough for a relatively free exchange among carriers. Most important, however, is the fact that nearly every airline owns or leases a computerized reservation package (using a 6-bit IBM protocol called PARS, for passenger airline reservation system). Each project vendor has its own approach for tying a secure network of keyboarded cathode-ray-tube terminals and ticket printers into a giant PARS data bank.

In Seattle. The heart of the Honeywell pilot system is a Level 6 minicomputer with 32,000 bytes of main memory and 10 megabytes of disk storage. It links travel agents' CRT terminals to airlines' central reservation systems through multidrop lines in a polled arrangement. John M. Colburn, manager for airline systems, notes that a single Level 6 minicomputer system can handle as many as 80 different travel agency locations on each communications line.

Tymshare uses its IBM System 370/158 as a central processing unit to connect travel agents with the airlines' PARS networks. The Chicago travel agents testing Tymshare's system will use the common airline reservation language that ASTA is developing to punch their requests for scheduling and booking into the office keyboard displays. The 370/158 will translate that language into a code understood by the designated airline.

Travel picture. Display in New York City travel agent's office is part of test of Incoterm's airline reservation system. It is linked directly to the airlines' computers.

Incoterm Corp. is entering the ASTA project as a licensee of Videcom Ltd. of Britain. Vice president Edgar L. VanCott describes the Videcom multiaccess system as simple and reliable. Eliminating a computer, Incoterm handles all data with an intelligent processor acting simply as a data bus for the input/output lines.

VanCott explains that software coding for the send/receive lines converts the Incoterm-developed language that travel agents use to the specific coded terminology that each airline accepts. Response data is common enough for travel agents to understand.

Next step. Travel agency tests are expected to end by November. Ray N. Smith, ASTA's vice president for automation, reports that "the next step is to determine whether such a system is really feasible. Then we'll file with the CAB what we feel is the format to follow." He emphasizes that this stage of the project is not an evaluation of hardware—contracts could eventually be awarded to one, two, or three system designers. A study by travel groups and airlines estimates that the five-year cost to set up and maintain a system could reach $173 million for about 5,000 agents. "This is not a winner-take-all situation," notes VanCott. "There may be three winners." □

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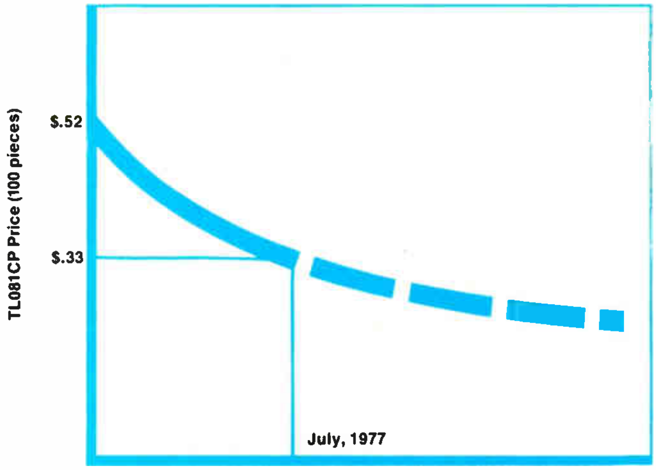

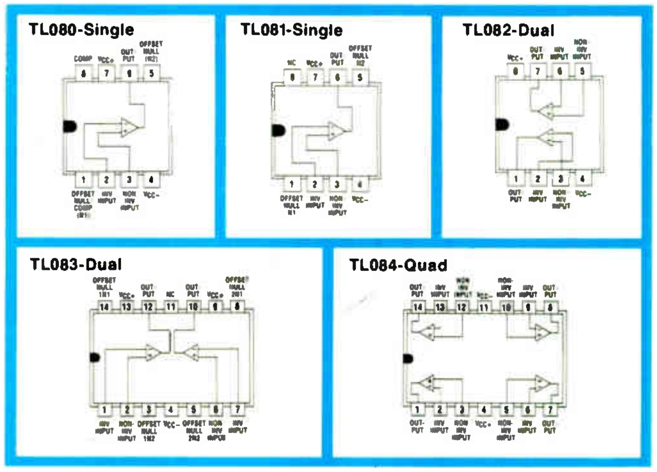

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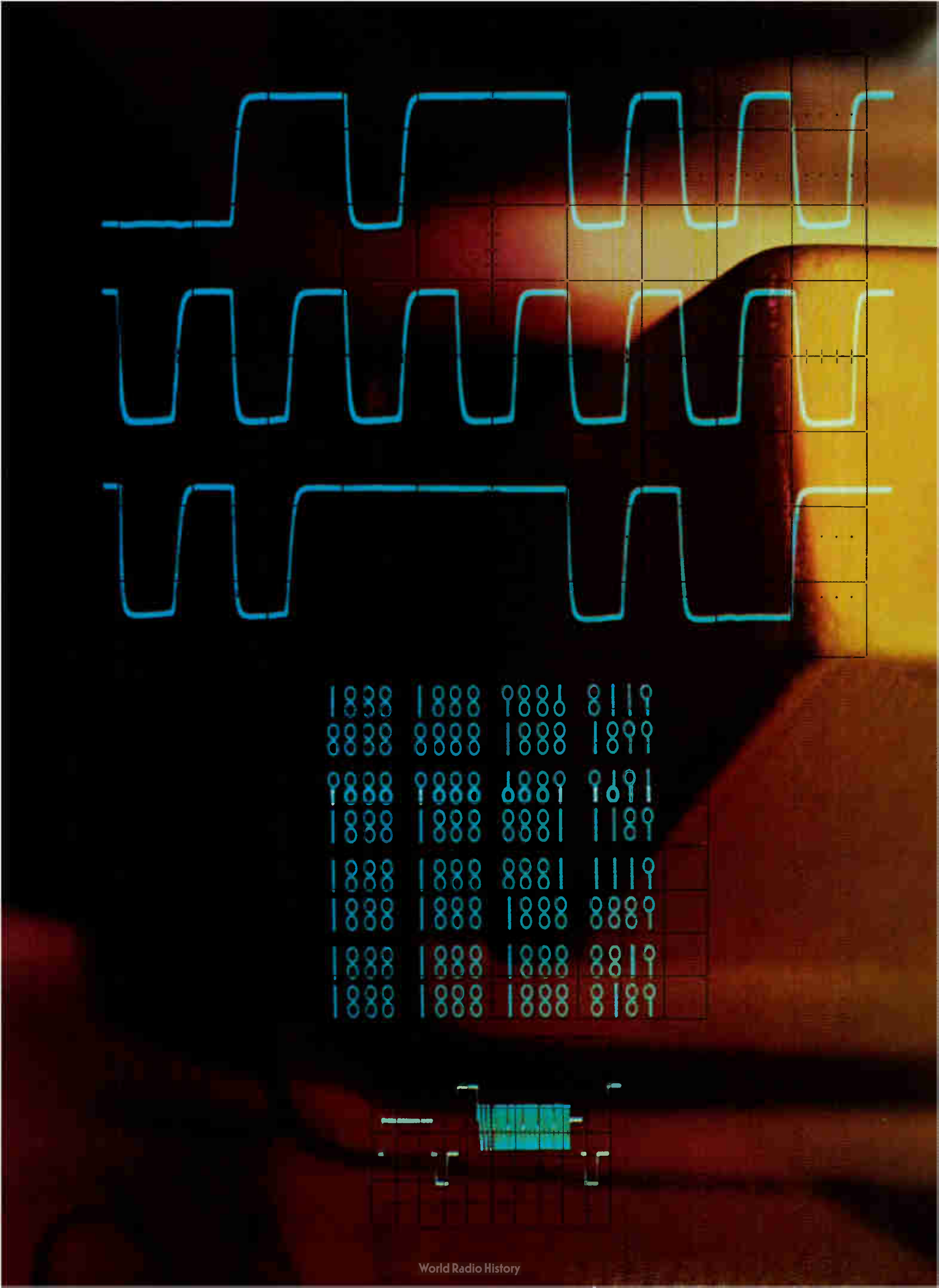

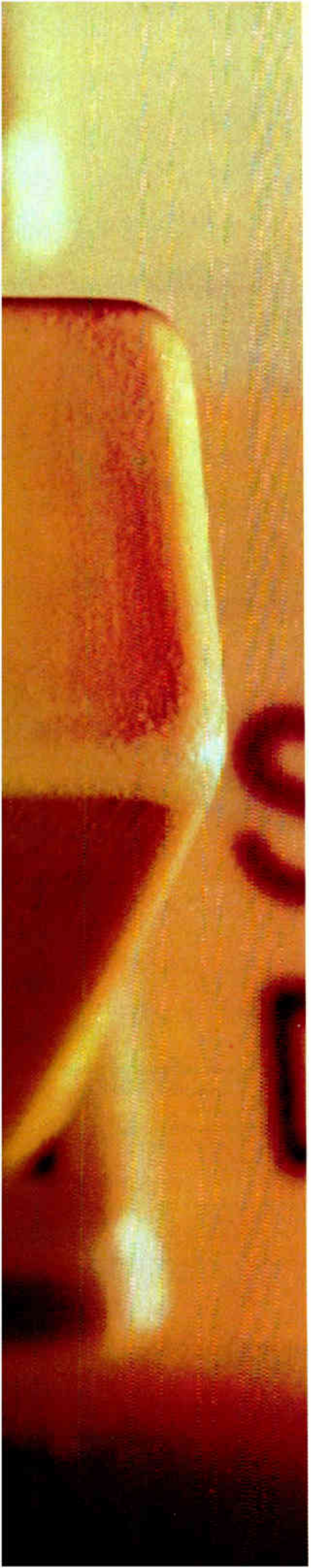

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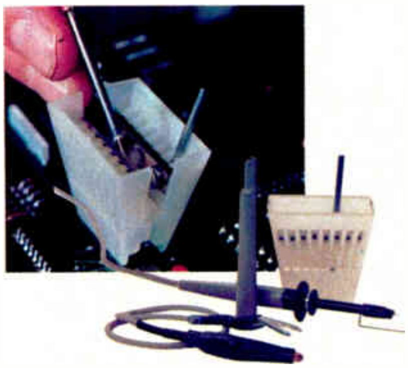

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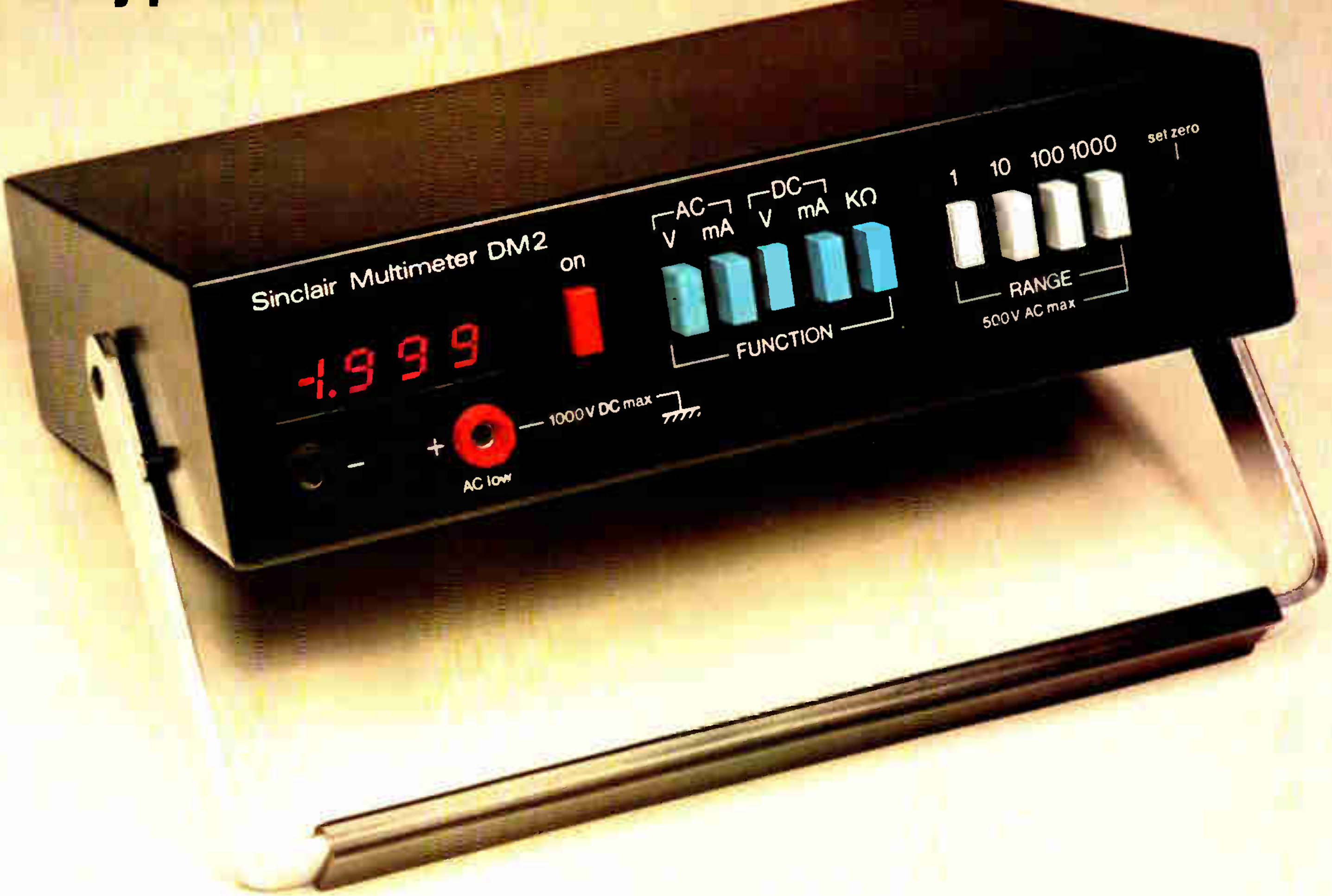

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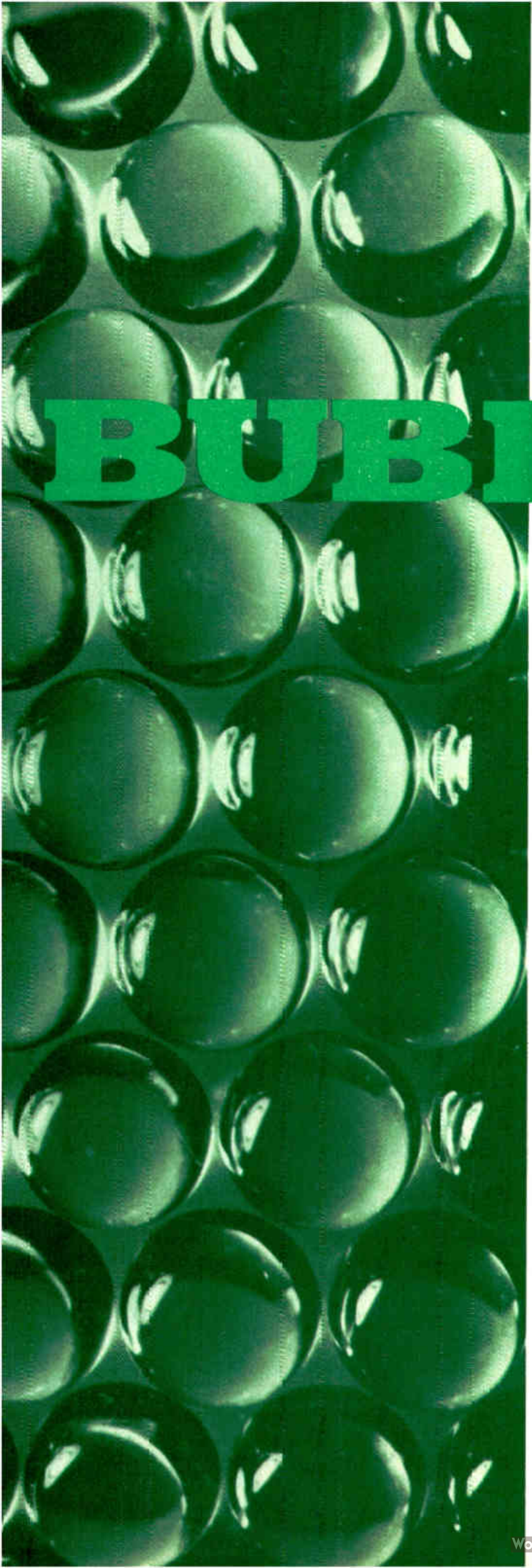

BUBBLES

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by J. Egil Juliussen, David M. Lee, and Gerald M. Cox,
Texas Instruments Inc., Dallas, Texas

☐ The arrival of the first commercially available magnetic-bubble memory chip, a 92,304-bit major-minor-loop device housed in a dual in-line package less than half a cubic inch in volume, marks a milestone in memory evolution. Offering easily accessible nonvolatile memory in a semiconductor-like package, it has every advantage foreseen for it over mechanical magnetic storage. It is smaller and faster, consumes less power, and will eventually become cheaper, as soon as chip density goes up enough and enough production experience accumulates.

But initial applications of bubble memories will be not in mass storage for large computers, as has long been predicted, but in microcomputer storage of at most a few megabits. At this level, bubbles are already cost-competitive with small floppy disks. For microprocessor systems, the nonvolatile storage of both programs and data is a definite advantage. But the real beauty lies in the mass storage residing on the same board as the central processing unit—a significant advance over a separate mechanical unit that requires lots of interface electronics and interconnecting cables. Moreover, the bubble module allows storage capacity to be tailored to size in small, 92-kilobit increments, and it is never necessary to purchase memory in excess of requirements, as can happen with cassettes or floppy disks.

As for the interface and control circuits, which often account for a large part of the entry cost of any storage technology, magnetic-bubble storage undoubtedly makes this circuitry quite extensive for microprocessor compati-

TABLE 1: CHRONOLOGY OF MINICOMPUTER MASS MEMORY

Year	Minicomputer	On-line memory	Off-line memory
1968	PDP-8: $13,000	mainframe disk (IBM 2311 class): $25,000	mainframe magnetic-tape (IBM 2401 class): $20,000
1971	PDP-11, TI-960, 980: $8,000	cartridge moving-head disk (Diablo 31): $10,000	minicomputer magnetic-tape $9,000
1974	"naked" minicomputer: < $3,000	floppy disk: $3,000	cassette: $2,000 3M cartridge: $3,000
1977	microcomputer-on-a-board: < $1,000	bubble memories, charge-coupled device memories: $75 and up	minicassette, minifloppy: $1,000 and up

TABLE 2: SPECIFICATIONS OF THE TBM 0103 MAGNETIC-BUBBLE MEMORY

Useful capacity (bits)	92,304 bits
Register organization	641 x 144
Drive field rate (maximum)	100 kHz
Input/output data rate (maximum)	50 Kb/s
Minor-loop data rate (maximum)	100 Kb/s
Average access time (first bit)	4.0 ms
Average cycle time (144-bit block)	12.8 ms
Power (100% duty cycle)	0.6 W
Maximum operating temperature range	0° to 70°C
Nonvolatile storage temperature range	−40° to 85°C
Size	1 x 1.1 x 0.4 in.
Pin count	14
Pin spacing	0.1 in.
Pin centers	1.1 in.
Weight	20 g
Maximum permissible external magnetic field in any direction	40 oersteds

bility. To keep its cost as low as possible, a family of large-scale-integrated circuits designed specifically for bubbles will be available by the end of this year.

The bit price of the competing disk technology is extremely dependent on the storage capacity. For example, a 700,000-bit mini-floppy disk has a cost per bit of about 0.3 cent, while a 6-megabit dual-density standard floppy disk has a 0.07-cent-per-bit price. For a 20-megabit cartridge moving-head disk, the cost per bit drops to about 0.05 cent and at the top end, an 800-megabit 3330-type moving-head disk costs out to only about 0.005 cent per bit. In all examples, costs include the interface electronics.

How bubbles measure up

As is evident, the smaller the storage capacity, the more rapidly the per-bit price of disks increases. This gives bubble memories a good shot at price competitiveness for storage capacities of less than about 3 megabits—and this puts them right in line for microcomputer-based systems.

Table 1 gives an outline of how mass-storage systems have developed to fit the basic price of typical minicomputers and latterly of microprocessors. Today's single-board microcomputer costs less than $1,000, and the entry price of magnetic-bubble memories follows that figure much better than the entry price of floppy disks. The system price for a single bubble chip and interfacing should be as low as $75 in quantity by the last half of next year.

Magnetic-bubble memories unite most of the best features of solid-state and mechanical magnetic storage, but they do better against some of these competing technologies than against others. (Just emerging is yet another technology, the electron-beam-addressable memory or EBAM, which is a potential competitor with bubbles, but only at large storage capacities of 30 megabits and up.)

In comparison with fixed-head and floppy disks, bubbles have a higher reliability and lower error rate, since they employ no moving parts. Other assets are a faster access time, less power consumption, smaller physical size, simple interfacing, and a lower entry price—all resulting from the elimination of mechanical elements.

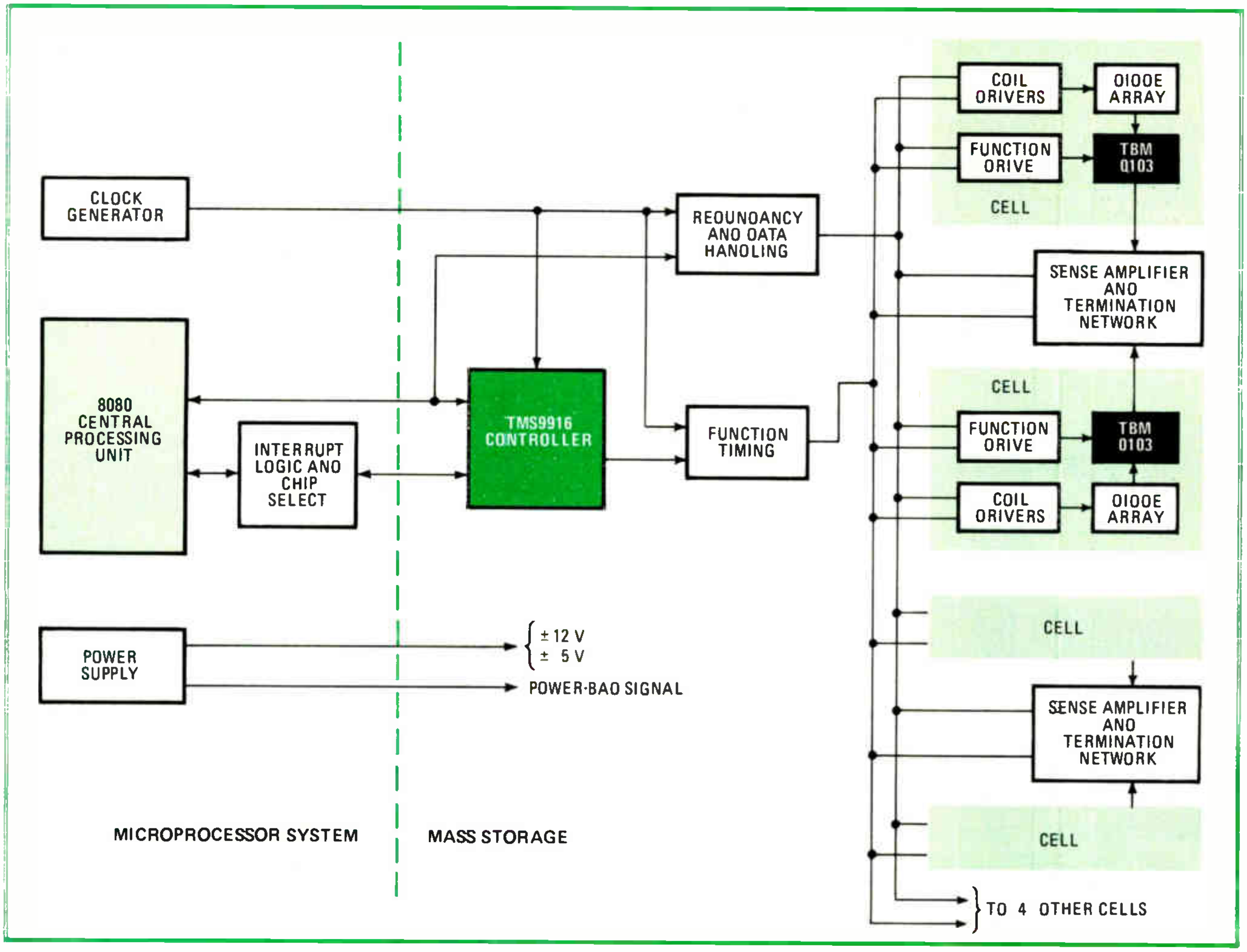
However, their data-transfer rates are lower than those of fixed-head disks. Also their per-bit cost at present is much higher than that of floppy disks, except in really small systems.

A comparison with semiconductor memories is really unfair to make, and more than likely, bubbles will work in conjunction with random-access memories. RAMS, which have dramatically better access times, higher data-transfer rates, and much simpler interfacing requirements, will stay their ground as main memory, while transferring data into and out of bubble mass storage. In relation to charge-coupled devices, bubble chips have the advantage of nonvolatility and higher packing density but suffer from slower access times and data-transfer rates. Per-bit price is currently about the same, though in the long run the higher packing density of magnetic bubbles will yield a price advantage over charge-coupled devices.

The present drawback of bubble-memory devices is that they cannot be removed inexpensively from a system. A removable magnetic bubble module is intrinsically feasible because of its nonvolatility but will be too expensive to be considered in the near future. In the meantime, the trend toward distributed processing networks will partly negate this disadvantage, since the communications link can in essence provide removability in many cases.

The bubble module

The Texas Instruments TBM0103 bubble module packs 92,304 bits of nonvolatile storage into a 14-pin, dual in-line package measuring 1.0 by 1.1 by 0.4 inches. Included in the package are the bubble chip, two coils, a pair of permanent magnets, and a magnetic shield that protects the data from external fields of up to 40 oersteds. Bubble control functions—the generation and replication of bubbles, for example—are handled by



1. Bubbles for microprocessors. A magnetic-bubble mass-storage memory for a microprocessor system retains programs and data indefinitely. In this configuration, up to eight nonvolatile memory cells provide a maximum storage of 738,432 bits or 92,304 8-bit bytes.

passing current pulses through appropriate elements on the chip. The bubble transfer rate is 100 kilobits per second, and the operating temperature range of the TBM0103 is from 0° to 50° Celsius. Table 2 lists all the specifications.

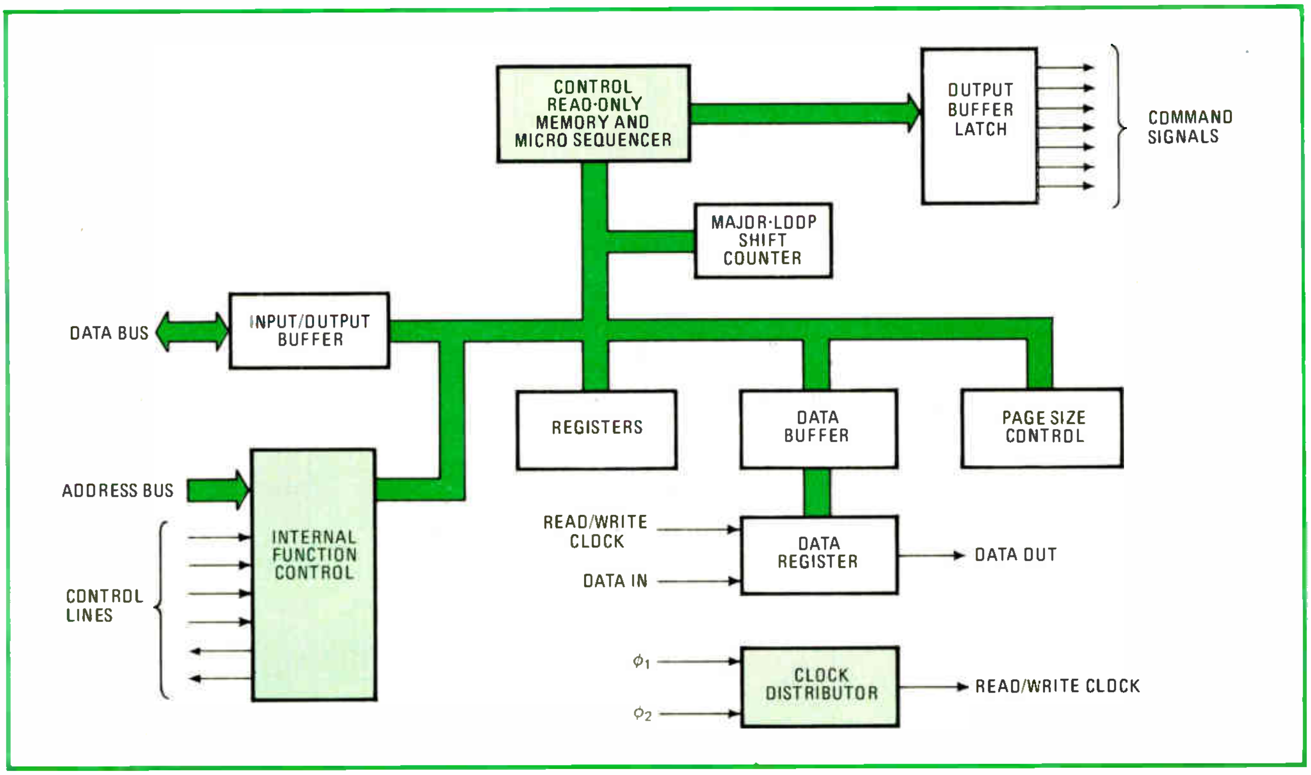
The bubble chip

The chip itself is composed of a gadolinium-gallium-garnet substrate upon which a magnetic epitaxial film is grown. On this film are deposited patterns of Permalloy metal that define the path of the bubble domains in the presence of the rotating magnetic field produced by the coils surrounding the chip. As the field rotates, the bubble domains move under the Permalloy patterns in shift-register fashion. The two magnets maintain a constant-flux bias field through the magnetic epitaxial layer that permits the stable existence of bubbles. Bubbles are generated by the pulsing of current through a microscopic one-turn loop located on a secondary metalization layer immediately above the magnetic epitaxial layer. They are detected by an array of detector elements (connected Permalloy patterns) that change resistance when the bubbles pass under them. The detector elements are connected to opposing legs of a bridge circuit and the unbalancing of the bridge registers the passage of a bubble. Since the access time associated with a single shift-register storage loop would be long, a much shorter time is obtained through the use of a multiplicity of shorter endless-loop shift registers. The TBM0103 uses such a major-minor-loop architecture. A total of 157 minor loops, each consisting of 641 bubble positions, provide a potential storage capacity of 100,637 bits with an average access time to the first bit of data of 4 milliseconds.

In the loop

Data bits are introduced into and read from the major loop of the chip. The presence of a bubble during a 10-microsecond period constitutes a logic 1, and conversely, the absence of a bubble during the period is a logic 0. The major loop is a unidirectional circular shift register that can transfer data to and from the top bit position of the 157 minor loops. Data blocks are accessed by rotating the minor loops until the desired page of data is adjacent to the major loop, whereupon a page can be transferred.

The fine geometries used for the device make the production of perfect chips difficult. To enhance production yields and thereby lower costs, the TBM0103 has been designed with redundancy so that as many as 13 of



2. Controller chip. The TMS9916 is an n-channel MOS device that controls the shifting of the bubbles, ensures their synchronization, and maintains page position information. It includes a mask-programmable ROM that can be programmed for different loop organizations.

the total 157 minor loops on the chip may be defective.

A typical microprocessor system design that uses bubble-memory mass storage is shown in Fig. 1. The memory portion comprises a TMS9916 bubble-memory controller, a function-timing generator, data-handling and redundancy logic, chip-select logic, and eight bubble-memory cells.

Each cell is made up of a TBM0103 bubble module, a diode-array chip, and function- and coil-drive chips. Each of four sense amplifiers and its associated termination network share two memory cells. This organization, though it restricts the data rate, since only one bubble module in each pair sharing a sense amplifier can be accessed at any one time, reduces parts count. The transfer rate in this configuration is 50 kilobits per second, but by reconfiguring the data-handling and sense circuitry this rate could be increased to 200 kilobits per second. However, maximum effectiveness of the bubble-controller chip is obtained when only one bubble module is accessed at one time at the 50-kb/s data rate.

In operation

A read operation in the system is relatively simple: first, the CPU selects a module from which to access data via the handling logic, and then it loads the controller with a page number and gives the read command. Upon accessing the proper page, the controller stores the data in its buffers and interrupts the CPU, which then reads the data from the controller's buffer. The cycle takes just a few milliseconds.

Similarly, for a write operation, the CPU writes the data into the buffer of the controller, initiates the transfer, and waits for the controller to signal that data storage in the magnetic-bubble domains is completed.

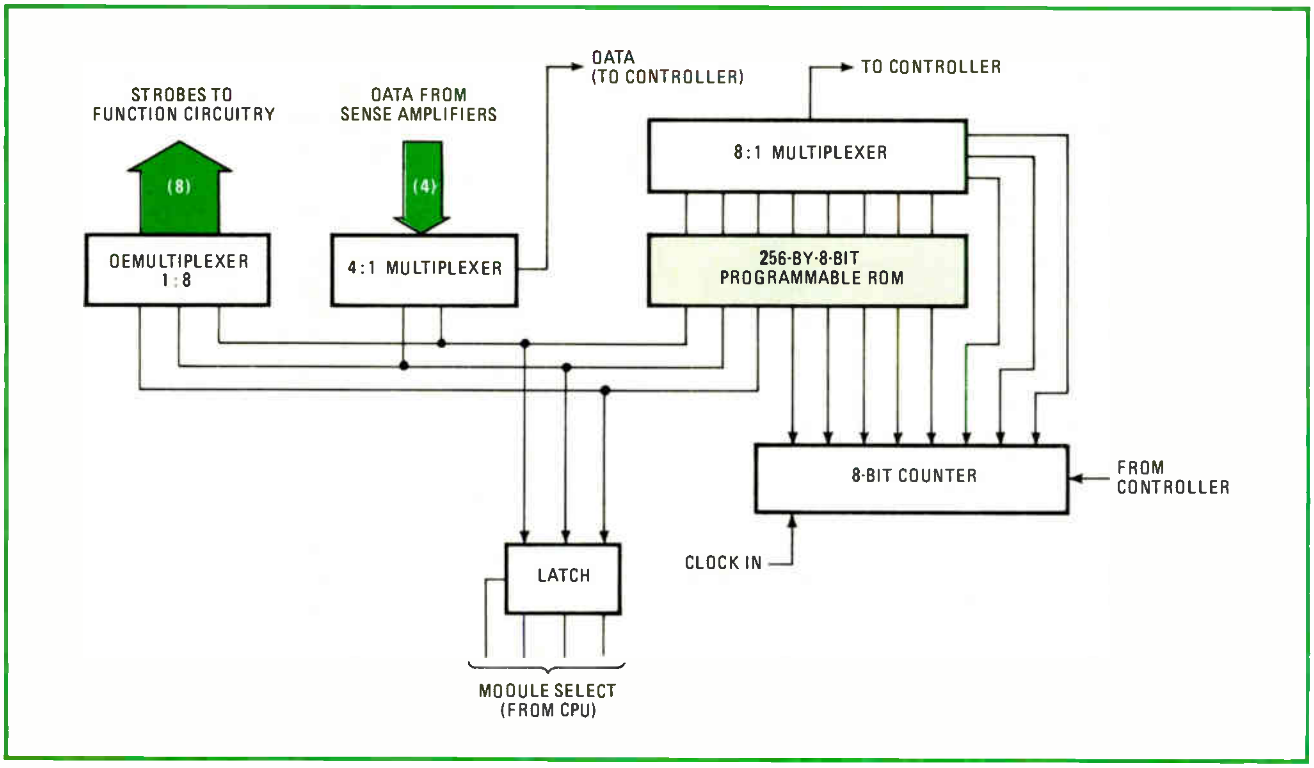
The TMS9916 controller, shown in Fig. 2, starts and stops bubble shifting, maintains page position information, and ensures synchronization with the bubble module. A 40-pin, n-channel metal-oxide-semiconductor device, the TMS9916 contains a control ROM, serial/parallel interconversion for data transfer with the bubble module, a 20-byte buffer for temporary data storage, and addressing logic to maintain synchronization with data shifting in the module. Software is used to set the controller for variable page sizes of 1 to 20 bytes, variable minor-loop size of up to 1,024 bits, and multipage transfer capability of 1 to 1,024 pages.

In response to commands from the CPU, the controller enables the functions necessary to access a page or pages of data in either a single-page or a multipage mode. In the multipage mode, it accesses long blocks of data a page at a time, and an interrupt is generated after each byte is read or written until the transfer is complete. In the single-page mode, a single interrupt is generated at the end of the transfer.

At the proper bubble field rotation period, the controller sends flags to external circuitry that performs bubble operations—for example, annihilation or replication of the domains.

Dealing with the extra loops

Because of the redundancy of minor loops—13 loops are unused—a map must be provided in the circuit controlling bubble shifting to prevent use of the defective loops. This map for each bubble module is usually stored in some kind of ROM. In operation, the map for an accessed module is read from the ROM and is used to



3. A matter of redundancy. Typical data-handling logic configuration masks out redundant minor loops by referring to map of loops stored in a 1,024-bit programmable ROM. The map is used to check each bit of the page as it is read out, to remove any bad bits.

inhibit data transfer when necessary to prevent bad bits from reaching the controlling buffer. The ROM used for the map may be a separate programmable device as shown along with the required data-handling logic in Fig. 3. Another possibility is to store the map in the bubble device itself and to read it into CPU RAM during system initialization.

Controlling function timing

Function timing is controlled by a 22-pin low-power Schottky transistor-transistor-logic chip that consists of: control flip-flops that synchronize and control the starting, shifting, and stopping sequences of the bubble field rotation; a mask-programmable ROM that coordinates timing pulses and which may be changed to accommodate other chip architectures; and output latches and gates.

To convert the TTL-level signals from this function-timing circuit into the current pulses required by the bubble device, there is a 16-pin function-drive IC. This chip consists of constant-current sources that are switched on and off from external inputs.

TTL input signals from the function timer also go to the coil-drive IC, an eight-pin device that in conjunction with the diode array provides triangular-waveform currents for the bubble module coils.

To produce a logic-level output upon the detection of a bubble, two devices are required. One is a termination network, an eight-pin hybrid circuit, which provides the remaining two legs of the bridge that includes the bubble detector elements. The network also includes ac-coupling and high-frequency filtering components and the current-setting resistors for the function-drive circuit. The second device is a sense amplifier, another eight-pin circuit that receives millivolt-level analog signals from the termination network and uses amplifiers and level-detection circuits to generate logic-level outputs.

Now the bubble-memory module and the equivalent of three 16-pin dual in-line devices make up a basic memory cell, and eight of these modules on a circuit board would provide a total of 738,432 bits, or 92,304 bytes. Such a memory system is clearly well-suited to microprocessor-based applications.

The bubble memory and its interface circuits are designed to operate from ±12- and ±5-volt power supplies. Table 3 gives estimates of the power requirements of the eight-cell system in both the standby and active modes. The active power dissipation assumes a system that accesses one module at a time. For ultimate lower-power operation, power switching either on the entire bubble storage system, including control circuits,

TABLE 3: POWER DISSIPATION OF A 92-KILOBIT MAGNETIC-BUBBLE MODULE AND ASSOCIATED CIRCUITS

	Module switched on all the time		Module on only when accessed	
	Standby (W)	Active (W)	Standby (W)	Active (W)
Bubble module	0	0.6	0	0.6
Coil drivers	4.8	5.5	0	1.3
Function drivers	1.6	1.9	0	0.5
Sense amplifier	0.7	0.7	0	0.18
Function timing	0.3	0.3	0	0.3
Controller	1.0	1.0	1.0*	1.0
Miscellaneous logic	1.5	1.5	0	1.5
Total	9.9	11.5	1.0	5.38

*can also be switched

Magnetic-bubble memories head to market

Bubble memories are undergoing intensive development throughout the world and will soon be popping up in products, mostly in association with microprocessors.

Bubble-technology pioneer Bell Laboratories Inc. has had a working bubble device for several years. The 272-kilobit package comprises four 68-kilobit straight-serial shift registers. However, the fully serial arrangement of Bell's 3-micrometer bubbles demands perfect chips—any defects produce a missing link in the shift-register chain.

So far, Bell's bubble package has made it into an announcement system installed last December in the Michigan Bell Co. in Detroit. Voice messages with ample fidelity for phone transmission are stored digitally in the package, which replaces a tape recorder. Otherwise, the package has been operating only in laboratory switching systems as the key element in a new subsystem called the serial bubble store, introduced also in December by Bell's facility in Whippany, N.J. Larger SBS systems, using more than one package for capacities of up to 1.1 megabits, are being planned, according to T. M. Burford, director of the Whippany common systems laboratory, and all applications are in conjunction with microprocessors.

Like Bell Labs, Rockwell International Corp.'s Autonetics group in Anaheim, Calif., is producing bubble memories packaged in subsystem form. Rockwell's chip uses 3.8-μm bubbles, also in a perfect, straight-serial shift register, only of 100-kilobit size. According to E. T. Brown, the group's bubble-domain-memory program manager, 100 kilobits is about the limit for serial devices, and he expects that all large-capacity systems in the future will use the major-minor-loop technology with 8% to 10% of the loops redundant. The company has even put together a fully operable, 2-μm major-minor device of over a million bits, fashioned as 512 loops of 2,048 bits each.

Rockwell's 100-kilobit chip is going into 800-kilobit subsystems. Much work, however, is being done in all phases of bubbles, and Brown thinks that the next step will be the use of electron-beam lithography to shrink bubble diameters for several-megabit storage capacity.

The push is on also at IBM's Thomas J. Watson Research Center in Yorktown Heights, N.Y., and at its research division's laboratories in San Jose, Calif. Advanced bubble-lattice devices now under investigation promise to up bubble densities 10 times over conventional bubble devices. But because of the present difficulties with lattice devices, the bubble memories IBM will soon be building into its typewriters and other small equipment for text editing will probably be conventional in design; they will operate under microprocessor control.

Hewlett-Packard Co. is working with 4-μm and smaller bubbles and despite a small 12-man program has made such progress in bubble propagation as to earn several patents. But according to Len Cutler, director of the Cupertino, Calif., physical research lab, a product is still far off.

Meanwhile, halfway around the world, Nippon Telegraph and Telephone Public Corp. in Tokyo is also involved in bubbles. At its Musashino Electrical Communication Laboratory, an experimental 2-megabit bubble memory made up of 32 64-kilobit chips has been tested as a file memory in switching systems and operated reliably for over a year. It will probably be in regular use in Japanese telephone switching systems by 1980. Fujitsu Ltd. and Hitachi Ltd. also report operable devices. **Raymond P. Capece**

or on the bubble-memory cells alone could be used.

As for space requirements, allowing 1 square inch (6.5 square centimeters) per IC for a two-sided printed-circuit board and 1.5 in.^{2} (9.67 cm^2) for a bubble module totals 40 in.^{2} (258.1 cm^2) for an eight-module board. Another 10 in.^{2} (64.5 cm^2) is required for the controller and data-handling logic, so that the total system needs 50 in.^{2} (322.6 cm^2) of board space.

Concerning weight

The weight of the system depends mainly on the number of bubble modules. A module and its associated interface electronics weighs 0.06 pound (27 grams). A system consisting of eight modules and electronics on a board would weigh 0.69 lb (312 g).

Finally, although the maximum data rate is 50 kilobits per second for each module, the sustained data rate is about 44 kb/s, as a result of the system redundancy and major-minor-loop architecture. Table 4 summarizes performance of the 92-kilobyte bubble-memory system.

TABLE 4: PERFORMANCE OF A 92-KILOBYTE MAGNETIC-BUBBLE MEMORY SYSTEM

Transfer rate	44 Kb/s
Average access time	4 ms
Power dissipation	11.5 W
Weight	0.69 lb
Volume	38 in^3

In designing such bubble memory systems, several pitfalls must be avoided. First, the bubble gate elements make good fuses because of their small geometries and high current densities. The designer therefore must take care not to allow a drive pulse to exceed specifications. Also intolerable are transients in either the coil-drive or function-drive circuitry, and internal provisions have been made to disable them during power cycling.

Because of the small amplitude of the bubble signal, care must be exercised in laying out a circuit board. Long runs of conductor between the sense amplifier, detectors, and termination network must be avoided. Good filtering of power supplies is a must, and a ground plane should be included in the design of the board.

Although the module is well shielded magnetically, it is possible to disturb the bubbles with an external magnetic field greater than 40 oersteds at the shield. However, this puts little constraint on applications, since few user systems are expected to contain fields with sufficient flux density to disturb bubble data.

The major-minor-loop architecture is susceptible to data loss if the field is stopped with data in the major loop. The TMS9916 controller, however, is designed to return data to the minor loops following a power failure warning, provided that the supplies remain on for a minimum of 12.8 milliseconds. □

Part 3: EEs appraise career trends for 1980s

Interviews see more diverse career, need to press for professional gains

by Gerald M. Walker, *Senior Editor*

☐ The spread of electronics technology today into virtually every industry has created a far more varied career for electronics engineers than was the case when defense and aerospace efforts dominated the field. As a result, the views of engineers toward their career have changed and have become less uniform.

Now, when asked to discuss their career, EEs roam across many topics covering both technical developments and the general professional needs of engineers. To a certain extent, the two subjects blend. This is especially true in their discussions of the impact of microprocessors on their daily work as well as on their career in general. On this question, there is much agreement. Most engineers also recognize that the importance of applying the latest technology increases the pressures on them to perform, because, with the widening reach of electronics, their technical know-how is basic to the success of more and more companies, both new and old.

In the first two parts of this series, a number of themes also emerged underscoring the differences among engineers. Although EEs expressed a solid vote of confidence in their career, they recognize problems of adequate recognition by management, continuing education, and improved status. In particular, the desire for professional gains has split EEs into opposing camps arguing over how best to reach their goals, including such controversial issues as controlling the number of EEs entering the field and establishing some form of certification of practitioners.

Some EEs expect to solve these problems by individual effort. They believe that keeping up with advanced technology and hard work are the key to success and that with success professional problems will fade away. Others see the need for united action.

In this, the concluding part of the series, a group of engineers representing a variety of experiences, types of company, and positions give their views on where electronics engineering is headed. They express in a personal way what the results of the *Electronics* survey say through statistics.

Career series: *This article concludes a three-part series on electronics engineering as a career. Part 1 [July 7, p. 87] reviewed results of an* Electronics *survey of readers concerning attitudes toward their career. Part 2 [July 21, p. 95] dealt with the impact of technology on EEs as reported in the survey and in interviews with engineers around the country.*

"The electronics engineering profession in the 1980s will be tougher, demand more multidisciplinary knowledge, and require a stronger person than ever before to survive the technical and social ramifications. In the meantime, the falling by the wayside of weaker colleges and weaker engineers is good for the profession but tough on those not prepared to face life in its raw form. What does this mean for the new EEs of the 1980s?

"I think it calls for better training in science and engineering fundamentals and less in a specialty. It means dividing responsibility for training between colleges on the one hand and industry or professional societies on the other.

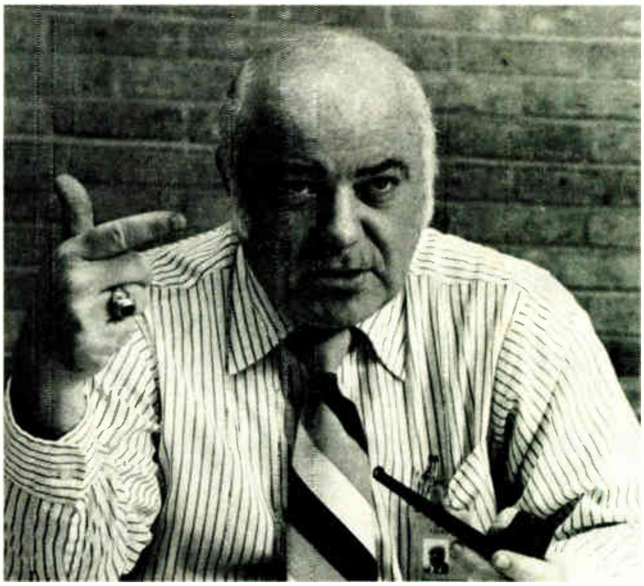
"Colleges will provide fundamentals to the engineer entering the field; industry and societies together will take care of specific techniques, applications, and supporting theory. A typical example of the latter was our recently completed course on digital signal processing given by the Orange County Institute of Electrical and Electronics Engineers, which 130 attended. By contrast, a similar college course attracted only about 15.

"Professionalism is a personal matter for each engineer, who must on his or her own continue education by home study, technical publications, and courses with experienced industrial instructors. Colleges can't do the job, in my opinion, because so-called 'midcareer retraining' is a myth perpetuated to support their own courses, which simply add more 'factory hands' rather than professionals to the ranks.

"It's the lack of individual career planning and a strong education in fundamentals that causes the average engineer of today either to go to seed or to leave the profession for greener pastures. To be a true professional, with its inherent risks, an engineer has to keep current and turn down safe, meaningless positions in favor of challenging assignments."

"The falling by the wayside of weaker colleges and weaker engineers is good for the profession but tough on those not prepared to face life in its raw form."

J. C. Hoagland, *communications engineering*
Rockwell International Corp.



"The engineering community now has to address the design problem, not with logic building blocks, but with microcomputers, solving problems with software."

H. Dean Toombs, *director of engineering*
Texas Instruments Inc.

"I think that the general aspects of programming, from calculators to microprocessors to computers, will become second nature to the equipment designer in much the same way as the calculus of differential equations is now. Programming is a tool that many engineers have to understand in order to execute their day-to-day jobs.

"We're heading into a new era of electronic equipment. The engineering community—the group of people who do electronic-equipment designs—now has to address the design problem, not with individual logic building blocks, but with microcomputers, solving problems with software.

"And the engineering schools are changing to catch up—it started nominally three years ago, and it's really moving now. The change is a kind of competition among microprocessor vendors. We're trying to get students exposed to a given family of microprocessors; we're trying to get our hardware and software into the engineering curriculum.

"The mid-1960s, when the integrated circuit eliminated the necessity for circuit design in the detailed sense, is often compared to the era that we're going through now. Then, the engineering staffs looked upon the IC as a threat to their jobs or admitted that they did not know how to use it.

"That's also true now concerning the microprocessor, but the present transition is broader, in a sense, than the discrete-to-IC evolution. A good example is the impact of the microprocessor on the low-end market. This market encompasses many products that have never really been electronics applications, products that have been built with relays, timers, motors, and the like. As a result, some engineers are having to jump two or three stages, not just from digital large-scale-integrated logic to microprocessors, but from analog or even from electromechanical parts directly to microprocessors."

"We're reaching a time in society in which scientists and engineers are regarded as 'bad boys' because they've brought so many 'bad things' into the world—some quite innocently, however, because they do not know how to factor human costs into their designs. The attitude has been, if the design works well technically, it's best.

"I think that engineers must now learn to include in their portfolio of tools some concepts of political science, management, economics, and law, integrally related to engineering education, research, and clinical practice. It's not good enough, for example, for a student to take economics in the abstract. He or she must see how economics connects with the daily work of engineering. What economics the professional economist must deal with and what economics an engineer must deal with in an educational program are not necessarily the same.

"I don't believe our universities have been doing as good a job in continuing education as they could. First, in any given subject the student from industry may know a lot about the topic in the first half of a course and not in the second half. But because of the way we package the content, the student from industry has to work through the entire course to get what he or she wants. Also, there is a lag between the time a subject is introduced into the engineering field and the time it is taught at schools.

"A solution to the first problem would be to produce what you might call fragments of subjects, that is, break topics into modules that students can take as needed. The National Science Foundation is funding a research project to do that in the chemical engineering curriculum.

"As for the second problem, seminars that address the hot topics such as microprocessor design would help close the gap between introduction of a new technology and introduction of courses dealing with the new technology. I see future continuing education as a mix of traditional courses, modular courses, and hot-topic seminars."

"Engineers must now include in their portfolio of tools some concepts of political science, management, economics, and law, integrally related to engineering education."

James D. Bruce, *associate dean*

School of Engineering, Massachusetts Institute of Technology

"Electrical and electronics engineering is at a crossroads. Should we organize unions or should we try to reorganize the IEEE so that it will address the problems of today's engineers?"

Faith Lee, *engineer*

Solid State division, RCA Corp.

"For at least 30 years, the occupation of engineering has been considered a career—a well-paid, interesting, even glamorous career. Recently, however, engineering has tended more toward being a job, with the engineer an expendable commodity.

"EEs today become highly specialized and cannot move readily to other positions. Thus, electrical and electronics engineering is at a crossroads. Should we organize unions or should we try to reorganize the Institute of Electrical and Electronics Engineers so that it will address the very serious problems of today's engineers?

"At present, the IEEE has budgeted over $1 million for professional activities in the U. S. Not all of this money is used for professional activities. Nor does any other entity in the IEEE suffer, since the $1 million comes from the $10 assessments in the U. S. members' dues. The members have gotten very little so far for their money: support of passage of HR 314 to end wage busting in service contracts, a review of ethics, a pension plan that may benefit a small fraction of the membership, a study of the midcareer crisis, a review of patent practice as it pertains to engineers' patent rights, and various other projects.

"There are two possible routes toward improving the EE's lot. One way is to allow unionization to take over, thus putting the engineer in a secure position while the institute fades away. The other would be to turn out in force at IEEE activities, to participate in forming and carrying out programs that reflect the needs of the practicing engineer. If the average practicing engineer doesn't start working to help the profession, there will be no profession."

"The EE's job in the 1980s will be influenced by the increasing use of analog and digital integrated circuits for sophisticated signal-processing systems in both military and industrial or commercial applications. More complex digital LSI chips will be designed to replace discrete and hybrid components.

"We have an increasing variety of very-large-scale-integrated digital building blocks that include fast digital multipliers, high-speed correlators, wideband analog-to-digital converters, and fast-Fourier-transform processors. To generate the level of integration required in the future will mandate changes in semiconductor technology and circuit topology, as well as interconnection and packaging techniques. These will include development of high-speed digital circuits using epitaxial and ion-implanted chips to operate at 1-to-2-gigahertz clock rates; high-speed digital processing and high-frequency linear circuits to employ optical waveguides and couplers, as well as modulated light sources; and high-density logic and memory VLSI circuits with 100,000 or more devices per chip.

"The trend toward more complicated functions on a single chip will require designers conversant with device physics and processing. The successful engineer must have both more specialization in a given area and a working knowledge in related areas. It is becoming increasingly evident that there will be design teams composed of multidisciplinary specialists with a background in systems design, software, materials, LSI processing, and circuit design.

"Today's engineers are finding it necessary to broaden their interdisciplinary knowledge by taking short courses. But engineers in the 1980s will have to master the various disciplines before they graduate."

"It is increasingly evident that there will be design teams composed of multidisciplinary specialists with a background in systems design, software, materials, LSI processing, and circuit design."

Thomas G. Mills, *manager microwave devices*
TRW Inc.

"Technology moves forward not only in digital but also in analog applications. For example, precision multiplication that we do digitally today requires conversion and reconversion. Analog designs could eliminate conversion entirely."

Walter S. Ciciora, *section manager circuits*
Zenith Radio Corp.

"People sometimes refer to television as a mature technology, but the opportunities to refine it made possible by advances in semiconductor technology have changed that view. As a result, the television engineer's job is going to change in much the same way that all engineers' jobs are changing—he or she is going to require more of an effort to keep abreast of many diverse technologies.

"Corny as it sounds, it's going to take all the enthusiasm the engineer can muster to keep up with technology. We hear comments about engineers over 40 not being as valuable as younger ones, and that's partially, but not entirely, their own doing. They haven't kept up. Today, without enthusiasm and drive, the engineer is going to be obsolescent in less than 5 years and obsolete in 10 to 15 years.

"Engineers are going to need better communicative skills, too. They will have to attend technical meetings in areas outside their specialty simply to meet engineers in other fields, ask questions, and broaden their understanding of new technologies that might apply to their job.

"Even today, the engineer who does not know how to program a calculator is at a great disadvantage. Programming is now extending to test instruments as well. Yet the engineer cannot lose sight of the fundamentals either. Our single biggest complaint about EEs coming out of schools today is that many of them are lacking in the fundamentals.

"In some cases, digital electronics has become such a preoccupation that engineers forget that we still live in an analog world. Technology moves forward not only in digital but also in analog applications. For example, precision multiplication that we do digitally today requires conversion and reconversion. In 5 or 10 years, analog designs could eliminate conversion entirely."

“Many senior engineers are alienated and disenchanted with the profession because they have been denied a lifetime career with adequate salary, recognition, and continued opportunity for growth. Engineers are having problems similar to those of knowledge workers and employed professionals in other fields. By the 1980s, some engineers will unionize, as other employed professionals have done, and others will expect their professional institute to assume the responsibility for upgrading engineering.

“In the last three decades, additions to technology have been predominantly analytic and scientific, reflecting needs of industries that grew as a result of Government investment in defense and aerospace. In the 1980s, growth will be in ‘people-based’ applications requiring creative design under constraints or ambiguous conditions. Additions to technology will be primarily applications-oriented.

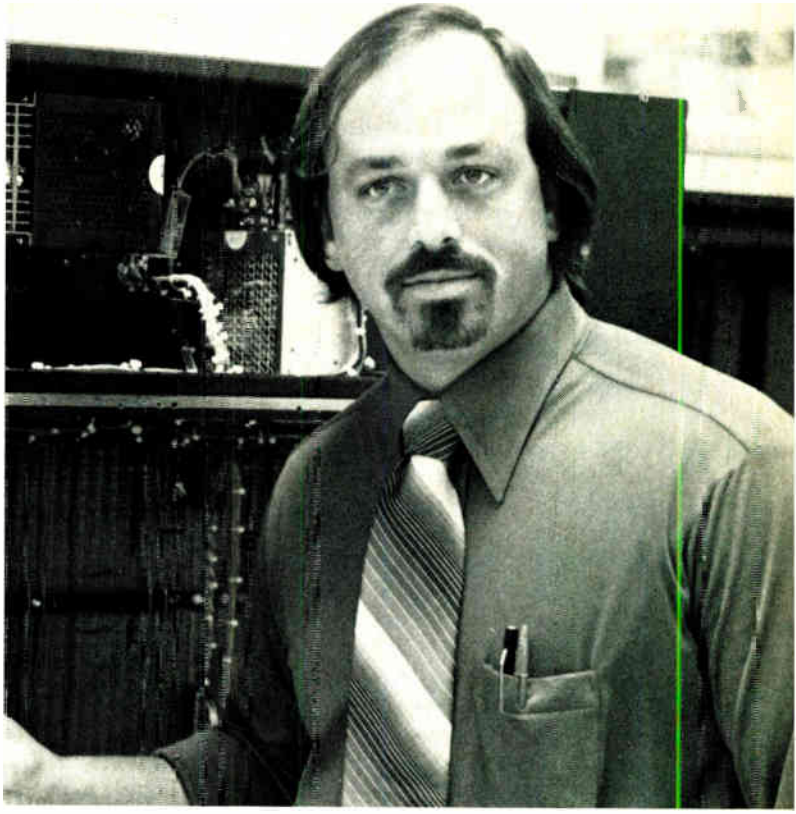
“Because the role of engineering is not well understood by the public nor adequately represented in Government agencies, engineers must assume responsibility for applying technology in the public interest. Yet engineering societies appear to have abrogated their responsibility as spokespersons for technology, passing the leadership to the scientific community. In the 1980s, there should be an American Association for the Advancement of Engineering to speak on behalf of the professional engineering community.

“But before that can be done, the engineer must establish and maintain qualifications and standards, because today anyone can call himself or herself an engineer. As a result, a third of the one and a quarter million practicing engineers do not have bachelor’s degrees. In the 1980s, the percentage of registered engineers will increase and certification may come into vogue. While registration by the state establishes minimum requirements, certification is administered by a professional society and implies proficiency at advanced levels in a specialty.

“Finally, in the 1980s, one third of new engineers will be female. Since women as a group are high in verbal skills and interest in people, their entry should serve to make the engineer’s image more human. Women engineers have the potential to make important contributions in this area.”

“Because the role of engineering is not well understood by the public nor adequately represented in government agencies, engineers must assume responsibility for applying technology in the public interest.”

Thelma Estrin, *director data processing laboratory*
Brain Research Institute, University of California, Los Angeles



“Once you walk out of a university with a diploma and into a job, there is no correlation between school and work. There are a certain number of surprises in a company that a school cannot prepare the engineer for.”

Craig Erickson, *engineering manager*
Systems division, Intersil Inc.

“My job as engineering manager was predominantly design but is gradually evolving into a management job. But I don’t think I’ll ever get divorced from engineering.

“New challenges have been constant here over five years. Now, I’m being exposed to the business side—budgeting, hiring, and managing people. Somewhere along the line, I hope to have enough exposure to business to start my own company. It would definitely be a technical company and, I hope, an innovative company. It seems that more and more companies in this area are making money doing mundane things, which is not very interesting. Everyone faces the fact sooner or later that he or she is not going to be on top. Maybe that’s why people start their own companies.

“Planning one’s career path is pretty much up to the individual engineer. A company may supply the opportunities, but the engineer has to be aggressive to take advantage of them. Actually, universities do not prepare students for the working world. Once you walk out of a university with a diploma and into a job, there is no correlation between school and work. Universities do an excellent job of teaching discipline and the learning process. But there are a certain number of surprises in a company, such as paper work, that a school cannot prepare the engineer for.

“When I take a course, I take it in philosophy—that’s my recreation, not my work. Nevertheless, philosophy is not necessarily unconnected with dealing with the business side of my engineering career.”

"If engineers have been in the design trade for any length of time, they have gotten used to the fact that they have had to continually upgrade their skills and learn new technologies. Now, we are seeing not only continued changes in hardware technology, but a shift to defining what a computer product does by virtue of its software. And what used to be primarily an electronics or electromechanical engineering activity is now staffed partly by hardware people, who have an electrical engineering background and partly by software people, who are also considered engineers but are not usually EEs by education or training .

"Although it is called an engineering capability and it is of increasing importance to the industry, software 'engineering' has not achieved the status of a discipline. Hardware engineering is a discipline, and there are books and rules on how to design. Software is more of a craft. There aren't any well-understood and accepted guidelines or rules, or even criteria of excellence, for software design as you find for hardware design.

"I think the whole engineering world is looking for guidelines and criteria for dealing with software-hardware tradeoffs. There aren't very good rules yet. Tradeoffs flip back and forth between the two, depending on a number of factors. There is no way, for example, to apply the principles of economics that were used in converting from vacuum tubes to transistors.

"Thus engineers who could successfully make the transition from one kind of hardware technology to another sometimes will find it difficult to make the transition from an engineering discipline into an activity where that discipline does not exist. That's a real change from the past."

"I think the whole engineering world is looking for guidelines and criteria for dealing with software-hardware tradeoffs. There aren't very good rules yet."

Irma M. Wyman, *director central engineering staff*
Honeywell Information Systems Inc.

"This period will see a sharply increased need for engineers because, if the quality of life is to be maintained or enhanced in the presence of increasing scarcity of resources, it will only be done by engineering."

Robert Saunders, *president of the IEEE, 1977*

"Engineering in the twentieth century may be characterized by three distinct periods: (1) resource development from 1900 to 1940, (2) resource protection from 1940 to 1975, and (3) resource management from 1975 to the present. In electrical engineering, the first period saw the development of nationwide and worldwide electric-power and telephone systems. It was characterized by plentiful raw materials and unlimited energy resources.

"Electrical engineering in the second period sparked the explosive growth of the application of electronics, especially solid-state devices, to computer, communications, medical, transportation, aerospace, and entertainment systems. At the same time, systems theory was developed. During this period, it became apparent that material resources were limited and needed some measure of protection to ensure continued availability.

"As we move into the third period—resource management—the character of engineering will undergo significant changes. This period will see a sharply increased need for engineers because, if the quality of life is to be maintained or enhanced in the presence of increasing scarcity of resources, it will only be done by engineering.

"In electrical engineering, undoubtedly we will be involved with obtaining better performance from our existing power and communications systems, developing and using new electronic devices, such as molecular circuits, revising our transportation systems, recycling scarce materials, and developing expertise to bring raw materials and energy from nonterrestrial sources. It is an exciting era we are entering and one to which the whole engineering community will make major contributions."

"Unhappily, the question whither the IEEE? may very well take the form wither the IEEE? Our professional society is at a crucial juncture in its existence. There are very deep divisions between those engineers who want the institute to function as a professional society and those who wish to return to the simpler structure characteristic of a purely technical society.

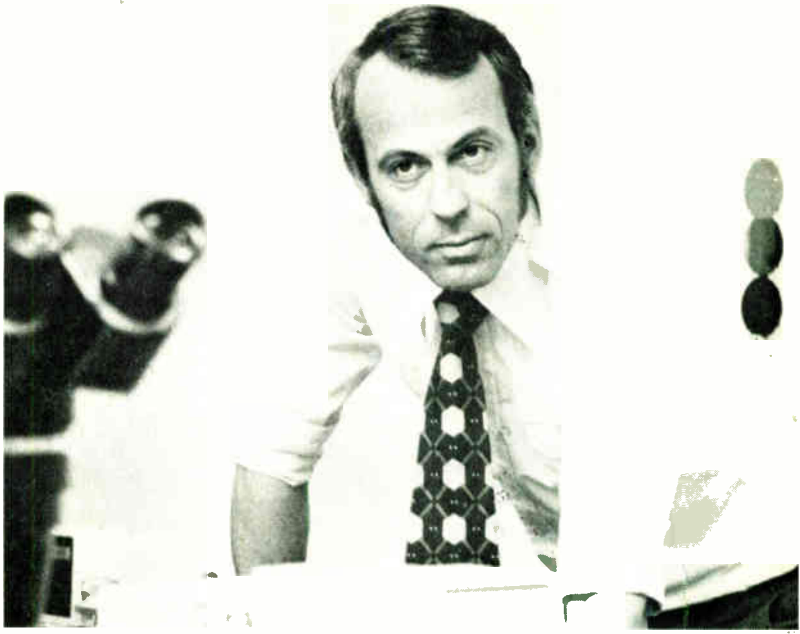
"But history shows that is it not possible to march backward. It must be understood that the needs of the working EE are not only technical, they are not only professional, they are not only educational—they are all of these. Only if the IEEE addresses itself to the total needs of the practitioners can it hope to survive. Our institute must seek to assure each EE a lifetime of highly professional and adequately compensated work.

"But even that may not be enough. The IEEE faces a growing credibility gap. The board of directors suffers from a 'We, not you, know best' attitude that can only increase the suspicion that the working EE feels toward his professional society. The institute cannot afford to shut itself off from the wishes of its members. Membership—nonstudent, U.S. practitioners—has been declining. Therefore, it is imperative that the institute take steps to close the gap, clean house of those who are dragging down the reputation of the society—and by association, its members—and open the way for all working EEs to be heard. The IEEE cannot afford to turn away the growing number of members who need strong support in their careers.

"The IEEE will not survive, and does not deserve to survive, unless it becomes a truly professional society."

"Only if the IEEE addresses itself to the total needs of practitioners can it hope to survive. Our institute must seek to assure each EE a lifetime of highly professional and adequately compensated work."

Irwin Feerst, *consultant and head of the Committee of Concerned EEs*



"The engineer of the 1980s must not only be creative in his or her profession, but must also commit energies to social and political causes. In other words, the engineer must get involved in nontechnical issues."

Rüdiger Karnatski, *product manager*
Intermetall GmbH, West Germany

"It's a truism that as something becomes abundantly available, it is taken for granted and its value diminishes. With engineers, I think, it's not much different. Fifty years ago, being an engineer was something special, and even during the past decade an engineering education meant a free ticket to a choice seat in the arena of society. But now, when society looks upon technical achievements casually, the profession is losing its image of the extraordinary.

"Nowadays, making technical ideas come true depends more and more on the amount of money invested and less and less on the achievements of the solitary engineer or inventor. This is not to belittle the work. Rather, it implies that the engineer's role is changing. To cope with the change, the engineer of the 1980s must not only be creative in his or her profession, but must also commit energies to social and political causes. In other words, the engineer must get involved in nontechnical issues.

"That means more engineers in politics, more engineers in Government agencies, and above all, more engineers in upper management positions in industry. I believe that only by taking this route can engineers expect society to duly appreciate and value their work, work that is essential to an industrial nation's prosperity, economic growth, and social progress. With involved engineers, society can in turn be sure that the potentials that technology offers are channeled in the right direction.

"For all the need for specialization, engineering education should be aware of the engineer's changing role. It should persuade him not to become a one-track individual with blinders around his eyes. Educators should induce the student to become an actively engaged citizen, one who helps shape the society in which he or she wants to live. If this course is not followed, in the 1980s an engineer will be considered a commodity even more than he or she is today."

"The key word for the 1980s is adaptability. Two important elements are going to dominate the engineer's outlook in the next decade: first will be internationalization, and second will be the continued rapid change in technology. Of course, I can't speak for all French engineers, but these two trends seem to me to be the most important influences.

"The engineer is going to have to be mobile physically and psychologically. He or she will have to adapt to an unlimited number of different situations. Perhaps the most critical factor in fitting the engineer for this changing role will be training. It will have to be training in adaptability—the EE will have to be taught how to acquire knowledge rather than specific facts applicable to present technology.

"Also, the engineer will have to recycle himself or herself and avoid overspecialization. He or she must not wait until the last minute before learning new techniques.

"Apart from this important need to be able to adapt to new technologies and new ways of operating, it is also going to be necessary for the engineer to be able to express himself or herself in writing and speech, to be able to communicate effectively. He or she is going to have to become a part of a team and will therefore need to be able to express himself or herself well to others. Lastly, the engineer will probably have to learn foreign languages—even the American engineer!"

"The engineer is going to have to be mobile physically and psychologically. He or she will have to adapt to an unlimited number of different situations."

André Lambert, *systems engineering manager*
CIT-Alcatel, France

"Improvements in technology will be mirrored in increasing sophistication in the design aids available. Rapid development is already taking place in computer-aided design techniques."

John F. Dickson, *MOS circuit design group leader*
The Plessey Co., England

"From a technical point of view, the 1980s should be one of the most challenging periods for electronics engineers involved in IC design. With the advent of VLSI, the dividing line between the circuit and system designer will become blurred, and the ability to implement complete systems on a single silicon chip will create the need for a fundamental reappraisal of system architectures. This is already being seen in the move from central to distributed processing in some large computers.

"Improvements in technology during the next decade also will be mirrored in increasing sophistication in the design aids available. Rapid development is already taking place in computer-aided design techniques for circuit synthesis, circuit analysis, and test-program generation. It is already feasible for circuits that are highly structured and not too demanding in complexity or performance to be designed completely by computer. In these cases, the only involvement of the engineer is to feed in a mathematical description of the device specifications, and the computer-aided-design program does the work of circuit design.

"While there will almost certainly be many circuits designed in this way in the future, there will be many more that will still demand the creative skills of the designer. With the availability of more powerful CAD techniques, the designer will be freed from much of the hackwork and will be able to handle a wider range of technologies.

"During the next decade, there should be a gradual improvement in the status of electronics engineers in the United Kingdom, mainly due to the growing maturity of the profession. There will be an increasing number of people with electronics engineering backgrounds in senior management positions. And as people become more exposed to electronics in the home and at work, they should develop a greater awareness and understanding of the electronics engineering profession. This is already happening with electronic calculators and watches and should continue with the predicted explosion of electronics in domestic appliances, toys, and games." □

Fast-attack detector optimizes ultrasonic receiver response

by Paul M. Gammell
Jet Propulsion Laboratory, Pasadena, Calif.

A radio-frequency amplifier with low output impedance greatly enhances the performance of an ultrasonic receiver. The low impedance, achieved by an open-collector output configuration, permits design of a detector having a fast rise time and somewhat slower fall time—characteristics important for high-accuracy distance-measuring applications. This inexpensive circuit is a wideband receiver with good overload-signal recovery. It has many pulse-echo uses, including nondestructive evaluation and depth finding, and performs well in biomedical ultrasonic applications.

As shown in the figure, a pulsed signal is simultaneously applied to a transducer and transistor amplifier Q_1. The transducer is one of many commercially available devices that will convert a typical 200-volt, 0.1-to-1-microsecond pulse into an ultrasonic (compressional) wave aimed at a distant target. The echo from the transducer, with an amplitude on the order of 1 to 10 microvolts, may return only microseconds later. Q_1 must therefore recover quickly from the large initial pulse in order to respond to the echo signal.

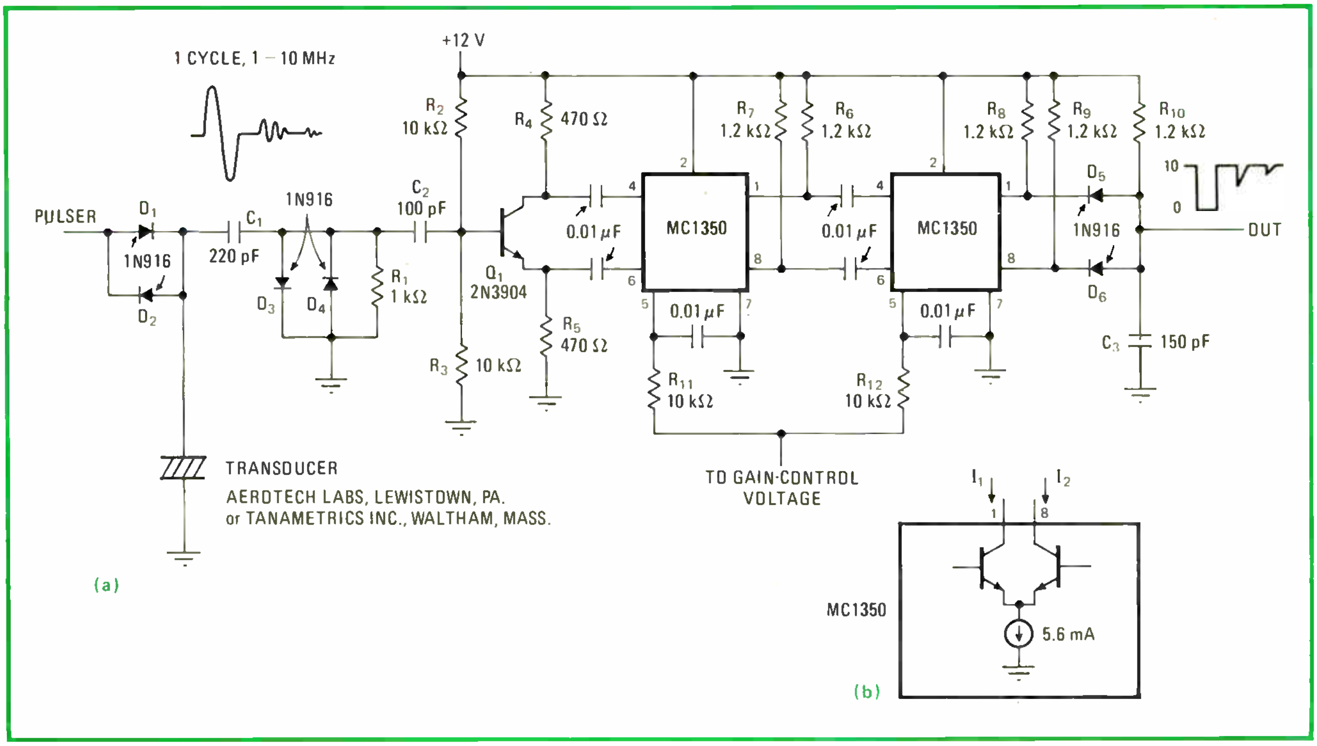
Components C_1, C_2, and D_1 through D_4 aid in isolating the amplifier circuits from the high-voltage pulse. Resistor R_1 improves the transient recovery by draining off any charge present on C_1 and C_2 that remains because D_3 and D_4 have not sufficiently bypassed the pulse to ground.

Q_1 is saturated by the initial pulse. Diodes D_1 and D_2 isolate the pulsed current from Q_1 (and the transducer) after the pulse drops below 0.7 v, thereby keeping the nonthermal noise contributions of the pulser out of the receiver. Q_1 drives the MC1350 radio-frequency/intermediate-frequency amplifier with a phase-split signal to increase the effective gain of the circuit and aids in isolating it from the pulser. To achieve a circuit gain of more than 50 decibels, a second MC1350 amplifier is added.

The output of the second amplifier drives a diode detector composed of D_5 and D_6 and the filter $R_{10}C_3$. Fullwave rectification is essential for optimum resolution, since the echo may be shifted 180° by the reflecting surface producing it.

A simplified equivalent circuit of the output stage of the MC1350 is shown at the bottom of the figure. A fast rise time for incoming signals is achieved by discharging C_3 through the 1-kilohm impedance of one of the output transistors. The longer fall time needed for a smooth

Pulse-echo receiver. Circuit (a) responds to wideband radio-frequency signals with good signal-handling capability. Time-dependent gain control is provided for sophisticated sonar applications. Choice of low-impedance rf amplifier (b) optimizes response.



echo envelope is attained by recharging C_3 through R_{10}. In some applications, it is desirable to provide a control to vary the fall time by adjusting C_3 and to reject echoes of small amplitude by varying R_8, R_9, and R_{10}.

At small signal levels, an approximate square-law response is provided by the logarithmic characteristic of the 1N916 diodes. The sum of currents I_1 and I_2 in the MC1350 is 5.6 milliamperes typical, as specified by the manufacturer. The currents determine the operating point of the diodes. With the circuit values shown, a quiescent current of approximately 0.8 mA flows through each of the diodes D_5 and D_6.

Although integrated circuits are widely available that perform low-level detection, the desired detector characteristics can be more easily achieved with the circuit described. Furthermore, a stable (oscilloscope) baseline and a large dynamic range are easier to attain if the detector is driven by a reasonably high rf voltage source. The amplifiers in this circuit make this possible by providing adequate predetection amplification.

The signal at the output has a well-defined leading edge suitable for determining time differences between the pulse and its echo with an oscilloscope. A 10-v offset occurs at the output. It may be removed with a base-line restorer circuit consisting of a decoupling capacitor, a resistor tied to 12 v, and a germanium diode to clamp the baseline to about 0.3 v. Another approach uses a differential amplifier.

For sophisticated systems, a time-dependent gain control can be added to the rf amplifiers. A 0-to-12-v ramp voltage, the amplitude of which depends on the range and anticipated attenuation of the echo, can be applied to pin 5 of the devices through R_{11} and R_{12}, which control the distribution of stage gain. The ramp voltage should be positive and decrease with time to provide a gain that increases with time. If pin 5 is grounded, the amplifier operates at full gain. Although the ramp is usually synchronized with the transmit pulse, it may be synchronized with other sources, such as the surface echo from an attenuating target. □

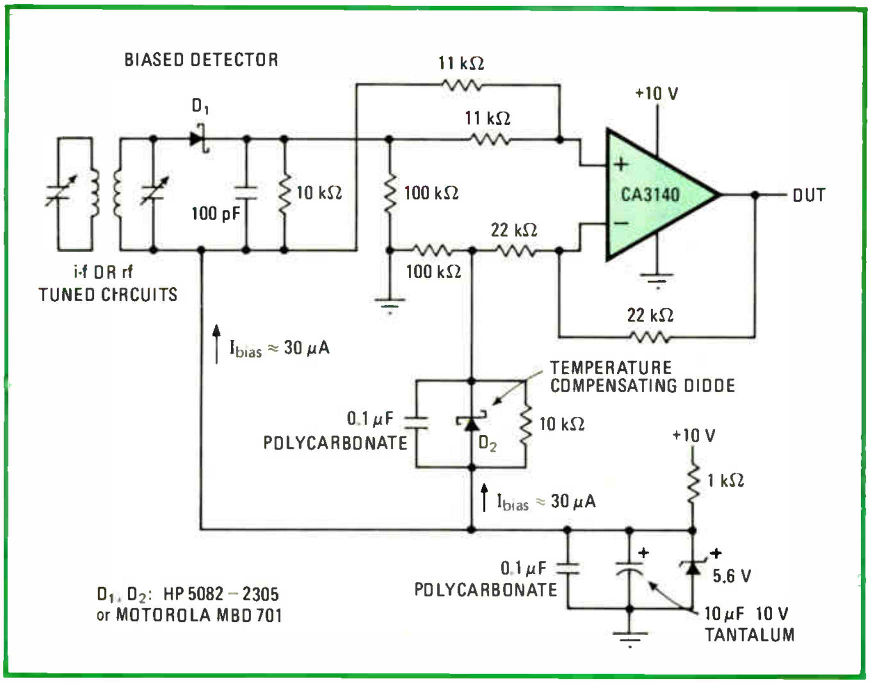
Biasing the diode improves a-m detector performance

by Antonio L. Eguizabal
Vancouver, British Columbia, Canada

The sensitivity, dynamic range, and linearity of a standard amplitude-modulation diode detector improve if the diode is biased into its conducting region. Sensitivity and dynamic range increase because the incoming radio-frequency signal does not encounter the barrier-potential voltage of the diode before the onset of rectification. Linearity improves because the biasing voltage shifts the operating point of the diode into the linear portion of its characteristic curve.

As shown in the figure, signals are applied to D_1, a Schottky diode that can be used at frequencies approaching 1 gigahertz. It has a low barrier potential (0.35 volt), about one half that of conventional silicon diodes, and allows linear operation at a lower biasing voltage than is possible with conventional diodes.

A 5.6-v zener and the voltage divider composed of the 10-kilohm resistor and D_1 send 350 mv across D_1, making it conduct. The voltage drop across D_1 is in effect eliminated for rf signals, making possible the detection of millivolt-level signals. The demodulated signal appears across the resistance-capacitance filter



Tweaked detector. Even the old reliable a-m detector can be improved. Increased sensitivity, linearity, and dynamic range are obtained by dc biasing diode D_1 into conduction, to eliminate voltage drop as seen by rf driver. D_2 provides temperature compensation.

MICROPROCESSORS:

WHERE THEY CAME FROM AND WHERE THEY ARE GOING

AN ANALYSIS OF ALL PRODUCTS ON THE MARKET TODAY

This seminar will be given by Dr. Adam Osborne at the Personal Computing Conference '77 in Atlantic City, at the Shelburne Hotel, from 9:00 a.m. to 4:00 p.m. The course will be offered twice, once on Friday, August 26th and the second time on Saturday, August 27th.

The cost of the one-day seminar is $30.00. This fee includes lunch.

During the first hour the origins of the various types of microprocessors on the market today will be identified. This introduction will cover some of the less well known, but critical circumstances surrounding the companies and products that first appeared. This introductory background is very important; in addition to defining the origins of microprocessors on the market today, it explains why many microprocessor strengths and weaknesses are the result of luck or inexperience on the part of designers and manufacturers.

The next four hours of the seminar are devoted to highlighting the important characteristics of all common 8-bit and 16-bit microprocessors on the market today, together with their support devices. In order to cover this formidable range of material in such a short time, the 8080A microprocessor is used as a frame of reference. Each microprocessor is described in terms of its signal interface, CPU architecture and instruction set. The justification for support devices is given, together with the effectiveness of each implementation. When microprocessors are compared with the 8080A, conceptual and functional differences are emphasized. In addition, other microprocessors are compared to each other where they compete, or where they have been directly influenced by a device other than the 8080A. The purpose of this four hour session is to describe the important characteristics of each microprocessor so that the types of application best suited to each microprocessor may be identified, and the types of application where the choice of microprocessor is virtually irrelevant are easily understood.

During the last hour of this seminar the status of the microprocessor industry today and the directions it is taking in the coming year will be defined. This discussion will cover sales volumes of various microprocessors on the market today, plus products planned by various manufacturers in the coming year. The customer base for microprocessors will also be described, since this is one area where supposedly knowledgeable industry observers have been proven completely wrong. As the microprocessor industry matures, we are seeing a customer profile emerge that differs markedly from the customer profile which was anticipated by manufacturers a year ago. This is having important repercussions on the economic fortunes of companies who are participating in the microprocessor and related industries.

Dr. Adam Osborne is the author of "An Introduction To Microcomputers: Volume I — Basic Concepts" and "Volume II — Some Real Products". Dr. Adam Osborne also wrote "8080 Programming For Logic Design" and "6800 Programming For Logic Design". The two-volume "An Introduction To Microcomputers" series are the standard texts used throughout the microcomputer industry. "An Introduction To Microcomputers: Volume I — Basic Concepts" currently holds the world's record in sales volume for any text sold for a profit.

Dr. Osborne's insights into the microprocessor industry have been gained by working with manufacturers and users of microprocessors while researching and updating the "An Introduction To Microcomputers" series of books. "Volume II — Some Real Products" describes nearly every microprocessor and support device on the market today; writing this book has provided Dr. Osborne with a critical knowledge of the parts described, and of the companies which manufacture these parts. The close contacts Dr. Osborne has with all manufacturers allows him to estimate quite accurately sales volumes, customer bases and future trends.

OSBORNE & ASSOCIATES, INC.

P.O. Box 2036
Berkeley, California 94702
(415) 548-2805

composed of the 100-picofarad capacitor and the 10-kilohm resistor.

Most diode detectors are used in conjunction with automatic-gain-control circuits to produce a constant audio output over a wide dynamic range. To ensure minimum response time of the diode detector, which is required when driving the agc, direct coupling between the two is necessary. Temperature compensation is therefore needed to eliminate drift caused by small temperature-dependent offset voltages.

A second Schottky diode and an operational amplifier, the CA3140, provide this function. Diode D_2 is biased similarly to D_1, with the result that voltage changes caused by temperature variations are almost identical across both devices. The CA3140 operates as a unity-gain wideband amplifier. It has a high common-mode rejection ratio and draws low input-biasing currents, qualities required in a good buffer amplifier.

The noninverting port of the op amp accepts the demodulated signal from the RC filter. The temperature-variable voltage drop across D_1 tends to increase the output voltage, but this is countered by an identical voltage across D_2 at the inverting port. Thus the net voltage change at the output as a function of temperature is approximately zero. Note that the op amp is operating with a single-ended power supply, which assures that D_2 is used in a temperature-compensating capacity only and does not upset the operation of the rf detection circuit.

This detection circuit can respond to a 10-mv rf input signal, and its dynamic range is 10 to 15 decibels greater than that of conventional diode detectors. In addition, the linearity of the circuit, especially at low levels, is noticeably better. □

Maximum voltage detector needs no a-d conversion

by Ronald Lumia
University of Virginia, Charlottsville, Va.

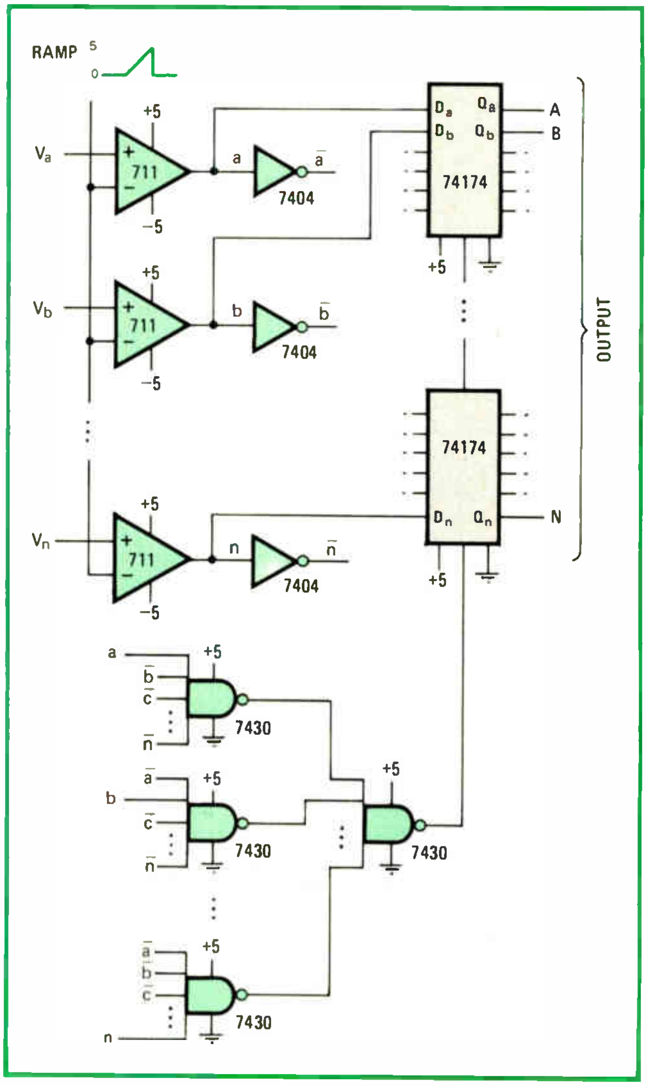
A detector that determines which of a set of analog voltages has the greatest positive value is useful for pattern-recognition systems and other classifying schemes. Only the relative magnitude of the input voltages is important in these applications, so that costly analog-to-digital converters are not needed.

As shown in the figure, a sample set of voltages is introduced at the noninverting port of a bank of 711 dual differential voltage comparators, which initially switch each amplifier high. All inverting inputs are driven by any monotonically increasing waveform, such as a ramp voltage.

Each comparator switches into the low state as the ramp voltage exceeds the particular sample voltage connected to its input, until only one comparator remains in the high state. The signal at this op amp input has the greatest amplitude in the sample set.

The combinational logic at the 7430 NAND gate array then generates a pulse to the 74174 device, clocking the lone logic 1 signal from the op amp input into the D input of its associated flip-flop and presenting it to the processing device. By this time, the ramp voltage has returned to its minimum value, and the next sample set may be again introduced.

As shown, the range over which the sample-set voltages may be detected lies between zero and 5 volts. This range may be changed by suitable adjustment of the ramp and supply voltages to the comparators. The use of complementary-metal-oxide-semiconductor logic circuits is advised when the operating voltage to the comparators exceeds 5 volts. □



Maximum-voltage detector. Relative maximum of sample set $V_1 - V_n$ is determined by ramp generator and logic circuit. Sample voltages drive all comparators high if values lie above the minimum ramp voltage. Logic detects lone op amp remaining high during the ramp sweep and clocks that state to its D flip-flop.

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.

Countering the effects of vibration on board-and-chassis systems

A simple analysis tells the electronics designer whether the circuit boards in his system will need strengthening against vibration stress

by David S. Steinberg, *Singer Corp., Kearfott Division, Wayne, N. J.*

☐ At some time in its life cycle, all electronic equipment encounters some form of vibration, at the very least when transported from manufacturer to customer. This vibration can cause fatigue failure in consumer systems, as well as in military or industrial systems, unless the electronics engineer has analyzed the design for its vulnerability to vibration stresses and built in an adequate safety margin against them.

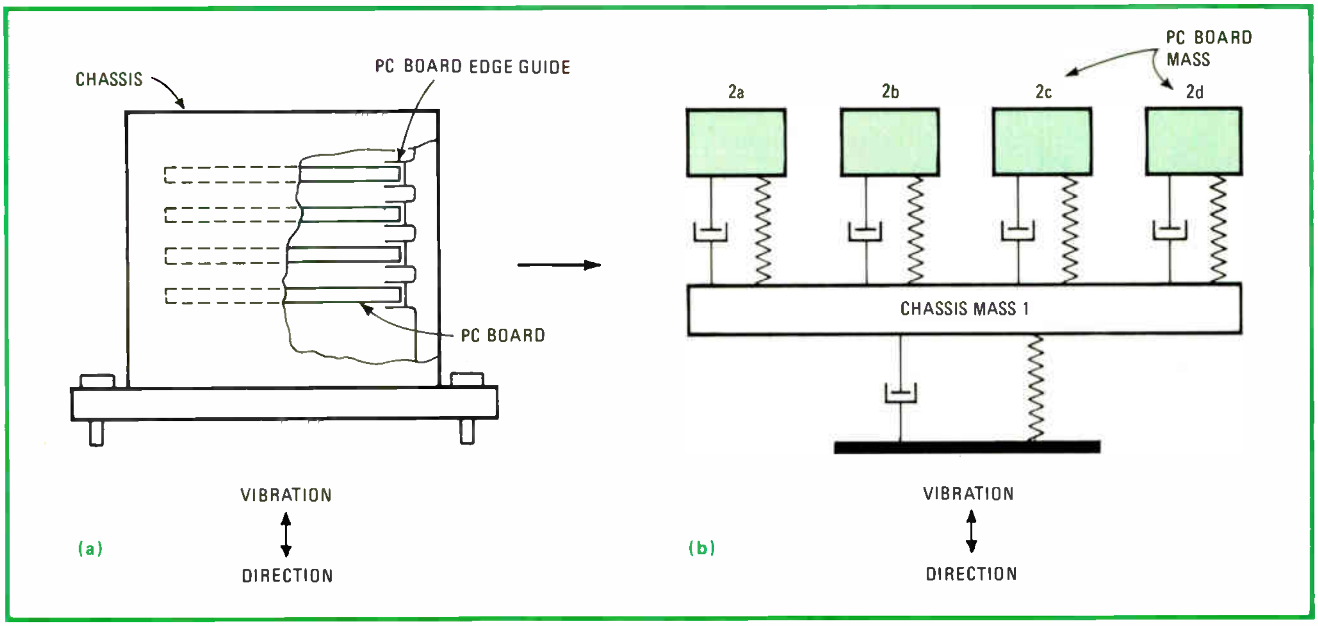
The procedure is straightforward. It involves basic vibration theory, which is not normally part of the electronics curriculum. But "A guide to vibration analysis" on page 102 explains the concepts involved, and the rest of this article tells how to combine these concepts into simple design rules for application to a board-and-chassis package.

The basic building block of today's electronic system is the easily serviced, plug-in printed-circuit board. These boards are mainly rectangular, epoxy-glass units with plated copper wiring. In general, a pc board acts like a flat plate in a vibration environment and is subject to fatigue failures, particularly at board resonance. Vibration fatigue failures in these boards usually take the form of broken leads, broken solder joints, and broken connectors. In extreme cases, parts have actually flown off a board under high vibration forces.

Applying the octave rule

Fatigue failures of these kinds can often be prevented by insuring that the boards and the chassis have different resonant frequencies. The goal is to avoid coincident resonances (see p. 102), which can amplify acceleration (g) forces in adjacent structural elements very rapidly. For example, if the resonant frequency of a chassis is too close to that of a circuit board within the chassis, high acceleration forces may develop in the board. High accelerations produce large deflections resulting in stresses that can culminate in rapid fatigue failures.

To illustrate, the chassis and the multiple plug-in boards of Fig. 1a will behave like a system capable of vibrating along more than one axis simultaneously—in other words, like a system with multiple degrees of freedom (see p. 102). The chassis usually represents the first-degree-of-freedom system for externally induced



1. Vibrating boards. A chassis with plug-in printed-circuit boards (a) has the equivalent mass spring analog of (b). The boards represent a second-degree-of-freedom system with respect to the chassis, since dynamic forces must be transmitted through the chassis to the boards.

vibrations. The boards represent the second degree of freedom with respect to the chassis since the dynamic forces must pass through the chassis before they reach the pc boards.

Coincident resonances can generally be avoided in multiple-degree-of-freedom systems by following the octave rule. This rule states that in a series spring mass system (see p. 102), the natural frequency of an element should be doubled for each additional degree of freedom in order to avoid severe resonant amplifications caused by a coincident resonance. Thus in Fig. 1b if the natural frequency of the chassis (mass 1) is 100 hertz, the natural frequency of each pc board (masses 2a, 2b, 2c, and 2d) should be at least twice that, 200 Hz or higher if possible. This separation of resonances prevents the chassis resonance from amplifying the pc board resonance, which in turn reduces the dynamic stresses and increases the fatigue life of the system.

Where to begin

What is the best starting point for a vibration analysis of the packaging configuration of Fig. 1? Should the natural frequency of the chassis or the pc board be determined first?

Experience, along with extensive analysis and testing, favors starting with the pc board. Tests have shown that it is possible to provide a long fatigue life (greater than 10 million cycles) for plug-in pc boards by basing the requirement for the maximum dynamic single-amplitude displacement (Y) of a rectangular board on the length of the shorter side (b) of that board. The displacement relation is shown by the equation:

$$Y_{max} = 0.003\ b \qquad (1)$$

For example, the maximum dynamic single-amplitude displacement at the center of a rectangular pc board measuring 4 by 7 inches should be limited to a Y_{max} of 0.003×4.0 in. or 0.012 in.

To provide a good fatigue life, Eq. 1 is based upon the dynamic stresses that are developed in the lead wires of the electronic components mounted on the board. As the board vibrates up and down during a resonant condition, it forces the electrical wires on the components to bend back and forth, as shown in Fig. 2.

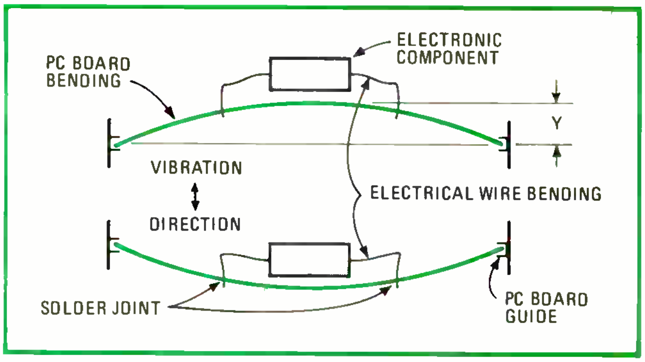
For a rectangular board, the most severe condition will occur when the body of the component is parallel to the shorter side of the pc board and at its center. The shorter side must have a more rapid change of curvature than the longer side because the displacement at the center is common to both.

The actual dynamic single-amplitude displacement of a single spring mass system can be determined from:

$$Y = 9.8\ g\ Q/f^2 \qquad (2)$$

where g is the acceleration force in gravity units, f is the sinusoidal vibration frequency, and Q is the transmissibility of the vibration from one element to the next (see p. 102).

Vibration test data on plug-in types of pc boards has shown that they act very much like a single-degree-of-freedom system when they are vibrating at their natural or fundamental resonant frequency. This test data shows



2. Over the waves. During a resonant vibration, a printed-circuit board moves up and down. These excursions can break leads and solder joints and even cause components to fly off.

that the approximate transmissibility for many different types of pc boards can be determined from this frequency, f_n:

$$Q = A\ (f_n)^{1/2} \qquad (3)$$

where A is a dimensionless empirical constant dependent on the natural frequency, f_n, and acceleration inputs.

A large number of factors influence the transmissibility of a plug-in board. These factors will vary from one manufacturer to another because they each use different construction methods. Other variations include the component size, type of edge guides, type of electrical plug-in connector, conformal coating, and acceleration force.

Given acceleration inputs that vary from about 3 to 10 g, the value of A in Eq. 3 appears to be about 1.0 for pc boards with resonant frequencies between 100 and 400 Hz, drops to about 0.70 for boards with lower resonant frequencies between about 50 to 100 Hz, and rises to about 1.40 for those with resonant frequencies between about 400 to 700 Hz.

Equations 1, 2, and 3 can be combined to establish the minimum natural frequency required by a pc board for a long vibration fatigue life as:

$$f_n = (9.8\ gA/0.003\ b)^{2/3} \qquad (4)$$

As an example of how to use this equation, suppose a typical plug-in printed-circuit board is required to have a long fatigue life—10 million fatigue cycles at its resonant frequency. Suppose also that the board has 5-by-8-inch dimensions and must operate in an electronic system that will be subjected to a prolonged sinusoidal vibration environment of 6.0 g peak over a frequency range of 100 to 1,000 Hz. What needs to be determined is the minimum required pc board natural frequency plus the maximum allowable chassis natural frequency.

Start by assuming the value of A is 1.0, to see where the pc board resonant frequency will be. From the above data, g = 6 and b = 5. Substituting these values in Eq. 4, the minimum required pc board resonant frequency becomes:

$$f_n = \left[\frac{9.8 \times 6.0 \times 1.0}{0.003 \times 5.0}\right]^{2/3} = 248\ \text{Hz}$$

Since the board's resonant frequency is between 100 and

A guide to vibration analysis

Any discussion of vibration will involve references to degrees of freedom, transmissibility, coincident resonances, and series spring mass systems.

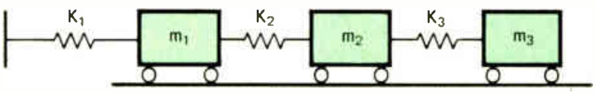
The **degrees of freedom** of a vibrating system describe the coordinates necessary to locate the position of the vibrating element at any time. For example, a single-degree-of-freedom system can move along only one axis, in both directions. A two-degree-of-freedom system will require two coordinates to describe the position of the elements. A multiple-degree-of-freedom system generally has many elements that can move along many axes.

The **transmissibility** of a vibrating system is usually defined as the ratio of the maximum output force divided by the input force at a given frequency, or the maximum output displacement divided by the input displacement at a given frequency. In a lightly damped system, the maximum output force can easily be 100 times the input force. Such a system would have a transmissibility of 100. If a printed-circuit board has a maximum vibration input displacement of 0.001 inch at its edges at a frequency of 180 hertz, and the center of the board has a maximum vibration of displacement of 0.100 in. at its center at the same frequency, then the board has a transmissibility of 0.100/0.001 or 100.

A **coincident resonance** is a condition where two systems are joined together (or coupled) and both systems are vibrating near the resonant frequencies at the same time. It often happens that the amplified output from the first system turns out to be the input to the second system, which amplifies that input a second time. If the transmissibility of the first system by itself is about 50, and if the transmissibility of the second system by itself is about 50, the joint (or coupled) transmissibility of the second system can approach about 50 × 50 or 2,500. If this happens in a real system, and it often does, the fatigue life is very short.

A **series spring mass system** consists of several springs and masses attached to one another, in a string-like manner. Any force or motion in the outermost member must pass through each adjacent member until it reaches the support. The figure shows a series system with three springs and three masses.

Of course, an electronic box does not really have springs and masses bouncing around during vibration—the springs and masses are used only as mathematical models, to simulate a system that will have vibration characteristics similar to the box. The mathematics associated with a spring and mass system is relatively simple compared to the mathematics required to analyze a complete box. The simplified mathematics permits a quick evaluation to be made of the structure supporting the electronics, to see how well it will hold up under the pounding it receives in a vibrating environment.



400 Hz, the assumed value of 1.0 for A is valid.

The natural frequency of the chassis that supports the pc board must also be established in order to prevent higher transmissibilities from developing in the board. Following the octave rule, the maximum natural frequency of the chassis must not exceed one half the natural frequency of the pc board, in this case, 124 Hz.

Finding that the pc board's minimum resonant frequency should be 248 Hz is only half the solution. It is still necessary to determine its actual natural frequency. Knowing the weight and thickness of the board of Fig. 3, it is possible to determine board natural frequency:

$$f_n = \frac{\pi}{2}\left[\frac{D}{\rho}\right]^{1/2}\left[\frac{1}{a^2} + \frac{1}{b^2}\right] \qquad (5)$$

where D is the plate stiffness factor in pound-inches, ρ is the mass per unit area of pc board, a is board length, and b is board width.

The equation for plate stiffness factor is:

$$D = Eh^3/12(1-\mu^2) \qquad (6)$$

where E is the epoxy Fiberglass modulus of elasticity, h is board thickness, and μ is Poisson's ratio for the board. In this example, $E = 2.0\times10^6$ lb/in.^{2}, h = 0.090 in., and $\mu = 0.12$, so that:

$$D = (2.0\times10^6\times0.090^3)/12(1-0.12^2) \text{ lb in.}$$
$$= 123.3 \text{ lb in.}$$

The equation for mass per unit board area is:

$$\rho = W/gab$$

so that for the 0.5-lb, 5-by-8-inch board, W = 0.5 lb, a = 8 in., and b = 5 in., and acceleration due to gravity, g = 386 in./s^2:

$$\rho = (0.5)/(386\times8\times5) \text{ lb s}^2/\text{in.}^3$$
$$= 3.24\times10^{-5} \text{ lb s}^2/\text{in.}^3$$

Substituting the values of D and ρ in Eq. 5:

$$f_n = \frac{\pi}{2}\left[\frac{123.3}{3.24\times10^{-5}}\right]^{1/2}\left[\frac{1}{8^2} + \frac{1}{5^2}\right]$$

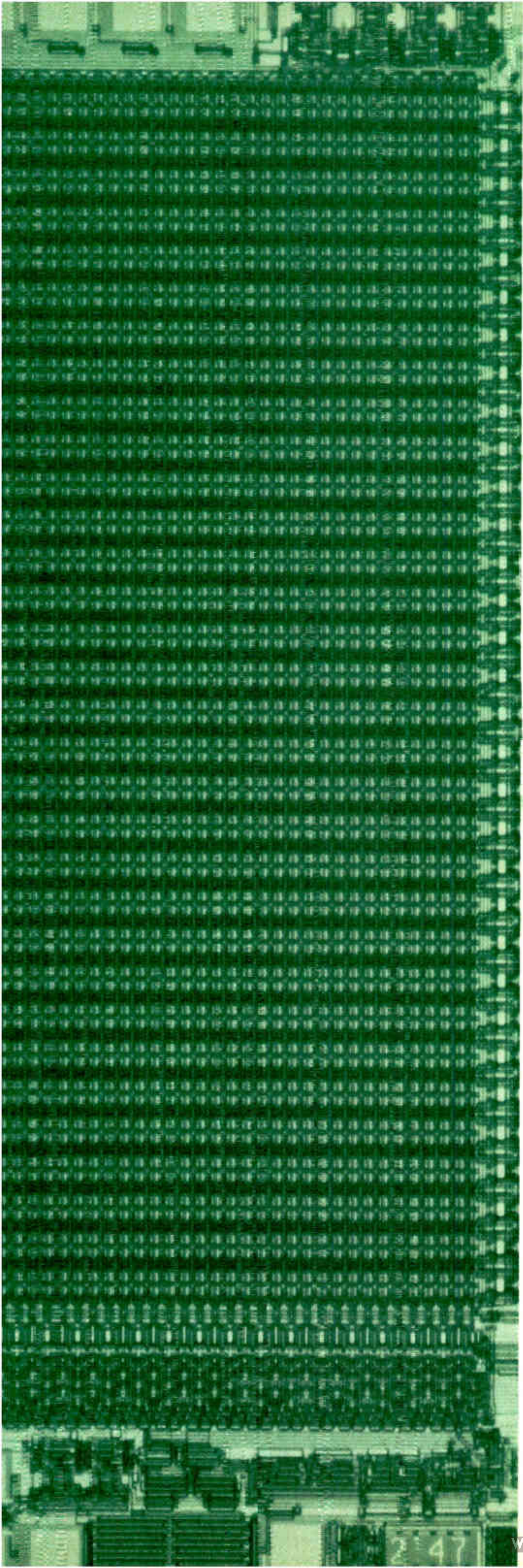
$$= 170.4 \text{ Hz}$$

Use of Eq. 5 results in a board natural frequency of only 170.4 Hz, which is below the minimum required natural frequency of 248 Hz. This design is not satisfactory, and its natural frequency must be increased. If pc board thickness is increased to 0.125 in., the natural frequency will be increased to 287.7 Hz, which is satisfactory. If for some reason the pc board thickness cannot be increased, then ribs can be added to stiffen the board. A single vertical rib 0.090 in. thick and 0.250 in. high can be made of epoxy Fiberglass and cemented across the center of the board parallel to the 5.0-in. dimension. This would raise the natural frequency to 275 Hz, creating a satisfactory solution for the vibration environment.

A design of this type might take perhaps one man-day, but it could eliminate many hours of time in the field spent servicing vibration-caused failures. □

Bibliography

David S. Steinberg, "Vibration Analysis for Electronics Equipment," John Wiley & Sons, New York, N.Y. 1973.



Speedy RAM runs cool with power-down circuitry

Static RAM's low-power standby mode minimizes memory system dissipation

by Richard Pashley, William Owen, Kim Kokkonen, and Anne Ebel, *Intel Corp., Santa Clara, Calif.*

☐ A new form of computer data storage—fast mainframe memory—is heralded by a new high-density, fully static random-access-memory chip that blends high speed at the chip level with low power dissipation at the system level. This marriage is accomplished in the 2147, a 4,096-bit static RAM that combines a high-performance metal-oxide-semiconductor technology (H-MOS) with circuit innovation to attain a new power-down mode.

The H-MOS process gives the 2147 access and cycle times competitive with bipolar technology—typically 45 nanoseconds—and superior speed-power performance. But the real key to the RAM's practical use in large, fast memory systems is its unique power-down capability.

Raw speed has always been restricted to use in scratchpads and other small memory systems, where cooling problems are not severe. However, building compact main memories and cache memories into computer mainframes requires modules containing high-density RAM arrays and, often, closely stacked memory boards. The 2147 provides a new way of minimizing power dissipation that makes this construction practical. It also will further simplify design of small systems.

The 2147 goes on standby automatically when the chip is deselected. Its typical power dissipation drops from 500 milliwatts to only 50 mw. More important, for a rock-solid memory design, worst-case dissipation drops from 880 mw to 100 mw, compared with a watt or more of continuous power dissipation for conventional bipolar static RAMs. These power ratings are for the standard 2147, which has a maximum access time of 70 nanoseconds and an identical cycle time. For higher-performance applications, a premium part is offered with a 55-ns worst-case access-cycle-time specification.

There is no access-time penalty for the low-power standby feature. The access time from chip select (power up) is equivalent to the access time from an address transition with the chip previously selected. Chip select has no special timing requirements: it can come up before, after, or coincident with address change.

Since the fraction of the RAMs selected during any given cycle in a large system can be small, using chip select to control power down and power up gives the system designer a simple means of solving power distribution and cooling problems. That is, modules containing large numbers of RAMs will operate at much lower average power than small modules, and the system designer can easily keep a low power density throughout the system. Equally important, the mode does not sacrifice access time or complicate design.

Breaking with tradition

Bipolar RAMs have dominated high-speed memory design since the dawn of semiconductor memory technology in the 1960s. However, they are costly and very power-hungry, all but ruling out use in large, fast, mainframe memories.

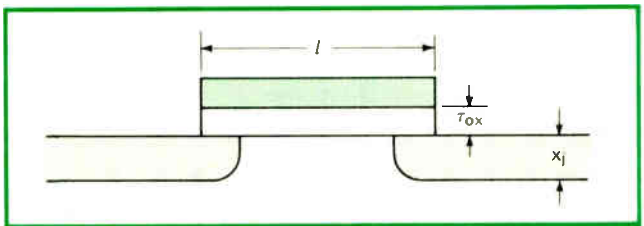


TABLE: MOS TECHNOLOGY EVOLUTION

Parameter	MOS, 1976	H-MOS, 1977
Channel length, l (μm)	6	< 4.0
Gate-oxide thickness, τ_{ox} (Å)	1,100	< 1,000
Junction depth, x_j (μm)	1.7	1.0
Depletion loads	yes	yes
Oxide isolation	no	yes
Built-in substrate bias	yes	yes
Speed-power product (pJ)	4.0	1.0

Generally, MOS devices have been used for main memory. They enjoy an edge in speed-power products but were unable to approximate bipolar speed until recently. Some early MOS RAMs that attempted to compete with transistor-transistor-logic static RAMs in the under-100-ns market required multiple power supplies and clocked chip-enable operation.

The 2147 offers the speed, compatibility, and simplicity of a static bipolar RAM built with TTL circuitry, yet provides the low power of MOS. It is the first high-speed RAM with this combination of features.

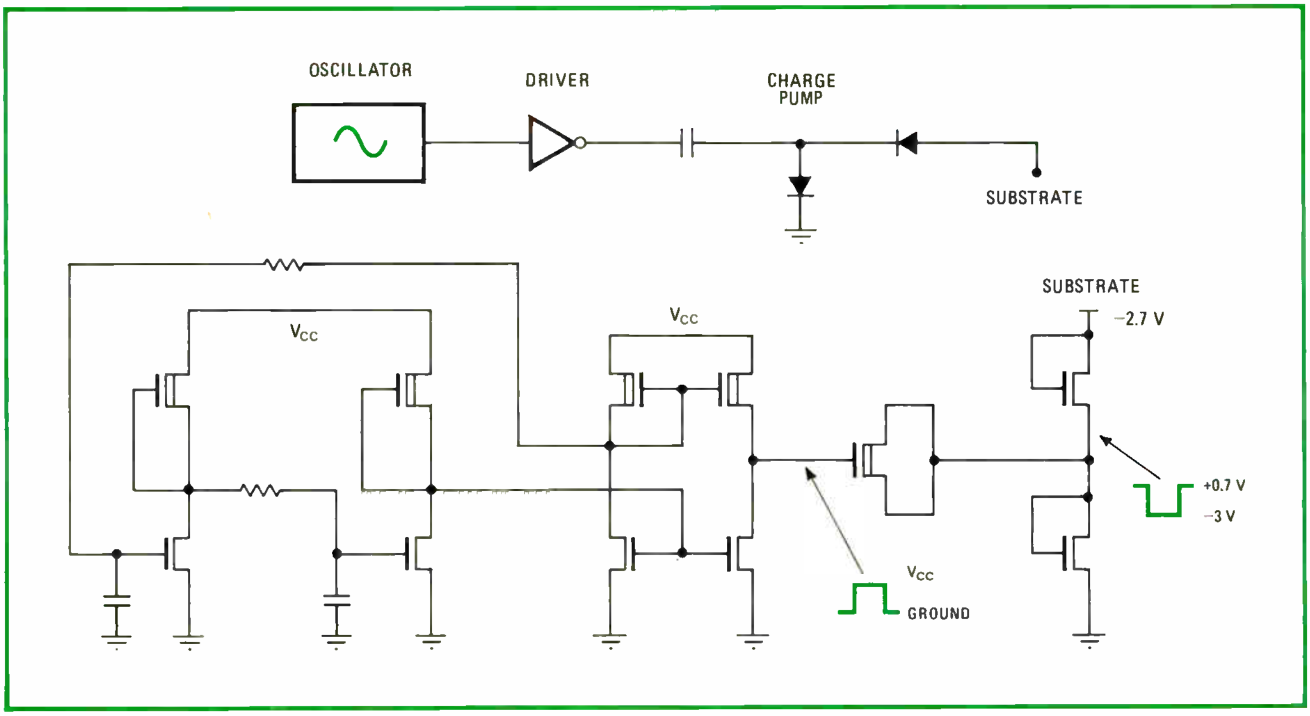
Moreover, the device is extremely easy to use. It operates on a single +5-volt supply like TTL devices and is designed so that a supply with 10% tolerances may be used. Input/output levels are also TTL, and unlatched inputs and outputs ensure simple, static timing.

The output typically sinks 25 milliamperes at 0.45 V and sources 15 mA at 2.4 V—ample current to eliminate output drive and sensing problems. Further, valid operation is guaranteed with input swings as small as 0.8 V to 2.1 V. Finally, the 2147 has an industry-standard 4,096-by-1-bit configuration and is packaged in a standard 18-pin dual in-line package.

H for high performance

H-MOS technology reduces the physical parameters of n-channel, silicon-gate MOS to new lows. It combines device scaling with on-chip substrate bias generation. This results in higher density and a 4:1 improvement in the speed-power product (see table) making the 2147 chip the smallest and fastest of the emerging generation of 4-k MOS static RAMs.

By reducing the physical parameters of the device by a fixed scaling factor, circuit density and performance were increased while active circuit power decreased. In



1. Getting back bias. To minimize the substrate's body effect, this on-chip back-bias circuit has a self-starting oscillator driving a charge pump that is capacitively coupled to the substrate. The oscillator runs at 13 MHz to maximize the pump's efficiency.

the H-MOS process, polysilicon gate lengths have been shortened to less than 4 micrometers and gate-oxide thickness to less than 1,000 angstroms. Using arsenic as the source-drain gives shallow junctions (<1μm). Circuit performance and density improve still further with use of oxide-isolation and depletion-load processing. Finally, substrate biasing reduces body effect and parasitic junction capacitance—the back-bias voltage is generated on board to eliminate the requirements for an additional pin and power supply.

As a result of these design factors, the power figure of merit is 1 picojoule (in an 11-stage ring oscillator with a per-stage fan-out of 3). Conventional 6-μm-gate n-channel MOS has a 4-pJ speed-power product.

Biasing the chip substrate

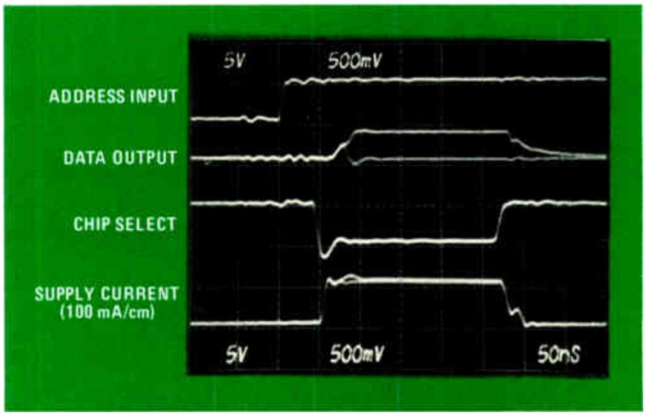
As device elements shrink and make substrate effects more noticeable, reverse or back biasing becomes more important for device performance. The 2147's on-chip bias voltage is self-regulating, so it needs no special regulation circuitry. Also, it tracks fluctuations in the 5-V supply, temperature changes, and process variations.

The circuit typically generates −3 V back-bias voltage and consumes 7 mW. It consists of a self-starting oscillator driving a small charge pump that is capacitively coupled to the chip substrate (Fig. 1). Its 13-megahertz frequency was selected to optimize the efficiency of the charge pump. The oscillator is inherently unstable—deliberately not balanced—to assure self-starting under all conditions. The charge pump is small—about the area of two or three bonding pads—since the generator's only current drain is substrate leakage.

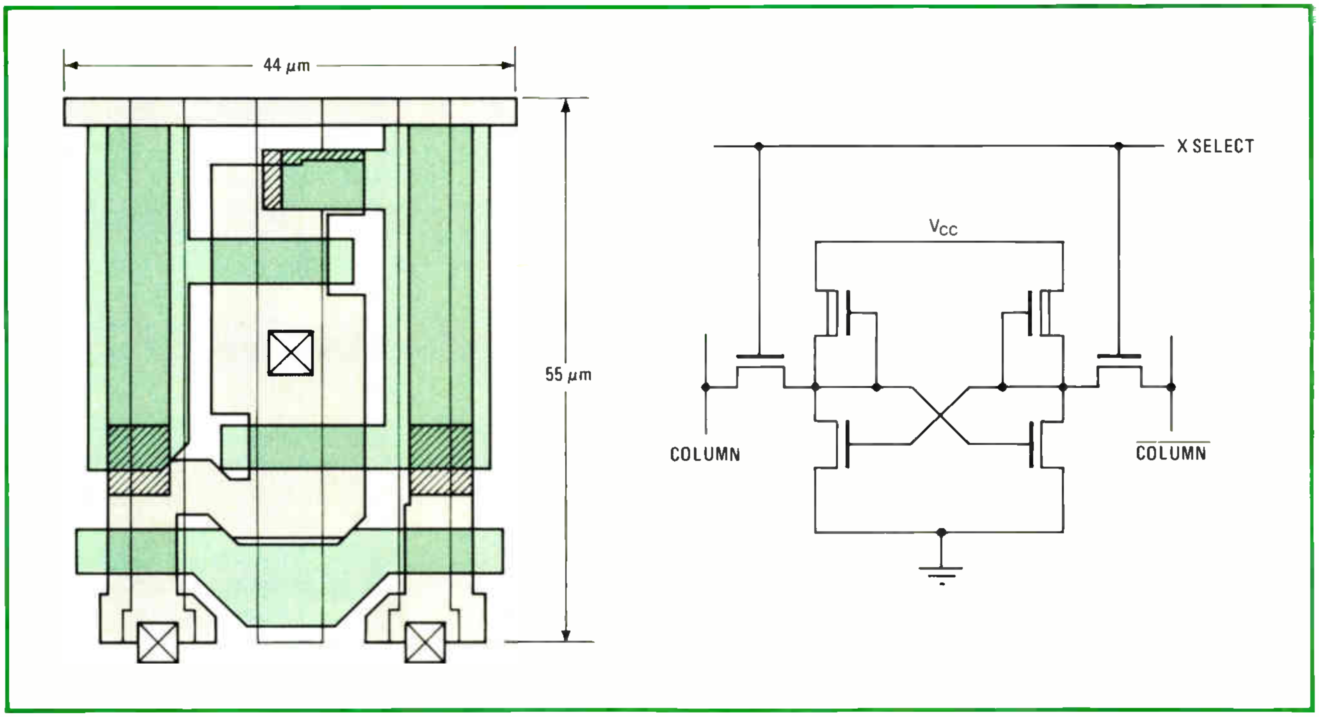
The chip's substrate diffusion capacitance is large enough to absorb the effect of momentary substrate-current spikes. Input coupling and internal node switching during memory accesses cause back-bias differentials of less than 100 millivolts.

A glance at the cell schematic (Fig. 2) indicates that the 2147 is still a fully static RAM like its grandparent, 1,024-bit 2102A. The cell is a conventional, six-transistor, cross-coupled flip-flop that uses depletion-load devices. It occupies only 3.75 square mils. Typically, it dissipates 5 microwatts of power, giving a power dissipation for the full 4-k memory array of 20 mW.

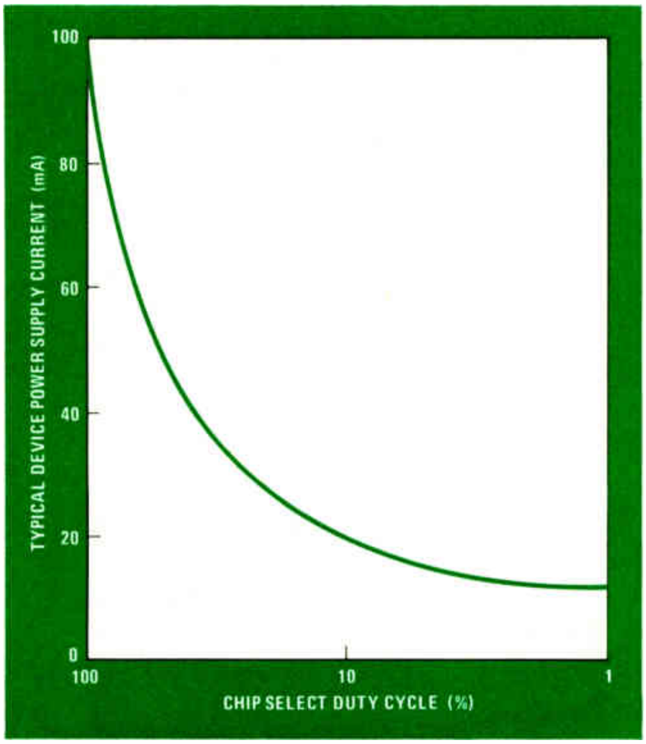
The memory is organized as a 4,096-by-1-bit RAM, although internally it is organized as two 32-by-64-bit subarrays with a common row decoder separating them. The die size measures 25,004 mil^2 (133 by 188 mil). The device contains all the buffers, decoders, and write circuitry needed for complete fully static TTL operation. The decoders are conventional depletion-load NOR gates



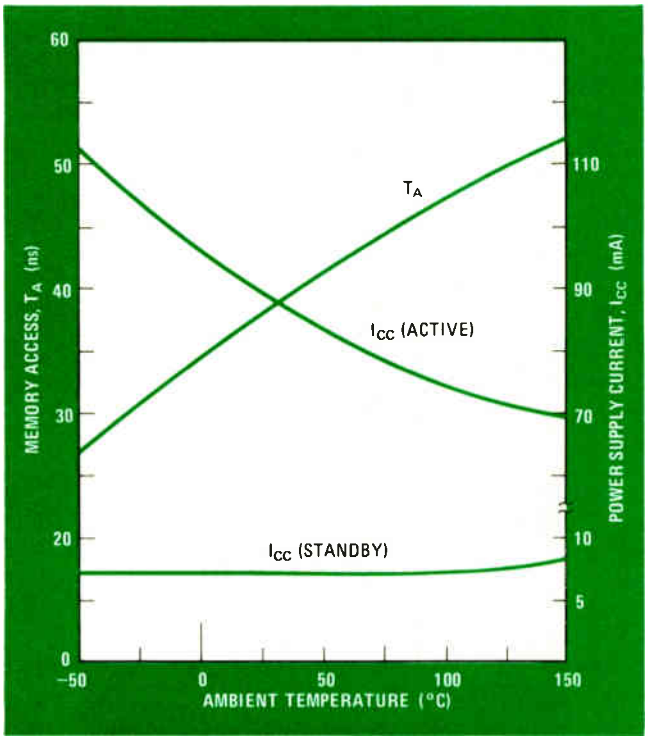
3. Quick and steady. The 2147 is fast, with the data output beginning to appear 40 ns after the address input goes up. No spikes appear in the supply current trace after power down; power is simply switched off in all but the essential circuit blocks.



2. The cell. While the 2147's cell is a conventional six-transistor design, the innovative H-MOS process reduces its size to half that of ordinary static RAM cells. The cross-coupled flip-flop design lays out in only 3.75 mil^2 and points to future H-MOS static RAMs of even greater density.



4. Saving energy. For large memory systems that operate at low duty cycles, the 2147 saves power, as the device's typical supply-current characteristic shows. At 10% duty cycle, the part burns only 20% of the supply current it uses at full duty cycles.



5. Standing by. While the 2147's performance—its access time—gets worse as expected at elevated temperatures, a useful feature of the part is its ability to maintain an almost constant standby current value over a wide ambient-temperature range.

with a power-down switch in the power-supply line. The input buffers are similar to those of the 2102A—a simple string of inverter gates driving two push-pull output stages. The RAM requires no clocks or internal precharging to attain its high performance. Using simple static circuitry in the periphery means that more than 60% of the chip area is memory array.

Circuit operation

Like other fully static RAMs, the 2147 can perform multiple read/write operations during a single chip-select cycle. However, with a fully static standby mode, it features two distinctly different read/write cycles: the address-access cycle and the chip-select-access cycle.

In the address-access cycle, the chip, selected previous to address change, operates just like a conventional static RAM. Address information is buffered to the decoders, the cell selected, and the data rippled through to the output. The device's power dissipation remains at a constant level throughout this read operation.

The new chip-select-access mode chip can control the device's power dissipation as well as initiating read operations. When the 2147 is deselected, it dissipates about a tenth of its active power. The access time from chip select to output stage is equivalent to that of the conventional address-access operation. Thus, there is no access-time penalty for this low-power standby feature.

The internal circuit operation during chip-select access is very simple. In such a cycle, the address inputs are valid before, or coincident with, the chip-select timing. It takes about 5 ns internally for the chip-select signal to be buffered and to activate the address buffers. By the time the address inputs have been buffered, the row- and column-select decoders have been powered up About 30 ns from the start of the cycle the memory cell is selected and its data enters the column lines.

Since the 2147 does not contain column sense amplifiers, the memory cells drive the output buffer directly. The signal ripples through the output buffer and is presented at the output pin, typically 40 ns after chip select (Fig. 3). As expected for static circuitry, the device supply current smoothly ramps up to the active power level and stays flat until the chip is deselected.

At first glance, it would appear that the 5 ns lost in powering up the address input buffers would make chip-select access longer than address access. However, during power down all the differential nodes in the RAM are equalized as a direct result of the fully static techniques employed. By balancing the internal nodes, about 10 ns is shaved off the chip-select access time. In fact the chip-select access is typically 5 ns faster than address access (Fig. 3).

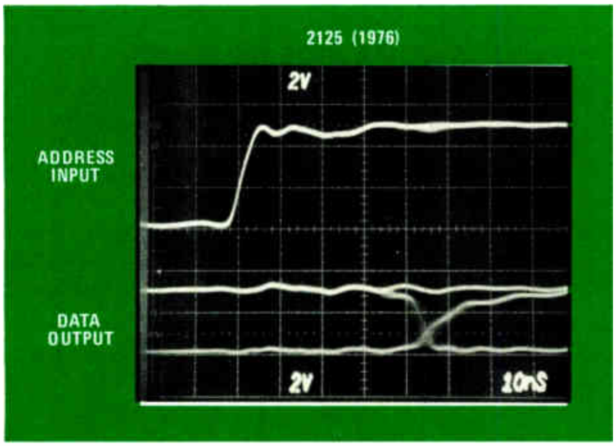
The novel standby feature was realized by utilizing the special MOS device characteristics of H-MOS. The power-down circuitry is fully static and requires no precharging or boot-strapping. Power is simply switched off in all but the essential circuit blocks. As a result, there are no power-up spikes or precharge spikes observed in the power supply current in a chip-select-access cycle. During standby, the memory array is completely deselected and the device output placed in the high-impedance state. To write into the 2147 the address inputs must be set up before the write-enable signal. Then the write operation will be completed, so long as

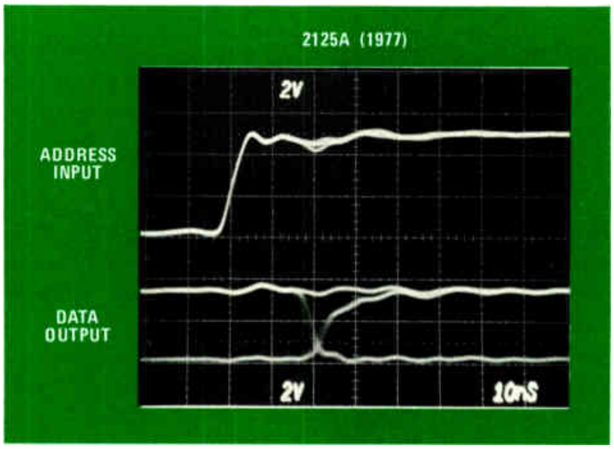
From development tool to product

The Intel 2125 random-access-memory was chosen as a test vehicle to evaluate the potential of H-MOS. During redesign in the new process, a simple 25% linear shrink was performed to take advantage of the improved density. For the same input signal, the typical access time for the data output of the H-MOS version is about half the value of the 2125 (see photographs).

The die size shrank from 18,496 square mils to 10,201 mil²—a 45% reduction. Furthermore, the performance of the 2125 improved from a typical access time of 45 nanoseconds to less than 22 ns, while the typical power dissipation at room temperature went from 325 milliwatts to 250 mW

The development work was so successful that it was decided to make this improved high-speed 1,024-bit RAM available as the 2125A. The open-collector version, the 2115A, is also available with a guaranteed 16-milliampere output-sinking capability. Both parts are specified with a worst-case 45-ns address-access time and 393-mW power dissipation level.





the data input is valid during the write-enable pulse. A short write recovery time is required before entering another memory cycle. In the write mode, the device output is in the high-impedance state.

Write cycles can be performed in the chip-select mode, as well. Chip-select and address changes are handled normally before write enable, and the write cycle proceeds from that point as usual.

Test and reliability

The 2147 is a simple fully static RAM, so it enjoys all of the testing and reliability benefits of a fully static design. The part has little or no pattern sensitivity and can tolerate a noisy system environment. Address inputs may be skewed and rise times different; access to the RAM will take the same time as it would if the addresses came up cleanly.

A common problem plaguing static RAMS is data retention. With recent technological innovations such as H-MOS, it is possible to reduce memory-cell power dissipation to less than 10 nanowatts. This low dissipation opens the door to low-power standby features, but the 2 nanoamperes of cell current present in such a mode comes uncomfortably close to the cell-junction leakage current at elevated temperatures. The testing problem is obvious: how to guarantee data retention over extended intervals at high temperature.

Depletion-load cells, as in the 2147, can be tested under conditions that will accelerate the retention-failure time of marginal devices. The test time is reduced by using conditions that will increase cell leakage currents (primarily junction leakage) without increasing the load-sourcing current at the same time.

The proof is in the test results established with the family of high-performing depletion-mode static RAMS: the 2147, the 2125A, and the 2115A (see "From development tool to product" above). In fact, the reliability of both the 2125A and 2147 is equivalent to that of the highly reliable 2115. One year's accelerated life test results for the 2125A/15A predict a failure rate of 0.02% for each 1,000 hours operation at 55°C, with a 60% confidence level. Preliminary results for the 2147 indicate that it has a similar reliability probability.

Designing systems

The 2147 has been designed for both large and small memory-system applications. The single-supply device in an 18-pin, dual in-line package yields higher board densities than other dynamic or static 4-k RAM designs.

For memory systems deeper than 4 kilobits, the standby feature results in a significant power savings to the user. For example, a memory 32,768 by 9 bits deep would typically dissipate 7,560 mw, while a conventional static RAM system would dissipate 36,000 mw. The larger the memory size and the slower the cycle time, the greater this difference becomes (Fig. 4). Specifying the 2147 reduces system power and cooling requirements, as well as improving system reliability.

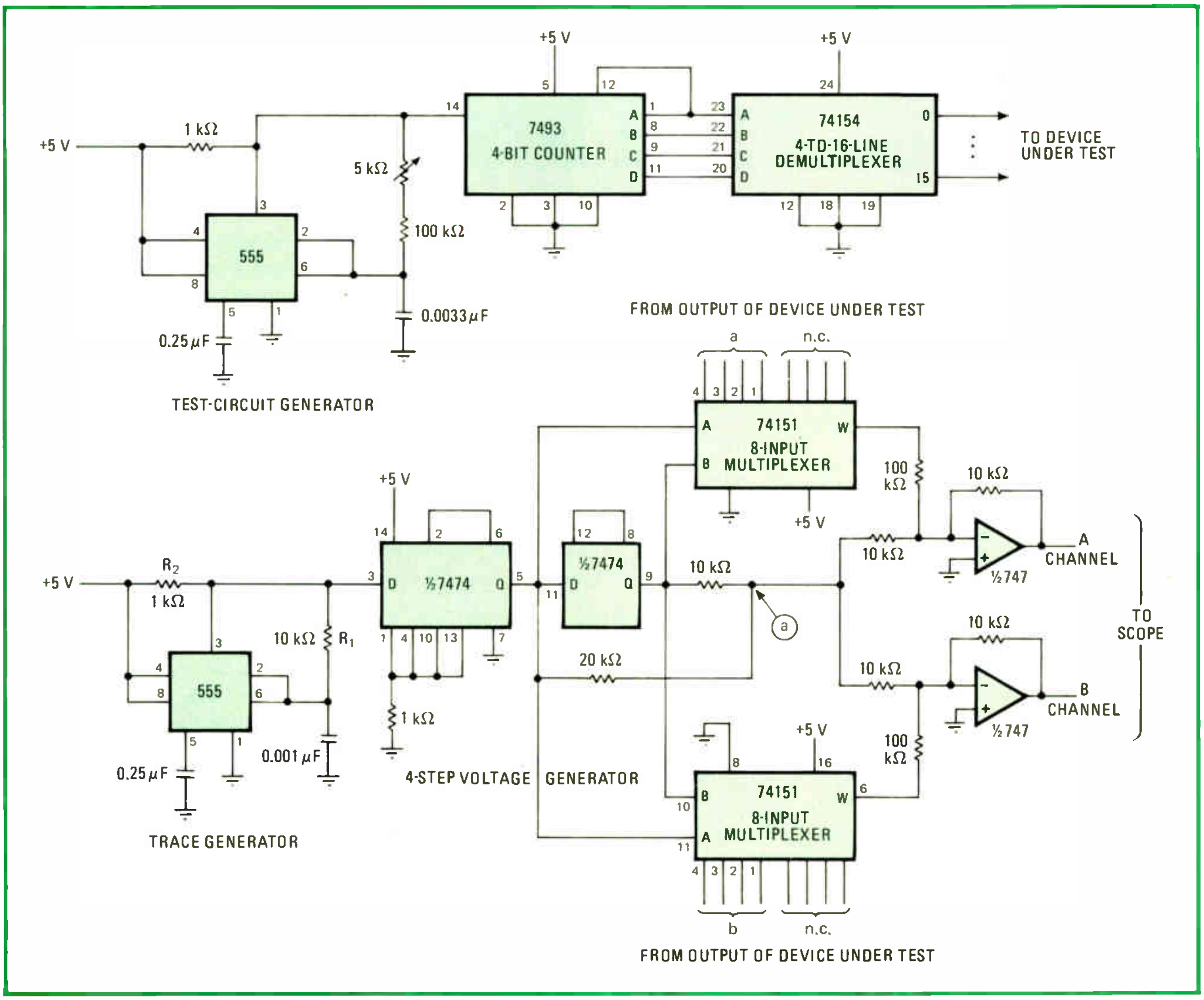
Like all MOS RAMS, the 2147's performance is sensitive to temperature. Both access time and active power vary widely over the military temperature range of −55°C to 150°C. However, it is significant that standby current is unaffected by temperature (Fig. 5). It remains at 8 mA over the entire military temperature range. □

Eight-trace scope display checks analog or digital signals

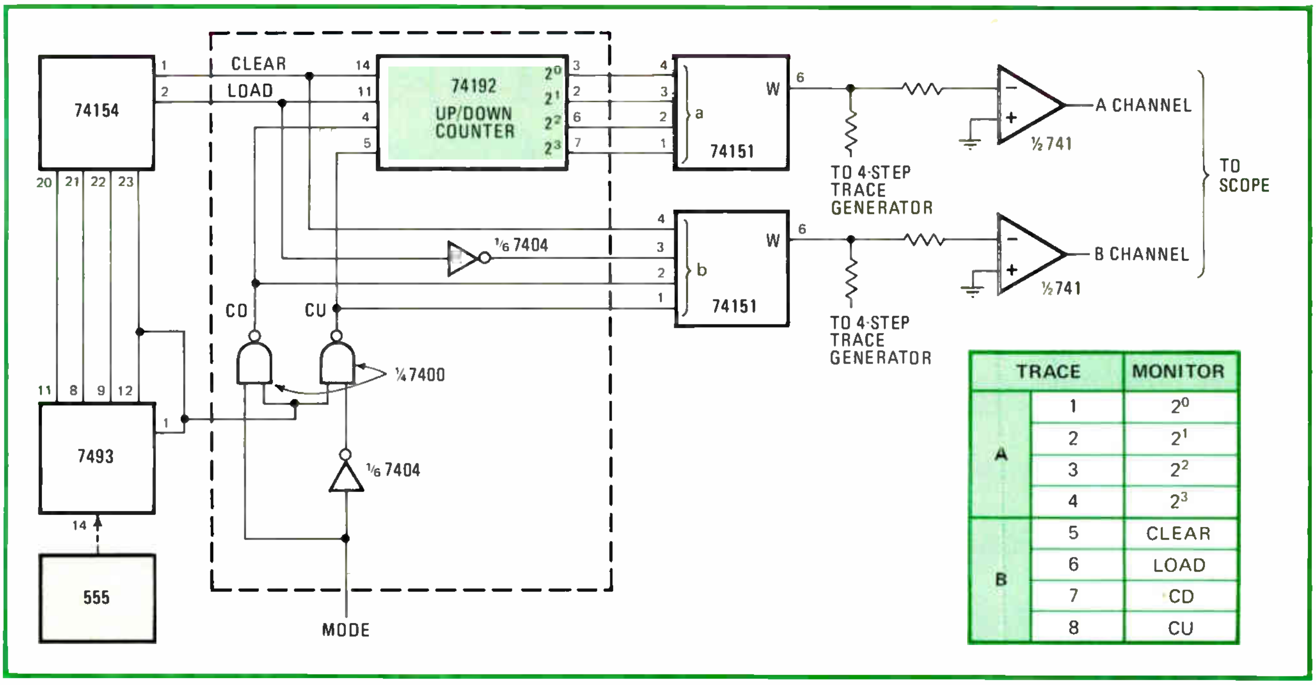
by George O. Wright
Washington, D. C.

Of all the circuits that enable a dual-trace oscilloscope to display multiple signals simultaneously, none yet provides the versatility of this one. It can be configured to monitor analog as well as digital signals. It does not require the use of the scope's sweep trigger voltage (which may not be available on some instruments) to drive the input-signal multiplexer. It also generates logic signals for stimulating devices under test. Thus the devices may be examined apart from their operating systems, which would normally supply the necessary stimulus. The circuit uses readily available integrated circuits, too, and can be built for less than $50.

The basic circuit for observing digital signals is easily implemented, as shown in Fig. 1. A trace generator using the 555 timer and operating at 60 kilohertz drives a 7474 dual D flip-flop to produce a four-step dc voltage. The output of each flip-flop is summed across the junction of the 10- and 20-kilohm resistors at point (a) to generate an output of 1, 2, 3, and 4 volts. These voltages are then synchronously added with the signal from the output of the two 74151 multiplexers, which are driven by the selected outputs of the device under test. One flip-flop also switches the multiplexers directly, so that a total of

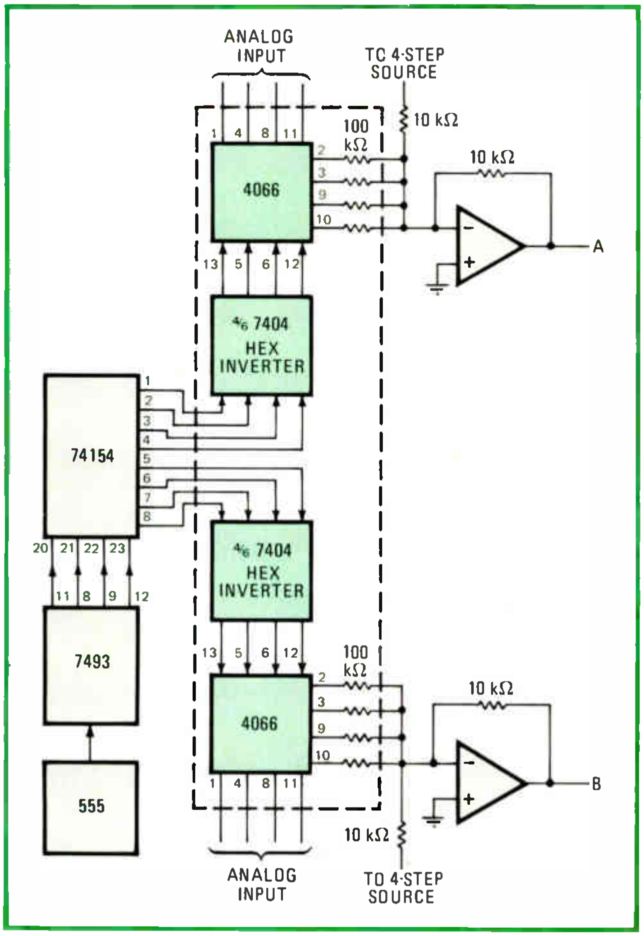


1. Low-cost analyzer. Four-step voltage generator, clocks, and counters generate eight-trace display for dual-input scope. Cost is under $50. Trace generator positions scope beam, while test-circuit generator derives logic signals to control device under test. Output of test circuit is digitally multiplexed through 74151s; alternatively, transmission gates may be used for observation of analog signals.



TRACE		MONITOR
A	1	2^0
	2	2^1
	3	2^2
	4	2^3
B	5	CLEAR
	6	LOAD
	7	CD
	8	CU

2. Digital application. Test of 74192 counter requires addition of inverters and NAND gates as shown, to derive logic signals for desired test sequence. Table specifies signal monitored by oscilloscope. Sync signal for scope is obtained from any point in trace generator chain.



3. Analog application. Replacement of 74151 multiplexers by transmission gates permits observation of eight analog signals, as shown. Logic generator continues to function in same capacity, driving 4066 analog switches with digital gating signals.

eight possible input signals can be displayed once every viewing cycle.

The test-circuit generator is similar to the trace generator but operates at 1,500 hertz. In conjunction with the 7493 decoder and 74154 multiplexer, it produces 16 logic signals for controlling the test pattern generated for the circuit under examination. The output signals from the multiplexer are sequential, each separated from its predecessor by one clock period.

Figure 2 shows a typical application of the circuit—testing the performance of an 8-bit synchronous up/down counter, in this case the 74192. Two NAND gates and two inverters have been added to derive signals that the 74154 could not itself generate, to cycle the test counter. The 74154 produces the clear and load signals, while the 7493, in conjunction with the NAND gates, derives the count-up and count-down signals (CU and CD in Fig. 2). All signals drive the 74151 multiplexers, either directly, through the counter, or through the logic gates. All eight output signals from the 74192 are multiplexed, four inputs per channel, to the oscilloscope.

As shown in Fig. 3, eight analog signals may also be observed if a slight modification is made to the basic circuit. This time, the 74154 provides the logic signals for the 7404 inverters, so that the 4066 transmission gates may be periodically sampled. The 74151 multiplexers are bypassed.

The trace generator frequency was initially set to provide acceptable scope viewing at minimum flicker rate. Step transitions of the four-value generator are not noticeable on the cathode-ray tube. The test-circuit oscillator frequency is 1/40 of the trace generator frequency to permit display of a sufficient number of events from the device under test; a 5-kilohm potentiometer has been added to permit small-range adjustments.

Both clocks should be separate and nonsynchronous to

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permit the scope's sync trigger input from locking-in to the output frequency of the four-step generator. Sync for the CRT can be obtained from any point in the trace generator chain. (Both oscillators were described in *Electronics*, May 13, 1976, p. 95). As mentioned, R_1 should be at least 10 times R_2. The current through R_2 should be minimized, so that the 555 can generate sufficient drive to trigger transistor-transistor logic circuits. □

Expandable FIFO buffers improve processor efficiency

by Krishna Rallapalli
Fairchild Camera and Instrument Corp., Mountain View, Calif.

The need to service computer interrupts immediately, especially in applications where data is supplied to a computer at a fixed rate, may be eliminated by storing data in first-in, first-out registers. With the large-capacity FIFOs presently available, system-interrupt schemes are simple to design, and the use of complex and expensive direct-memory-access controllers is avoided.

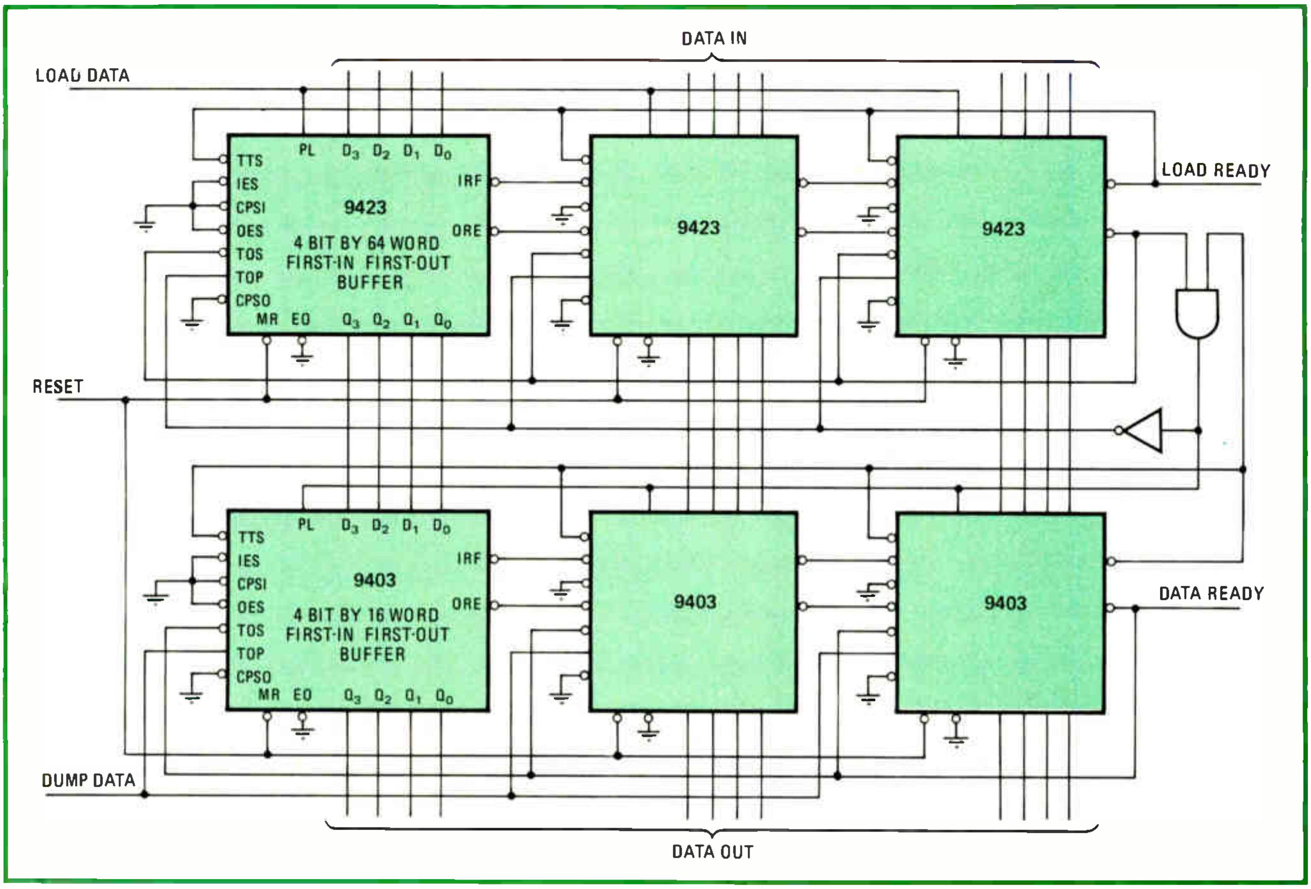
Data to the computer is typically introduced at a fixed rate by card readers. Once a card is fetched from the input hopper of most readers, it travels nonstop past the read head to the output stacker. An interrupt request must be serviced after every column of data is read, for otherwise the data is lost.

This potential problem is surmounted with the circuit shown. Three Fairchild 9403 16-word-by-4-bit FIFOs, simply cascaded with three 9423 64-word-by-4-bit FIFOs, can provide storage for up to 80 12-bit words before an interrupt request is serviced. Even with a busy computer, data is not likely to be lost.

The particular configuration of the control circuit that drives the FIFOs varies with the application. In all cases, however, it must generate a reset signal (to initialize the FIFOs), a data-ready signal, which is the interrupt request to the computer, and the load-data signal, which permits parallel loading of 12 bits of new data. The circuit must also monitor the availability of storage space in the FIFOs through the load-ready indicator, to determine if the load-data signal can be generated.

The dump-data signal, which is the interrupt-service signal, is generated by the microprocessor. It accepts the data from the output stage of the FIFOs while extracting the next data word. □

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.



No need for DMA controller. Expandable FIFOs can store up to 80 12-bit words before interrupt request is serviced, eliminating need for direct-memory-access port. Several easily synthesized control signals generate interrupt and load signals, determine status of FIFOs.

Engineer's newsletter

Recycling protected program cards in HP calculators

Cutting off the corners of a magnetic program card for the HP-67 and HP-97 calculators protects the program, but what if you later want to overwrite the protected information? Cass R. Lewart of Homdel, N. J., **recommends making a special plastic card and inserting it from the exit side of the card slot to disable the protection switch.** Use a card that's about 0.35 millimeter thick and cut it into an L shape, with the vertical arm measuring 11.3 mm across and extending 35 mm above the horizontal arm. (The horizontal arm serves merely as a handle, and its dimensions are unimportant.)

Lastly, trim the tip of the vertical arm at a 45° angle across its full width, slanting the cut down towards the horizontal arm. This clipped end aligns with the clipped end of the protected program card, which when inserted in the calculator will push the special card out as the new program is recorded.

Transistors can make better zener diodes than zener diodes

Certain types of bipolar transistors make excellent micropower zener diodes, says R. W. Brown of Kodak (Australasia) Pty, Coburg, Australia. He points that the reverse breakdown of the base-emitter junctions of most switching transistors, especially National types MPS 3638A and MPS 3642, is extraordinarily sharp even down to microampere levels, where ordinary zeners exhibit very soft turn-on. This means that **in the 8-to-10-volt range where most transistors break down, they can be useful alternatives to zeners.**

Brown also points out that the transistors have about a 10 times better figure of merit, defined as a ratio of percent voltage change to percent current change. Since the transistors take virtually no current until breakdown is reached, they could be useful in a number of applications—for instance, as a reference in a micropower circuit or as an active clamp in a high-gain preamplifier where the zener must not interfere with the circuit except when clamping.

Nonpolluting pc-board chemicals are on the way

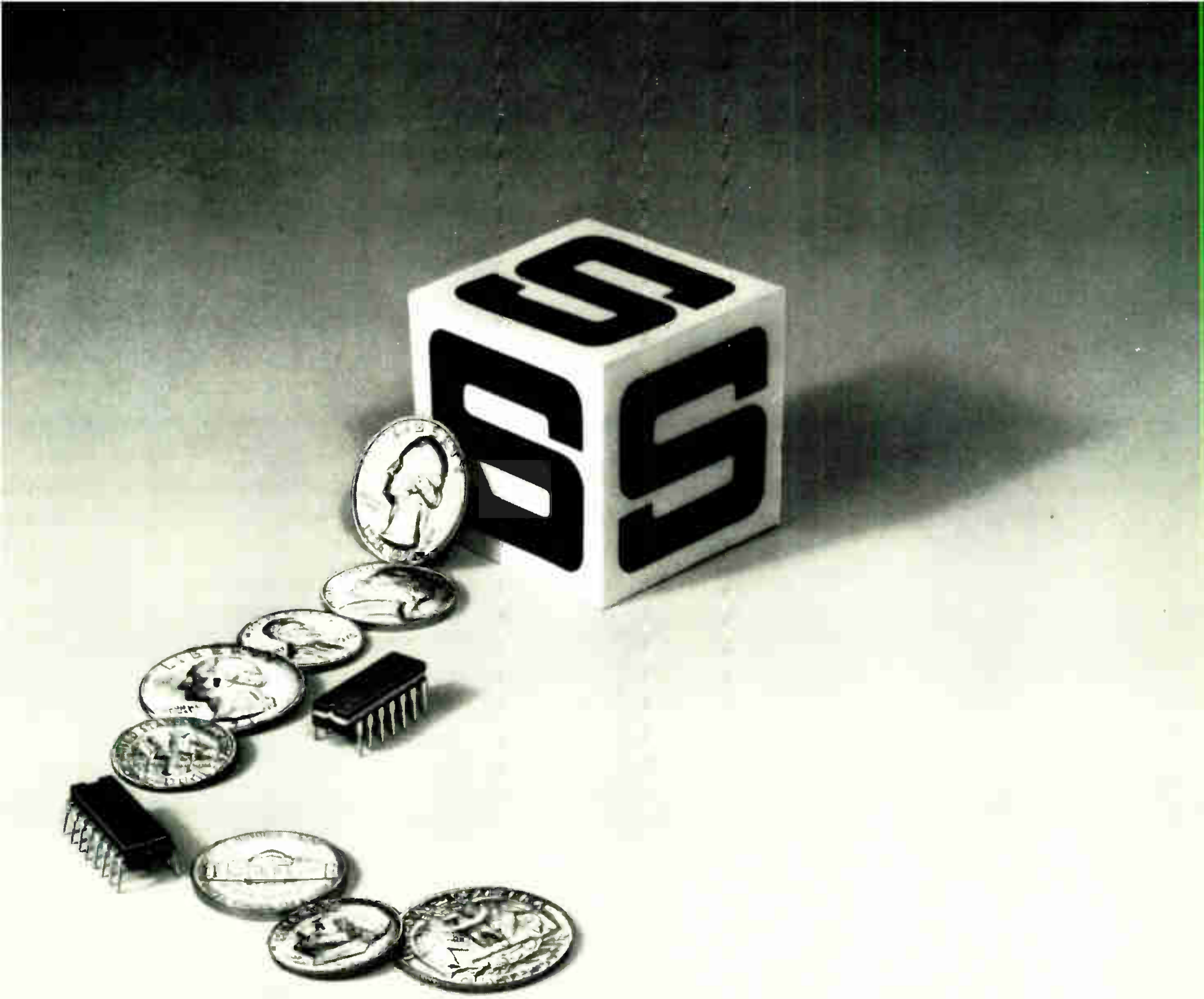
The ban on fluorocarbons, if it goes into effect next year as proposed, looks like it will catch aerosol-spray manufacturers unprepared—a situation viewed as an awful warning by suppliers and users of printed-circuit boards. They're determined to have some options in hand **if the use of organic photoresists in board manufacture attracts a similar ban or tough regulations,** in line with the growing body of other legislation protecting workers and the environment. So several chemical companies are already studying aqueous systems and other alternatives to the present hydrocarbon-based solvents, and nonpolluting pc board chemicals could start appearing within the year.

Card aids in use of the 8080 microprocessor

Using the 8080 microprocessor? Unless you're doing it full time, you will probably have difficulty remembering the hexadecimal code for the various instructions. For $2.95, you can get a slide-rule-type code card that **shows the mnemonics and the corresponding hex codes.**

The code card also shows which flags are affected during execution of the 8080 instructions. Write to J. A. Titus at Tychon Inc., P. O. Box 242, Blacksburg, Va. 24060.

Stephen E. Scrupski



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Photorepeater works directly on wafers

Optical step-and-repeat unit accommodates wafers up to 4 inches in diameter, provides geometries as fine as 1.25 micrometers

by Lawrence Curran, Boston bureau manager

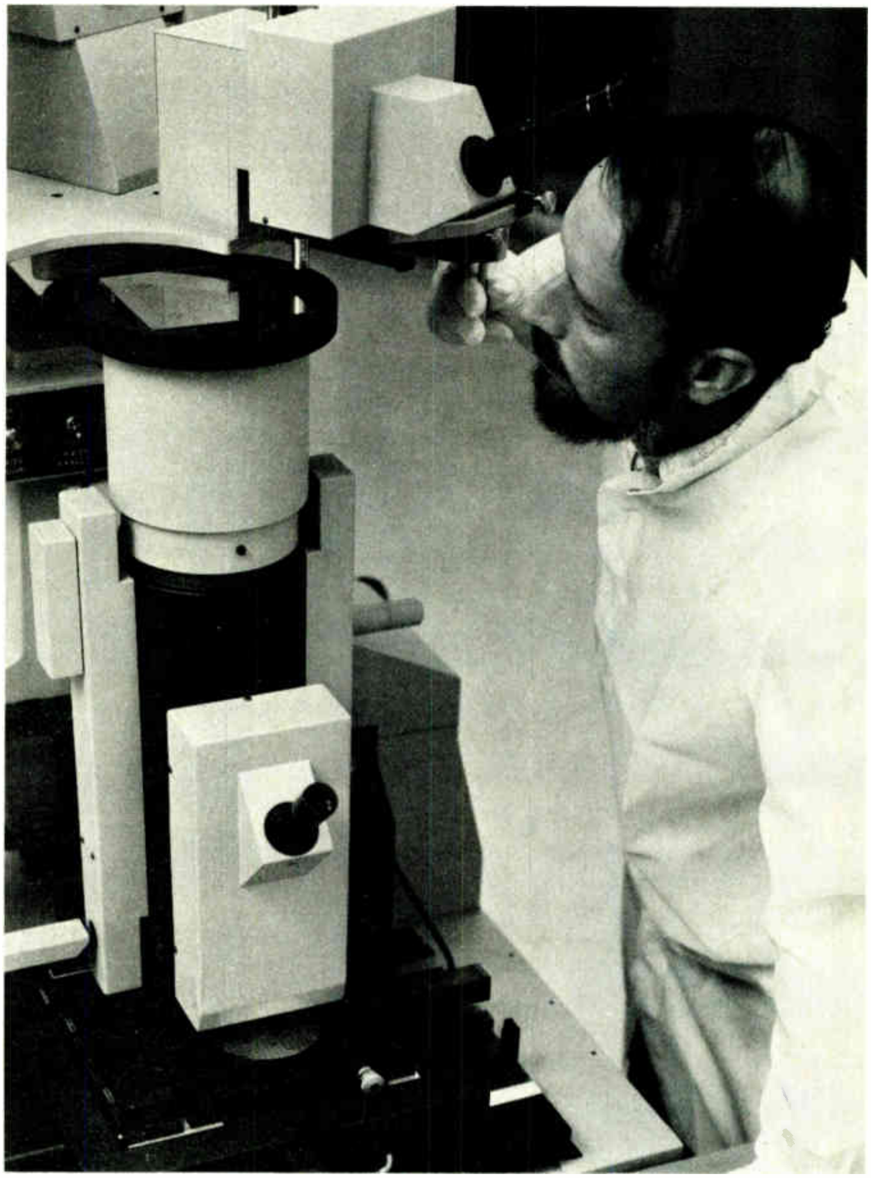
For all the publicity that electron-beam lithography has attracted as a means of making integrated-circuit masks, the Burlington, Mass., division of GCA Corp. sees a substantial market for photolithographic equipment at least through 1985. The division is therefore modifying its type 3696 Mann optical photorepeater to make it capable of exposing the circuit patterns directly on the resist-covered wafer and stepping and repeating them across its surface.

Aubrey C. "Bill" Tobey, the division's director of marketing, maintains that by 1980, the semiconductor industry will need minimum geometries of 1.25 to 2.0 micrometers in production, and the modified 3696 will meet that requirement. In contrast, he says that today's early electron-beam systems are limited in mask-layer overlay registration by the projection printers that must be used with them—a limitation that translates into minimum geometries of 3 to 5 micrometers in production.

Moreover, even though the division is developing its own electron-beam system [*Electronics*, Feb. 17, p. 26], Tobey has some convincing data that shows a gap between the capabilities and affordability of today's photolithographic mask makers and the eventual development of direct writing on the wafer with production-quality electron-beam systems. It is this gap that the Mann DSW (for direct step on wafer) is intended to fill.

But Tobey does not regard the DSW as merely a stop-gap machine. "This system will have an extended life," he says. "It will compete with electron-beam direct-step-on-wafer systems, when they arrive, for geometries greater than 1.0 micrometer."

Enabling the 3696 photorepeater to write directly on the wafer meant substantial modifications, including the addition of a wafer-stage holder, new software, and a split-field monocular-viewing microscope. Added to the optical column, the micro-



scope allows the operator to view the wafer so that he can position it manually, using a knurled knob to align the wafer stage and the machine axis, and using a joystick for X- and Y-axis alignment. The laser interferometer from the 3696 is retained; it is directly referenced to the optical column for maximum accuracy and stability.

The input to the wafer-stepper is a 10× or 5× reticle, produced by a pattern generator, that is reduced and then stepped and repeated directly on the wafer. Tobey says that the interferometric metering provides motion control to a resolution of 0.1 micrometer. "The operator does a single wafer alignment," Tobey notes, "and once that's done, the next layer is laid down by stepping and repeating, with the assumption that the wafer is stable enough to provide good overlays from one mask step to the next."

He adds that the error analysis that GCA has done indicates a total error of no more than 14 microinches overall. That includes alignment of the wafer to the machine, reticle alignment, stage repeatability and thermal effects. "We feel that's a conservative number, though, and we think that we will be able to do a little better than that 99.7% of the time," he says.

The DSW will accommodate wafers up to 4 inches in diameter. With 10× photoreduction, it will handle maximum die sizes of 10 millimeters on a side and deliver minimum geometries of 1.25 to 1.5 micrometers with a throughput of 20 wafers per hour. With 5× reduction, the numbers are: die size, 20 millimeters; minimum geometry, 2 micrometers; throughput, 30 to 35 wafers per hour. Overlay precision is typically 0.25 micrometer, assuming minimum wafer distortion.

Automatic wafer feeding is not presently available on the DSW, but a company spokesman says that the firm recognizes its desirability and indicates that the designers are considering adding it in the future for fully automatic operation.

The DSW sells for between $315,000 and $325,000, about $50,000 more than does the 3696. Deliveries are scheduled to begin late this year.

GCA Corp., Burlington Division, 174 Middlesex Turnpike, Burlington, Mass. 01803. Phone Aubrey C. Tobey at (617) 272-5600 [338]

Temperature sensor sells for about $1

Bi-FET technology yields a temperature-to-current transducer that can also be used as a programmable constant-current source

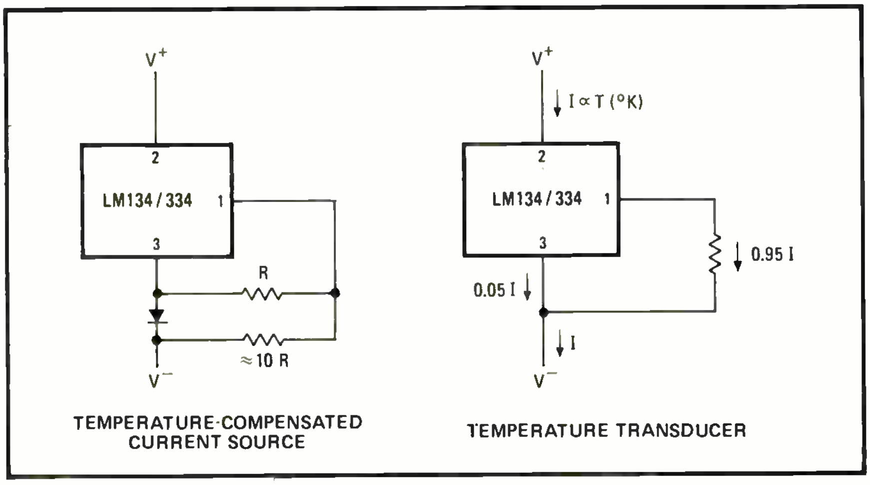
by Bernard Cole, San Francisco bureau manager

Using its bi-FET mixed process, which combines bipolar and junction field-effect transistors on the same chip, National Semiconductor Corp. has come up with a most unusual device—a current-mode temperature transducer that can double as a programmable constant-current source. The new device is dubbed the LM134/334.

As a current-mode temperature sensor, the device is designed for remote temperature-sensing applications now requiring as much as $10 to $25 worth of discrete and hybrid circuitry. By comparison, the LM134/334 in high volume will cost between 50 cents and $1. As a current source, it is designed to replace both FET sources and discrete circuitry.

According to design engineer Carl Nelson, the LM134/334 is a three-terminal device featuring a 10,000-to-1 range in operating current from 1 microampere to 10 milliamperes, adjustable by means of a resistor between the trim terminal and either the positive or negative pin. The sense voltage used to establish the operating current is only 64 millivolts at 25°C and is directly proportional to the absolute temperature (degrees Kelvin), Nelson says. With the addition of a single external resistor, the LM134 produces a current that is also linear with absolute temperature.

This linear relationship between the current and absolute temperature is what is used when the LM134/334 is operated as a current-mode temperature transducer, over a 100-μA-to-1-mA range for best accuracy. The commercial version (LM334) has a guaranteed initial accuracy ranging from within ±3°C to ±6°C. For 1% slope accuracy, it is only necessary to trim the device at one point. "These devices are ideal in remote-sensing applications, because series resistance in long wire runs do not affect accuracy. In addition, only two wires are required," Nelson says.



Versatile. The temperature-sensitive current source (right), can be converted into a temperature-independent source with the addition of a diode and a second resistor (left).

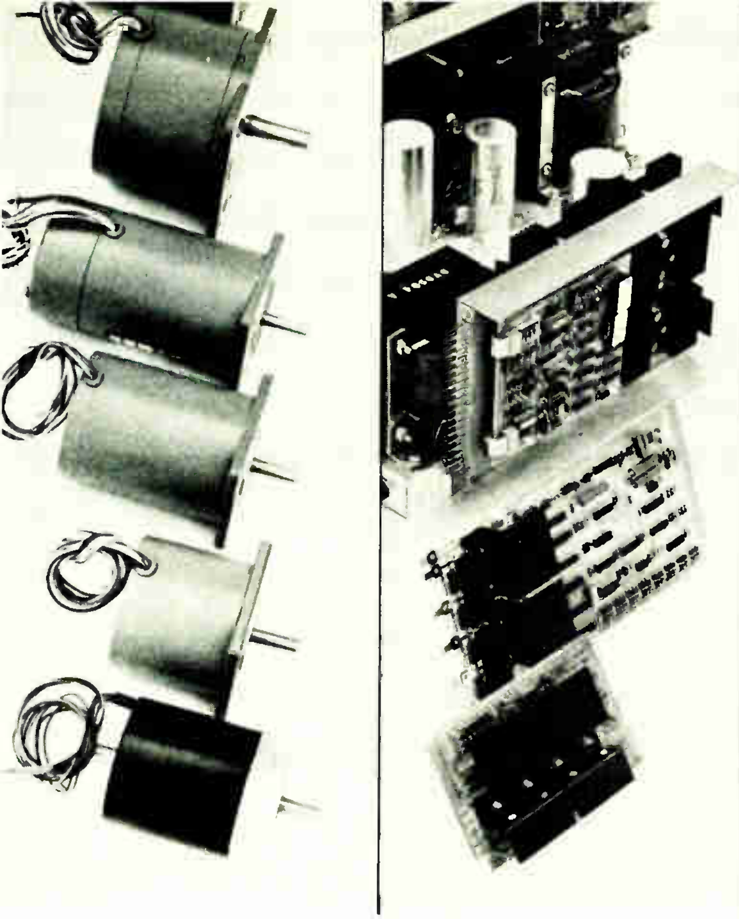
With the attachment of a single programming resistor, the LM134 becomes a true two-terminal floating current source; that is, it can be used between any two voltages anywhere in a circuit, or between one voltage and ground, and does not need a separate supply. It will absorb voltages from 800 millivolts up to 40 volts with a maximum current change of no more than 0.02% per volt. Over the 40-V range, this is less than a 0.5% change, vs about 5% to 10% for FET current sources. From 40 to 60 V, change in current is no more than 0.04% to 0.3% per volt.

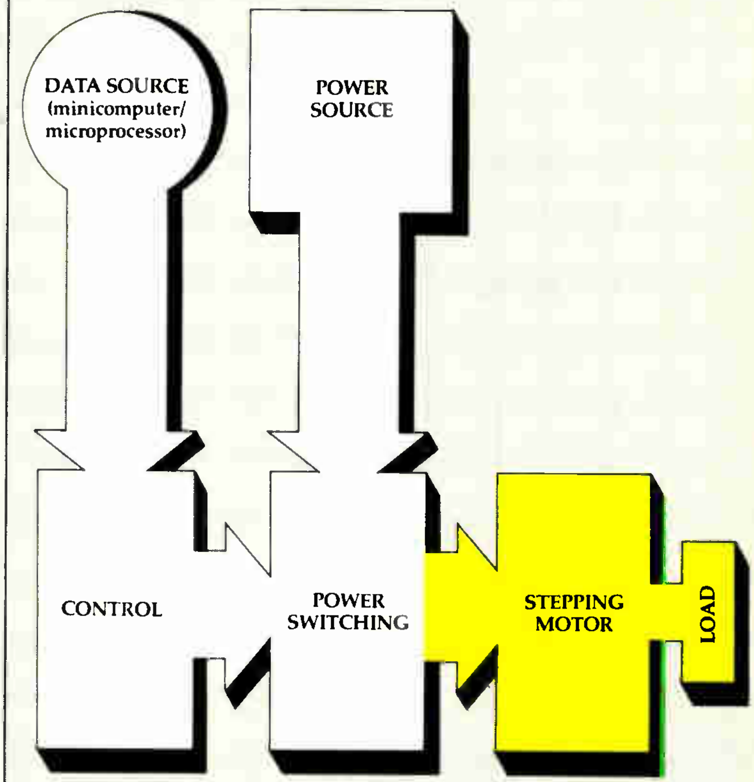
Key to the versatility and wide dynamic range of the LM134/334, according to Nelson, is the use of a mixed-process technique in which two ion-implanted J-FETs are fabricated on the same 34-by-38-mil IC as four bipolar transistors.

According to Robert C. Dobkin, National's director of advanced linear-product design, the LM134/334 is unique in linear IC design because "it is the first commercial high-volume IC implemented without on-chip resistors"—the feature "that allows it to be programmed over such a wide range."

The LM134 is guaranteed over a military temperature range from −55°C to 125°C and the LM334 from 0°C to 70°C. In the TO-46 hermetic package, the LM134 is priced at $3.50 each in quantities of 100 and up; and the LM334, $1.33 each. In a TO-92 epoxy package, price of the LM334 is 90 cents.

National Semiconductor Corp., 2900 Semiconductor Drive, Santa Clara, Calif. 95051 [339]





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Components

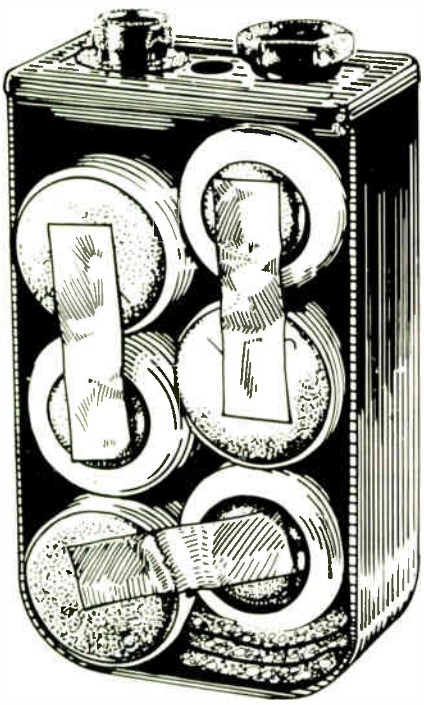
Tiny cells make secondary source

Rechargeable rectangular battery powers portable electronic units

In its easily housed 1.938-by-1.031-by-0.656-inch case, the 9-volt primary battery is in heavy use in calculators, citizens' band radios, smoke detectors, portable radios, and much other equipment, though the manufacturers would often prefer a rechargeable version.

General Electric is now manufacturing a rechargeable power source with the same dimensions as the primary 9-V type. The new battery is composed of six small cylindrical nickel-cadmium cells connected in series. At 25°Celsius, it can supply 65 milliampere-hours at 7.5 V. Maximum continuous discharge at 25°C is 150 milliamperes; maximum momentary (1 second) discharge is 600 mA.

The new batteries have all the features of GE's existing nickel-cadmium line. A recharging cycle requires 16 hours for standard batteries, and specially selected batteries will have a 5-hour quick-charge capability.



Up to 1,000 recharges are possible with the new rechargeable 7.5-V unit, and it can sustain continuous overcharging for extended periods with no damage. Operating temperature ranges are: 5°C to 50°C under charge; −20°C to 50°C under discharge; and −40°C to 50°C while in storage.

These rechargeable units will be applicable to new designs or redesigns of older battery-powered equipment. They are not meant as direct replacements for the 9-V battery and in fact have a mechanical feature to prevent this—a special three-terminal (+, −, and a locating pin) connector will be required for the new battery rather than the two-terminal connector used for the older primary batteries.

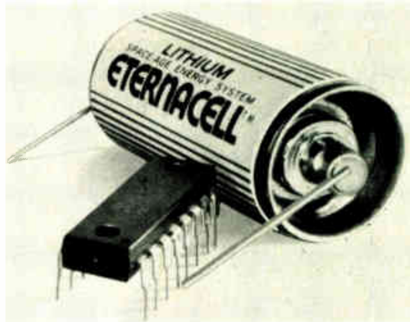
The new battery will typically power a transistor radio for 10 to 12 hours, a cassette recorder for 4 to 5 hours, or a CB radio for about 8 hours. Pricing will be from \$3.53 to \$9.98 for a standard-charge battery and \$3.71 to \$10.48 for a quick-charge battery, depending on quantity.

The six small cylindrical cells shown above each measure 0.598 by 0.497 in. R. K. Bridgers, GE's manager of market development foresees further product applications for the individual cylindrical cells, such as a standby supply for microprocessors.

General Electric Co., Battery Department, P. O. Box 992C, Gainsville, Fla. 32602. Phone (904) 462-4762 [341]

Lithium battery powers semiconductor memories

A compact lithium battery, intended for use as a standby power source for all types of semiconductor memories, is rated at 1 ampere-hour. The cell, which has a diameter of only 0.64 inch and a length of 1.31 in., operates over the temperature range



from −65°F to 165°F. It has a shelf life of 10 years, a cell voltage of 2.8 volts, and is available with a hermetic seal. The model 440 Eternacell is designed for mounting on a printed-circuit board; it can be wave-soldered.

Power Conversion Inc., 70 MacQuesten Parkway South, Mount Vernon, N. Y. Phone (914) 699-7333 [343]

Power transformer stands only 0.5 inch high

A low-profile power transformer that puts out 0.1 ampere root mean square at 7 volts rms makes it

possible to include power supplies on circuit boards that must be closely spaced. Designated part number 52593, the transformer measures 1.875 by 1.5 by 0.5 inches. Its 7-V output is suitable for making 5-V dc supplies, the most commonly needed type.

The standard transformer accepts an input of 115 V at 60 hertz. Other voltages and frequencies can also be accommodated; a 400-Hz unit that delivers 4 watts can be made on special order, for example. The 52593 sells for \$6.80 each in thou-

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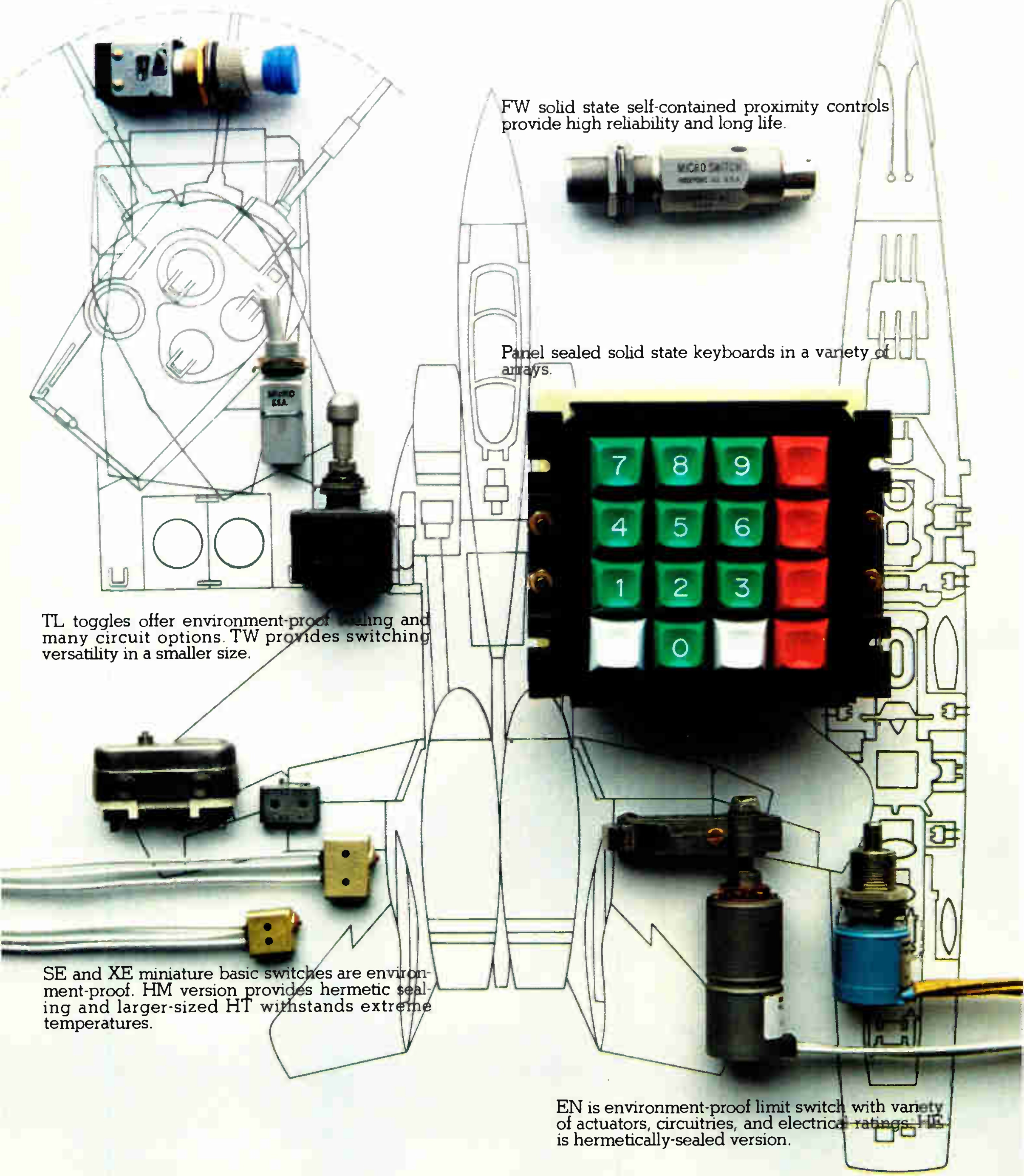

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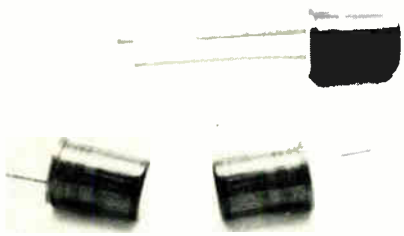
Magnetico Inc., 182 Morris Ave., Holtsville, N. Y. 11742. Phone T. Sullivan at (516) 654-1166 [344]

LED lamp can be seen over more than 180°

Although highly favored for use as indicator lamps because of their excellent reliability, light-emitting diodes have heretofore been limited by narrow viewing angles. Now, by employing a flat-topped, cylindrical fresnel lens, Data Display Products has produced an LED lamp that retains most of its brightness over viewing angles in excess of 180°. Called the Ledy bug, the lamp has a nominal intensity of 5 millicandlelas



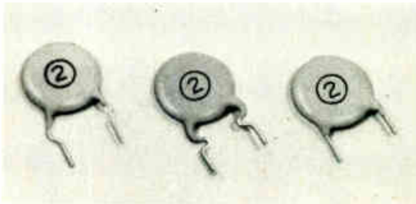
at a forward current of 20 milliamperes. it is available in red, amber, and green.

Ledy Bugs can be installed with panel-mounting clips, mounting bushings, or mounting sockets. They have a diameter of 0.203 inch and a length of 0.280 in. In quantities of 1,000 to 4,999, the lamps sell for 56 cents. A lamp of lower brightness is offered in the same package for 39 cents each for the same quantities. Delivery is from stock to six weeks.

Data Display Products, 303 N. Oak St., Inglewood, Calif. 90301. Phone (213) 677-6166 [345]

Barium titanate packs high capacitance into small space

Type 563 capacitors use a ceramic body to meet the requirements of solid-state low-voltage circuitry for small size and high capacitance. Made of barium titanate, the capacitors vary no more than ±22% over the range from −30° to 85° Celsius. The miniature units are furnished in 11 case sizes ranging from 0.25 to 0.87 inch in diameter. They are specially suited for bypass and coupling applications. Capacitance values range from 0.01 microfarad to 0.47 μF at two working voltages: 16 and 25 volts dc.

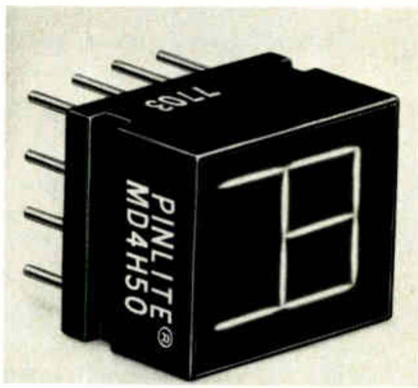


In addition to the conventional rating by capacitance and voltage, nine units in the series are offered to meet specific impedance values as a function of frequency. Maximum impedances have been specified for these capacitors at 262 kilohertz, 1 megahertz, and 10 MHz. In thousands, the capacitors are priced from 4.5 cents to 19.7 cents each.

Technical Literature Service, Sprague Electric Co., 35 Marshall St., North Adams, Mass. 01247. Ask for Engineering Bulletin No. 6141H [346]

Small incandescent display offers nine segments

Less expensive than full alphanumeric displays, a series of nine-segment readouts from Pinlites allows hexadecimal numbers to be



easily displayed. The MD-4H series of 0.25-inch readouts is a family of directly viewed incandescent-filament displays that are easily seen even in direct sunlight. Units are available for operation at 3, 4, and 5 volts. The packages weigh 1.6 grams and have dimensions of 0.375 by 0.465 by 0.312 inch. Designed to be mounted directly to a circuit board to save the cost of connectors, the displays can be soldered in place or plugged into solderless terminals. The single-piece price of any MD-4H display is $15.25.

Refac Electronics Corp., P. O. Box 809, Winstead, Conn. 06098. Phone Walter Gillis at (203) 379-2731 [347]

Compact transformer provides high isolation

A line of miniature transformers for mounting on printed-circuit boards offers extremely good isolation between its primary and secondary windings: 2,500-volts root-mean-square HiPot rating is standard, and the leakage capacitance is only about 25 picofarads. Transformers in the Split/Trans series achieve their performance by having their windings placed side by side instead of one over the other. According to the manufacturer, the resulting drop in magnetic coupling is not significant. In small quantities, the transformers sell for $4.90 to $7.90 each. Power ratings range from 2 to 20 volt-amperes.

Signal Transformer Co., 500 Bayview Ave., Inwood, N. Y. 11696. Phone (516) 239-7200 [349]

TOPICS

Components

Bourns Inc., Riverside, Calif., has introduced the first RJR28- and RJR32-style trimmers qualified to the established reliability requirements of MIL-R-39035. Both units have cermet elements. The RJR28 device is a 10-turn pot housed in a rectangular package that measures 0.5 inch long. The RJR32 unit is housed in a 0.75-in. dual in-line package and provides 20 turns. . . . **Industrial Devices Inc., Edgewater, N. J.,** is offering an indicator-light sampling kit for use in breadboarding and prototype building. The IDI Engineer's Kit consists of 24 different lamps: 16 styles in 7 colors for 5 voltages from 6 to 250 V. The kit sells for $10. . . . **Sprague Electric Co., North Adams, Mass.,** is now selling its multilayer ceramic chip capacitors with capacitance identification codes marked on the chips. The optional marking code uses 6 colored inks and 24 letters or numerals to handle the full range of capacitances (1.0 picofarad to 0.91 microfarad) and tolerances (±20%, to ±5%).

Here are two ways to measure ceramic capacitor reliability

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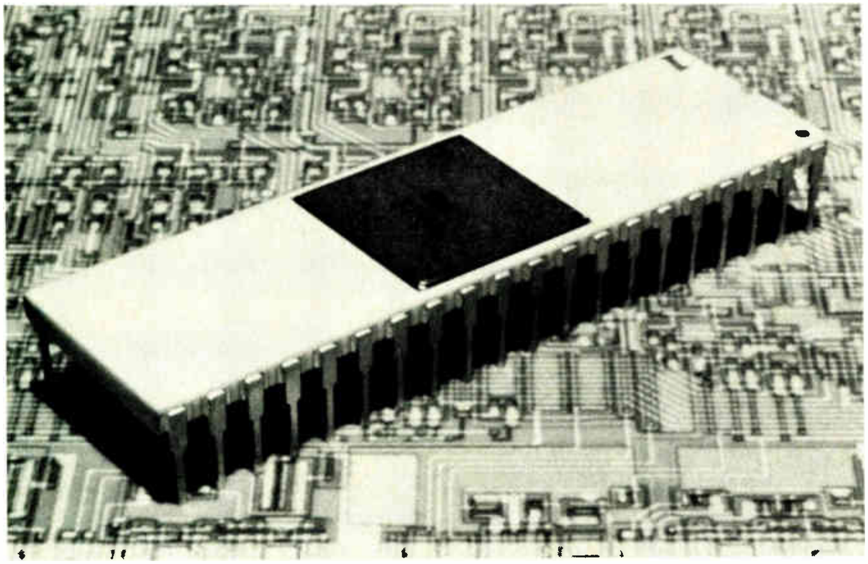
Semiconductors

8-by-8 multiplier dissipates 1 watt

IC built for digital filters, other high-speed applications multiplies in 100 ns

The last few years has seen a remarkable increase in the use of digital signal-processing techniques in such applications as medical electronics, speech processing, and music processing. Paralleling this development has been an increase in the level of integration in the circuits used in these systems: in the case of multipliers, from 1 bit by 4 bits to 4 by 4, 8 by 1, and most recently, 8 bits by 8 bits.

The newest entry in this marketplace, and one promising an unusual speed-power product, is Monolithic Memories Inc.'s low-power Schottky bipolar 57558/67558. The high-speed 8-bit-by-8-bit combinatorial multiplier can multiply two 8-bit unsigned or signed two's complement numbers and generate the 16-bit signed or unsigned product in an average time of 100 nanoseconds, about 25% to 30% faster than combinatorial devices of the same complexity, according to engineers at the Sunnyvale, Calif., company.



More remarkable is the power dissipation of the unit—only 1 watt. This is less than half that of similar devices, says Schlomo Wasser, senior engineer for new product development at MMI.

The 57558/67558, which is being second-sourced by ITT Semiconductor, incorporates the equivalent of 675 gates into a 180-by-180-square-mil area. It is designed for such high-speed applications as digital filters, fast-Fourier-transform signal processors, and floating-point arithmetic units. Each input-operand X and Y has an associated mode-control line. When a line is at a high logic level, the operand is treated as an unsigned 8-bit number. When a mode-control line is at a low logic level, its associated operand is treated as an 8-bit signed two's complement number.

Two extra inputs allow the addition of 1 bit in the multiplier array at the appropriate bit positions for rounding signed or unsigned fractional numbers. The most-significant-product bit is available in both true and complement form to assist in the expansion to larger signed multipliers.

The product outputs are three-state, controlled by an active low-output enable that allows several multipliers to be connected into a parallel bus or to be used in a pipelined system. The device uses a single 5-volt power supply and is packaged in a standard 40-pin dual in-line package. For 1 to 24 units, the Cerdip version is priced at $100 each. In quantities of 100 to 999, the price is $65 each.

Monolithic Memories Inc., 1165 E. Arques Ave., Sunnyvale, Calif. 94086 [411]

ITT Semiconductor, 74 Commerce Way, Woburn, Mass. 01801 [412]

Memory family shows low power dissipation

Using a newly developed n-channel metal-oxide-semiconductor process, Intersil Inc. has gone into production with a family of 28,000 square-mil 4,096-bit static random-access memories, including versions it claims have the lowest operating power dissipation in the industry—less than 300 milliwatts.

The new 18-pin family consists of three memory types: the 7114 series, with microprocessor-compatible 1,024-by-4-bit organization, the 7141 series, with a 4,096-by-1-bit organization optimized for mass memory, and the 2114, a 1-k-by-4-bit static RAM with Intel pinouts. All three come in three speed types: 200, 300, and 450 nanoseconds. The 7114 dissipates 265 milliwatts. The 7141 comes in two versions: one dissipates 265 mW; the other, 370 mW. The 2114 is available with a power consumption of 370 or 710 mW.

The 7114 and 7141 are devices with storage cells and decode and control circuitry that are completely static. Therefore, no clocks or refresh operations are required. Memory access occurs within the specified access time after all the address inputs are stable. A chip-select input is provided for simple memory-array expansion.

The 7114 is pin- and performance-compatible with the Intel 2114 series, except that the Intersil part has lower power dissipation. Since the 7141 uses the same circuitry, its performance is identical to the 7114. Both devices are assembled in the industry-standard 18-pin dual in-line memory package for maximum sys-

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tem packing density where required.

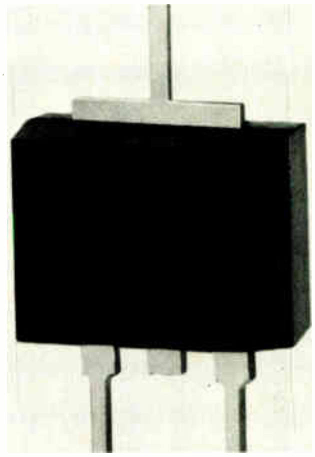
Pricing in quantities of 100 or more on the 265-mw 7114 is $31.75, $27.50, and $23.25 each, for the 200-ns, 300-ns, or 450-ns versions, respectively, and $27.50, $23.25, and $18.70 for the 265-mw 7141 with the same speeds. Pricing on the 370-mw 7141 version is $25.50, $21.25, and $16.70. The 2114 at 370 mw is $27.50, $23.25, and $18.70, respectively, and $25.50, $21.25, and $16.70 for the 710-mw version.

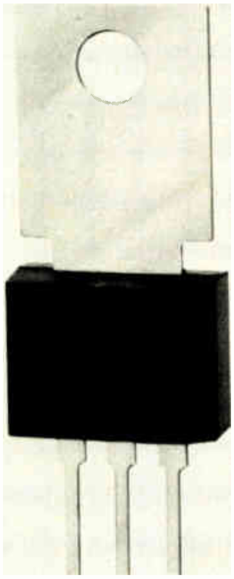
Intersil Inc., 1275 Hammerwood Ave., Sunnyvale, Calif. 94086 [417]

4-ampere SCRs offer many packaging choices

The models T-106 and T-107 sensitive-gate silicon controlled rectifiers are 4-ampere devices with voltage ratings up to 400 V. They are offered in four basic versions of the industry-standard TO-202AB package, of which two are shown in the photos. An additional five types are formed by various lead-bending operations.

The T-106 features a gate sensitivity of 200 microamperes, a holding current of 3 milliamperes, and a surge rating of 20 amperes. The T-107 has a 500-μA gate sensitivity, a 6-mA holding current, and a 15-A surge rating. In lots of 10,000 pieces, the new thyristor devices range in





price from 18 cents to 27¢ each.

Teccor Electronics Inc., 1101 Pamela Drive, P. O. Box 669, Euless, Texas 76039. Phone (817) 267-2601 [415]

One-chip a-d converter boasts 0.025% linearity

A one-chip dual-slope analog-to-digital converter intended primarily for use in 3½-digit meters has a typical nonlinearity of 0.025% plus one-half count. The complementary-MOS circuit, which pulls only 10 milliwatts, needs only five capacitors, four resistors, and an external 1-volt reference to form a complete a-d converter. Display components would, of course, also be needed if the circuit were to be made into a meter.

Designated the MP-7138, the converter has two input ranges: 0 to 199.9 millivolts and 0 to 1.999 V. Its input impedance is greater than 1 megohm. The unit is powered by a ±5-V supply. It is housed in a 28-pin plastic dual in-line package and sells for $8 in lots of 100 to 999 pieces.

Micro Power Systems Inc., 3100 Alfred St., Santa Clara, Calif. 95050. Phone (408) 247-5350 [414]

Monolithic multiplier is accurate to within 0.25%

Usually, if one needs high accuracy in an analog multiplier, one must go to a multicomponent assembly to

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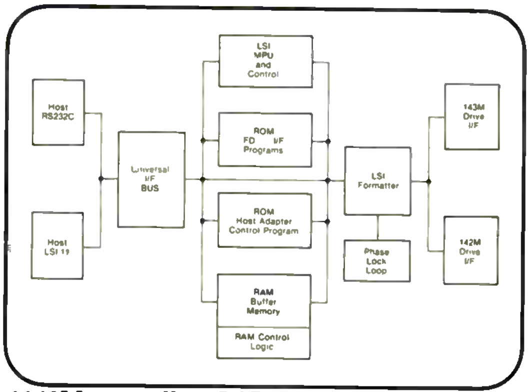

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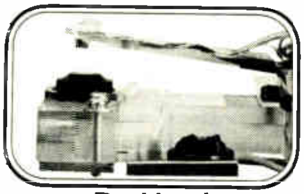
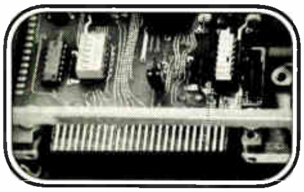
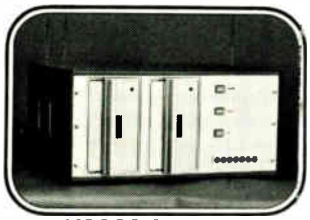


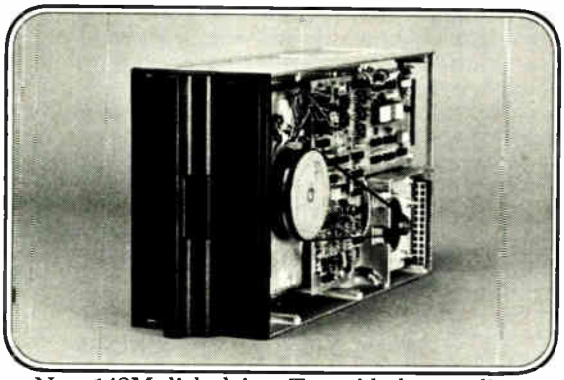
Dual head



50 pin LSI interface



1149M Multipurpose Cabinet assembly. Rack or table mounted.



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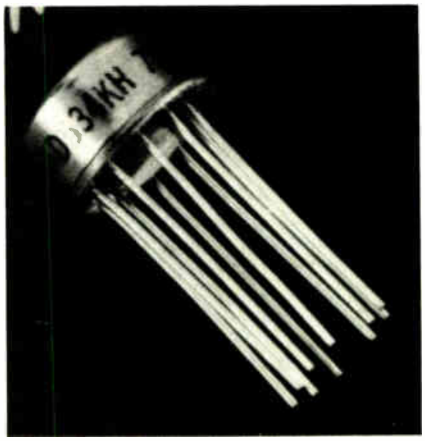

achieve it. Now Analog Devices is using automatic laser trimming to bring high accuracy to a monolithic multiplier. Its model AD534L is a four-quadrant unit with a maximum room-temperature (25° Celsius) multiplication error of 0.25%. The unit, which requires no external components, has a maximum offset voltage of 10 millivolts, a maximum nonlinearity of 0.1%, and a noise level of only 1 mv rms over its 10-hertz to 5-megahertz bandwidth. Feedthrough is a maximum of 0.12% on the X input and 0.10% on the Y.

Versatility is another strength of the AD534L. Its inputs are all fully differential; its scale factor can be varied from three to ten by adding one external resistor and one potentiometer; and it can be used as a divider. In this application, the multiplier uses a high-gain output stage to overcome accuracy problems that often affect other multipliers when they are used as dividers. The device can maintain a 1% maximum error over a 10:1 denominator range. If the X input offset is trimmed out, that range can be extended to 100:1.

In hundreds, the AD534L sells for $36 each. Other versions, with different accuracy and temperature specifications have 100-piece prices from $16 to $60. The units are housed in hermetically sealed TO-100 cans and are available from stock.

Analog Devices Inc., Route 1 Industrial Park, P. O. Box 280, Norwood, Mass. 02062. Phone Applications Engineering at (617) 329-4700 [413]

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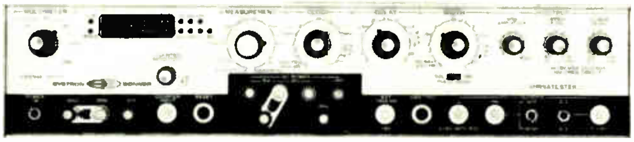

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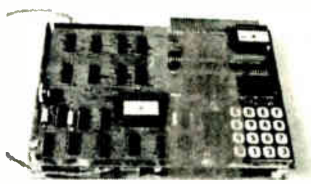

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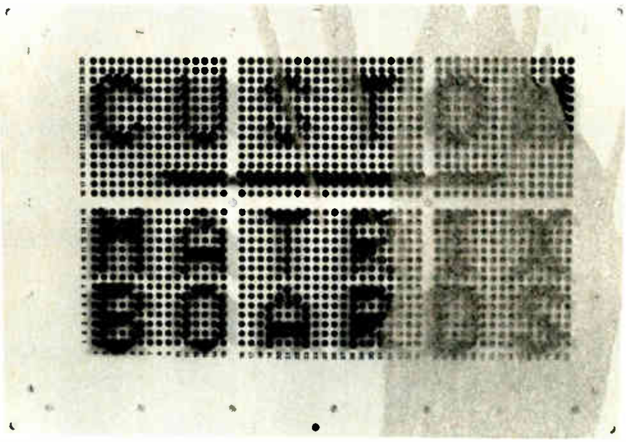

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Circle 131 on reader service card

Subassemblies

Triple-output converters bow

Dc-to-dc units for use in microprocessor systems have low ripple and low overshoot

Dc-to-dc converters with triple outputs are increasingly sought by makers of microprocessors, memories, and analog peripherals that work with microcomputers. The latest company to offer a line in response to that need is Semiconductor Circuits Inc., Haverhill, Mass. Heretofore, the company suggested two separate modules to customers, says Ted Brewster, product manager for dc-dc converters, one with the −5-volt output for substrate biasing and another with the dual 12-V and 15-V levels required by complementary-MOS and bipolar logic and by analog circuitry.

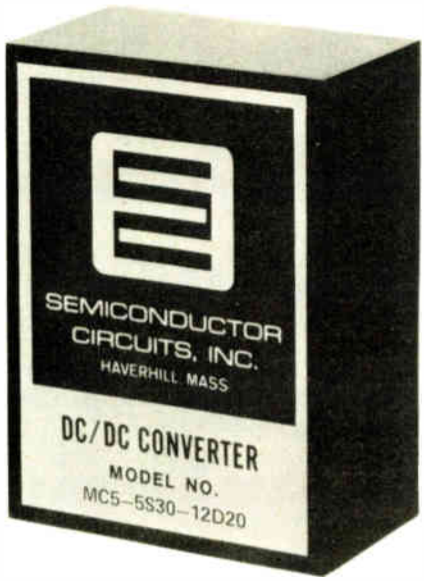
The new MC Series encompasses 20 model numbers in which the triple or dual outputs totaling up to 12 watts are all provided by a single module. The units are rated at efficiencies from 55% to 65%. The fixed triple outputs consist of either a single or twin 5-V output, with the available combinations defined by the model number. Available outputs include +5 V at up to 1,500 milliamperes, −5 V at 100 mA, +12 V to 450 mA, −12 V to −300 mA, and ±15 V to ±300 mA.

Each unit operates from an input of 5, 12, 24 or 48 V dc over a range of 4.5 to 5.5 V, 10.0 to 15.0 V, 21.0 to 32.0 V, or 42.0 to 56.0 V, respectively. The design incorporates a pi input filter to keep input-reflected ripple low. "The front-end switches on these units will often bounce noise onto the input," Brewster says, "but with our filter, it's less than 1% of the input voltage." Input-to-output isolation is 300 V dc minimum, and output ripple and noise is specified at 2 millivolts rms (30 mV peak to peak, typically).

Short-circuit protection is provided on the outputs, and the units prevent chip-destroying overshoots, to which microprocessors are particularly vulnerable. No derating is required; the units deliver full power from −25°C to +71°C.

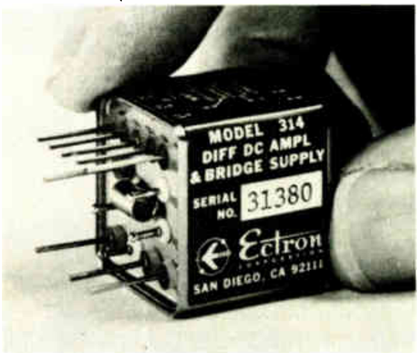
Single-unit prices range from $94.95 to $109.95. For 10 and up, the price drops to from $85 to $100, and discounts for original-equipment manufacturers are available. Delivery time varies from three to six weeks.

Semiconductor Circuits Inc., 306 River St., Haverhill, Mass. 01830. Phone Ted Brewster at (617) 373-9104 [381]



Compact amplifier withstands 2,500 g

The model 314A amplifier is a compact unit that has been designed to withstand a lot of electrical and physical abuse. All of its leads, for example, are protected against noise and transients by filters, and it operates from an unregulated power supply. The amplifier will operate over the range from −40°C to 93°C, at humidities as high as 100%, at any altitude, and while receiving as much as 2,500 g of shock. Its volume is less than a cubic inch, and it weighs less than 1.5 ounces.

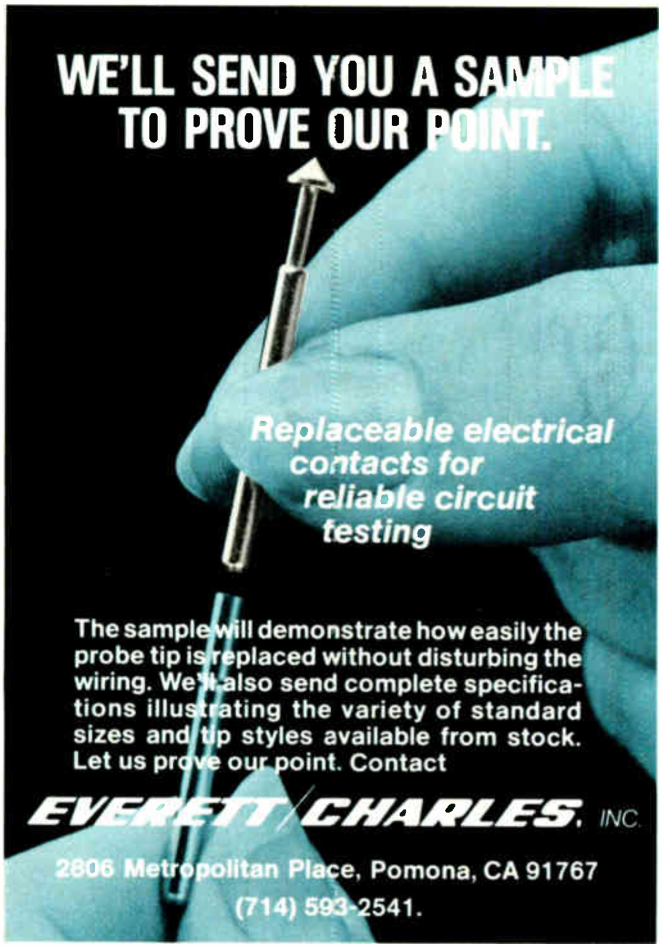


Input impedance is a minimum of 10 megohms shunted by 1 nanofarad. The gain is adjustable from 10 to 1,000 by means of an external resistor. And the frequency response is within 2% over the range from dc to 4 kilohertz. The output can swing over ±5 V at up to 5 milliamperes. Short-circuit protection is standard, and limiting at −0.8 V and 6.0 V is available as an extra-cost option. The model 314A sells for $450; its delivery time is 60 days.

Ectron Corp., 8159 Engineer Rd., San Diego, Calif. 92111. Phone (714) 278-0600 [384]

Dc servo amplifier stresses reliability

Protected against nine specified fault conditions, the model A6524B dc servo amplifier is designed to work with motors rated at 9 horsepower. It is capable of putting out up to



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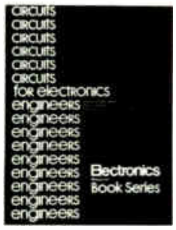

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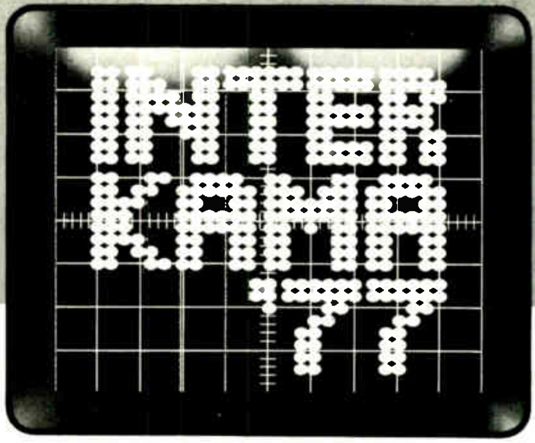

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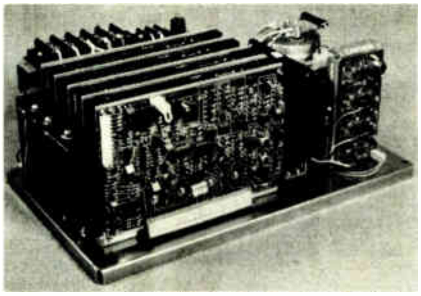


±100 volts at a continuous current of ±75 amperes or a peak current (0.5 second) of ±120 A.

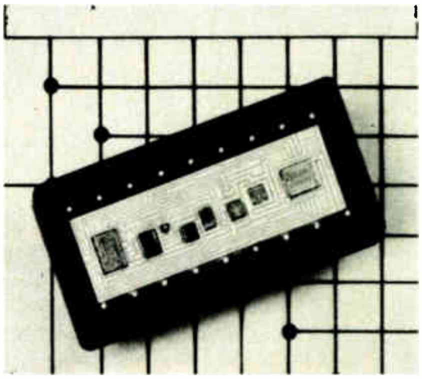
The fault conditions against which the amplifier is protected are: shorts across the output, either before or after the 1.3-millihenry series inductor; shorts of either leg to ground; loss of or low dc-bus voltage; loss of or low bias voltage; excessively high dc-bus voltage; excessive motor current; system oscillation that requires excessive current; and excessive temperature. Some of these conditions cause the unit to shut down, others can be handled safely while the amplifier is operating.

Three 18-turn adjustable pots allow the signal, tachometer, and auxiliary input gains to be adjusted from 0 to 6,000 amperes per volt. The amplifier, which requires a separate power transformer, weighs 9 pounds. It is the largest of 10 in a series designed to work with motors as small as 2.7 hp.

Westamp Inc., 1542 15th St., Santa Monica, Calif. 90404. Phone Jim Manda at (213) 393-0401 [383]

Companding a-d converter has 72-dB dynamic range

Housed in a single dual in-line package, the model MN5110 companding analog-to-digital converter is a variable-resolution device with a 72-decibel dynamic range. Its 8-bit output is composed of a sign bit, three chord bits, and four step bits. The chord bits, which can take on a total of eight values, determine the voltage values of the step bits. In the first chord, the least significant step bit has a value of 1.25 millivolts. With each successive chord, this value is doubled. Thus the output has a resolution that is proportional to the input level rather than to the full-scale amplitude. The converter has the equivalent of 12-bit resolution at low levels, but drops to 6-bit resolution as the input approaches full scale. Except for its nonlinear transfer function, the MN5110 is similar in design and application to other Micro Networks successive-approximation a-d converters. It sells for $55 each in hundreds and is



available from stock to four weeks.

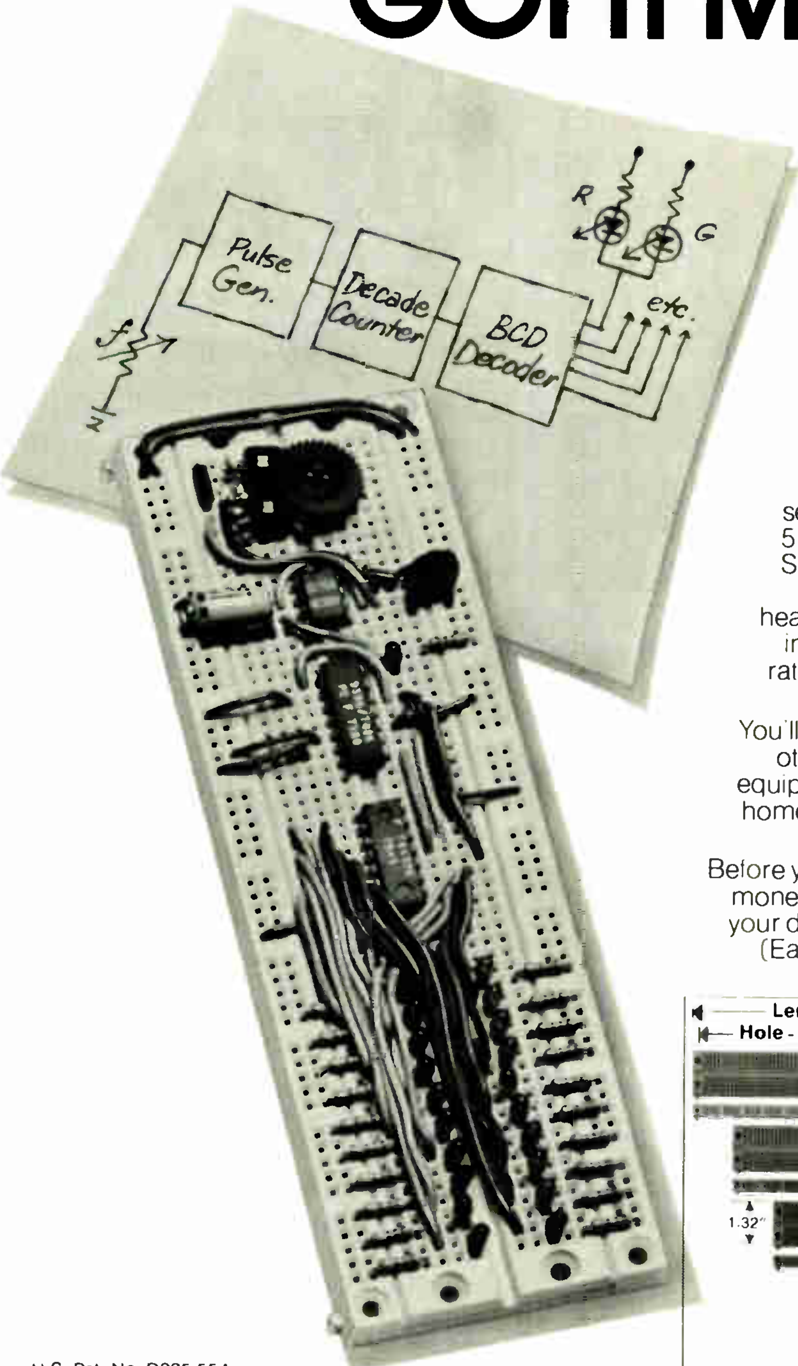
Micro Networks Corp., 324 Clark St., Worcester, Mass. 01606. Phone (617) 852-5400 [387]

Ferroresonant supplies get smaller and quieter

A new type of magnetic structure has made possible ferroresonant dc power supplies that deliver more power per cubic inch and make less acoustic noise than previous units. The power-density improvement amounts to 50%, allowing the fabrication of a 450-watt supply in the same 490-cubic-inch package that previously could only deliver 300 W. At the same time, the acoustic noise that ferroresonant devices produce because of the magnetostrictive effect has been reduced to levels comparable to those of ordinary transformers.

Offered in both cased and uncased versions, supplies in the PRM-450 series produce from 12 volts at 35 amperes to 48 V at 10 A. They are line-regulated to within 1% at full

ONCE YOU'VE GOT IT DESIGNED, YOU'VE GOT IT MADE.



It's that easy when you use CSC's QT solderless breadboarding Sockets and Bus Strips. Working directly from logic or block diagrams, you plug in IC's, transistors, resistors, capacitors, LED's—virtually any component—and optimize circuits stage-by-stage, literally as fast as you can think. (No special jumpers required, either—just ordinary #22-30 solid hookup wire.)

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Available for as little as $3.00* QT units snap together into larger breadboards, and mount securely wherever you need them. Sockets have 5 interconnecting tie points per terminal and Bus Strips feature 2 separate rows of interconnecting terminals. And all QT models are built to last: heavy-duty prestressed nickel-silver contacts, vinyl insulated backing and glass-filled plastic sockets rated at better than 100°C insure optimum day-in, day-out performance.

You'll find QT Sockets and Bus Strips useful in lots of other ways, too. Mounted on power supplies, test equipment, bench or plug in cards, they're equally at home in lab, on production lines, in QC test jigs or in the field, for on-the-spot emergencies.

Before you start your next project, start saving time and money with QT Sockets. Pick up your phone and call your dealer—or order direct by dialing 203-624-3103 (East Coast) or 415-421-8872 (West Coast). Major credit cards and purchase orders accepted.

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QT-47B	5.3"	5.0"	16	2.25
QT-35S	4.1"	3.8"	70	8.50
QT-35B	4.1"	3.8"	12	2.00
QT-18S	2.4"	2.1"	36	4.75
QT-12S	1.8"	1.5"	24	3.75
QT-8S	1.4"	1.1"	16	3.25
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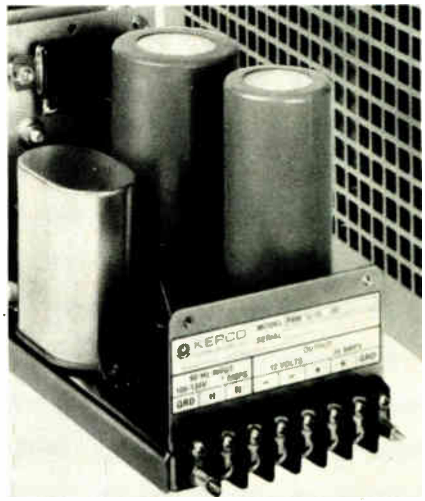

load and vary greatly in their regulation under changing loads. The worst-case 48-volt units will increase their outputs by as much as 1.4 V as the load is dropped from 100% to 25%. Because of their ferroresonant design, the supplies are inherently short-circuit-proof and pose no overvoltage hazard.

PRM-450 models sell for $299 in singles and $239 in hundreds. The 50-Hz versions sell for $329 in singles. They are available from stock.

Kepco Inc., 131-38 Sanford Ave., Flushing, N. Y. 11352. Phone (212) 461-7000 [385]

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Avtech Electrosystems Ltd., P.O. Box 11426, Stn. H, Ottawa, Ontario, Canada K2H 7V1. Phone (613) 828-4823 [386]

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Microprocessors

I/O cards aimed at control jobs

Analog boards designed as subsystems for use with Z-80 microcomputer

It could be getting a bit monotonous for Paul Severino. As director of engineering for computer products at Data Translation Inc., Natick, Mass., he has designed analog input/output boards for just about every single-board microcomputer there is. The latest is the DT1781 series of subsystems for the 8-bit Zilog Z-80 MCB series and MCS system. The series consists of four circuit boards; two have analog inputs and outputs on the same board, and two are analog input units only.

Of the I/O subsystems, the DT1781 is a high-level board handling ±10 volts full scale. It offers 16 single-ended or 8 differential input channels, plus full 12-bit resolution in both its analog-to-digital and digital-to-analog converters. The price is $895 for a single unit.

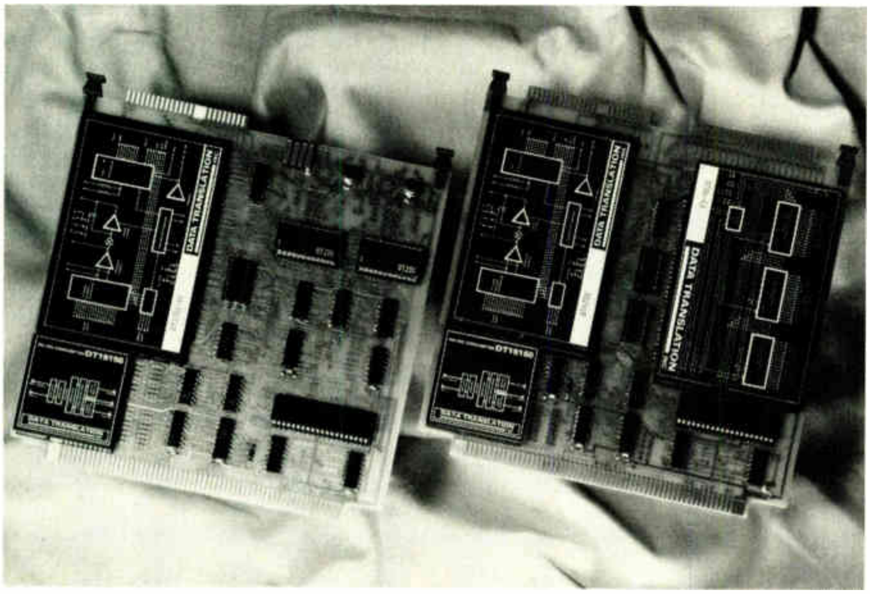
The 1781 also has current-loop inputs and outputs of 4 to 20 milliamperes as options for the user.

In discussing applications in process control for which the DT1781 series is primarily intended, Severino gives three examples. One involves use of the Z-80 microcomputer to control the temperature of an extruding machine's barrel, handling 32 thermocouple inputs. Another is temperature sensing in oil-well drilling, and the third entails scanning of tire X rays for quality control in manufacturing operations.

The other analog I/O board in the series is the DT1785, designed for low-level, wide-range signals from 10 millivolts full scale to 10 V. It, too, offers 16 single-ended or 8 differential channels and a 12-bit a-d or d-a converter providing two analog output channels. The single-quantity price is $995.

The two boards that provide for analog inputs only are the DT1782 and 1784. The former is a high-level (±10-v or 0-to-10-v) board, and the latter is for low-level, wide-range signals (10 mv full scale to 10 v). Both have up to 64 single-ended or 32 differential channels. The 64-channel 1782 sells for $995 ($595 for 16 channels), the 64-channel 1784 for $1,095 ($695 for 16 channels).

All four boards are compatible with the Z-80 single-board size of 7.7 by 7.5 inches, and they plug directly into the microcomputer's



bus. Delivery time is four weeks. For the first time, Data Translation is offering an expander module for the low-level boards. It allows the user to accommodate up to 64 single-ended channels, instead of 16, as with previous low-level boards. The customer can set the number of channels by selecting a logic line that will determine whether the channels on his I/O board are single-ended or differential.

Data Translation Inc., 23 Strathmore Rd., Natick, Mass. 01760. Phone Fred Molinari at (617) 655-5300 [401]

Interfacing v-f converters with computers gets simpler

Although voltage-to-frequency converters are cheap and effective devices, they have not come near to realizing their potential in such applications as process control because their outputs are not readily interfaced with computers. Now a small company in Wayland, Mass., has developed a pair of products that simplifies the interfacing task: an 8-bit digital frequency meter and a 16-channel digital multiplexer with a built-in memory. The meter will work alone; the multiplexer must always be used in conjunction with the meter.

The AIM-1005 frequency meter interfaces with most 8-bit microcomputers. It has a resolution of 13 bits plus overrange, and it is accurate to within one count from 0° to 70° Celsius. The unit has a minimum frequency span of dc to 25 megahertz, although it will typically work up to 40 MHz.

Its companion, the AIM-1006 multiplexer, derives much of its value from its internal 32-byte complementary-metal-oxide-semiconductor memory. The memory, which stores 16 frequency readings (each reading takes up 2 bytes), makes it unnecessary for the microcomputer to go through an interrupt routine every time a frequency measurement must be made. The microcomputer can read the frequency of any channel as 2 bytes at

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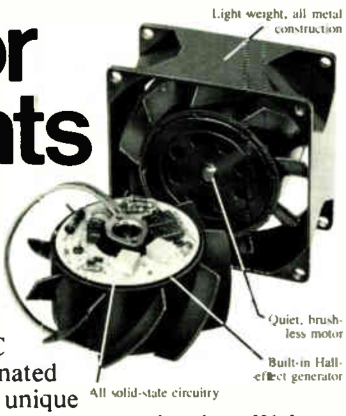

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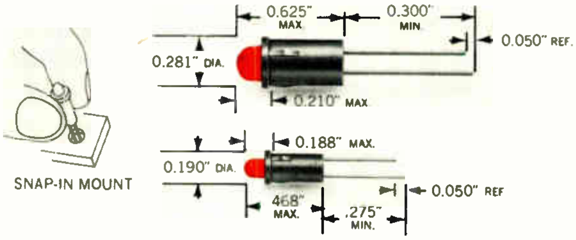

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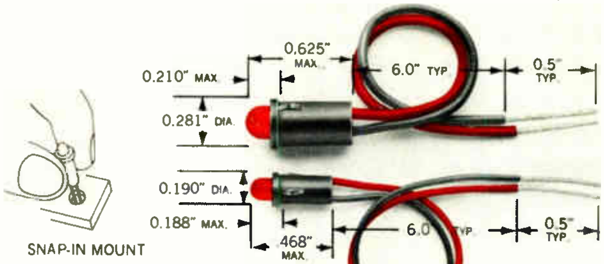

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any time, without waiting for a conversion.

At the end of a count period, which can vary from 10 microseconds to one hour, the frequency meter generates a 12-microsecond end-of-count pulse. The pulse triggers two one-shots in the multiplexer and enables the writing of 2 bytes of data from the frequency meter into the multiplexer memory. The computer can retrieve the data from the memory in 500 nanoseconds or less.

The 16-channel multiplexer switches channels sequentially until it reaches 15 or the maximum number programmed and then jumps back to channel 0. Numbers between 0 and 15 can be programmed by means of jumper wires for applications in which the user does not need the full 16-channel capability of the multiplexer. In any event, data in the multiplexer memory is updated each cycle.

Like the frequency meter, the multiplexer can be interfaced with a microcomputer as either an input/output device or as a memory-mapped unit. It mounts on the same-sized board as the AIM-1005—4 by 4.5 inches—and gets its 5-volt power from a regulator on the frequency meter.

The AIM-1005 frequency meter sells for $178 in quantities of one to nine; the AIM-1006 multiplexer's price is $143 for the same quantities. An Altair or Imsai mounting board that will accommodate both sells for an additional $35. Delivery is from stock to four weeks.

Automated Industrial Measurements Inc., P. O. Box 125, Wayland, Mass. 01778. Phone Barry Hilton at (617) 653-8602 [402]

Graphics capability gets cheaper and easier

Edac Corp. has introduced a set of six microcomputer peripherals designed to make it cheaper and easier to add a cathode-ray-tube display to a microcomputer system. Aimed primarily at original-equipment manufacturers, the set of products is easy to configure, according to general manager Fred Kreiss, and makes it possible to build a complete intelligent terminal at low cost.

The three main products are: the 711-1 CRT control board, the 711-2 CRT graphics board, and the 711-3 keyboard. The CRT control board allows the computer to display eight columns by six lines directly on a CRT. It offers a five-step zoom capability, underlining, and letter inversion. Its read/write memory eliminates the cost of double buffering and helps keep the price of the board down to $302 each in hundreds.

The 711-2 graphics board gives the user the ability to mix graphics and alphanumerics on the screen. By adding a software routine, the user can also give himself the ability to slide characters around. The 711-2 sells for $325.

Like the other 711 peripherals, the keyboard acts like a memory, requires no special interface hardware, and is compatible with most microcomputer systems. Two read-only memories function as its character generator, so it is only necessary to program two $10 programmable ROMs to change languages, if desired. The price of the 711-3 is $341. The other three support products are a power supply ($139), a CRT display ($170), and a case ($162).

Edac Corp., 1417 San Antonio Ave., Alameda, Calif. 94501 [403]

Printer for 6800 system bangs out 65 lines/minute

An impact-printer subsystem for use with M6800 development systems produces lines of up to 80 5-by-7-dot matrix characters at a maximum rate of 110 per second—equivalent to about 65 lines per minute. Called Exorprint, the printer is compatible with both Exorciser and Micromodule systems. Its impact head uses a conventional teletypewriter ribbon to print on 8.5-inch-wide roll paper.

To enhance reliability, the system was designed without brakes, clutches, and dampers. Optoelectronic sensing accurately positions

each dot and permits characters to be printed on the fly. A stepper motor provides silent line advancing and a paper slew rate of 400 lines per minute. The table-top machine has a unit price of $1,725 and is available immediately.

Technical Information Center, Motorola Semiconductor Products Inc., P. O. Box 20924, Phoenix, Ariz. 85008. Phone (602) 244-6815 [404]

High-performance computer fits in small package

The 11/B computer system is a compact unit built around the Digital Equipment Corp. LSI-11 central processing unit. It features dual floppy disks, floating-point-arithmetic firmware, 20,000 16-bit words of memory, a 9,600-baud video terminal, and DEC RT-11 operating software. Except for the terminal, the entire computer is housed in a single rack-mountable chassis only 10.5 inches high.

The system's floppy-disk controller, which makes its small size possible, is available separately as the FDC-11. This unit can control four drives and can format diskettes. It interfaces with Shugart SA-800 drives directly; to interface with Pertec FD-400 or -500 drives, it requires a personality card.

The 11/B sells for $8,317. For an additional $685 the video terminal can be replaced by an LA-36 terminal. The FDC-11 controller is priced at $850, and the personality modules for the Pertec drives go for $50 apiece.

Andromeda Systems, 14701 Arminta St. #J, Panorama City, Calif. 91402. Phone Jim Reynolds at (213) 781-6000 [405]

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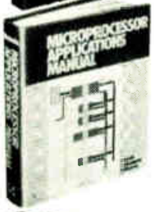

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Communications

Voice system saves bandwidth

Linear predictive coding allows digitized voice to be transmitted at 2,400 b/s

Digitizing voice for secure communications and other applications usually requires the rather high transmission rate of 56 kilobits per second—and therefore a large bandwidth—to get good-quality reception. But Time and Space Processing Inc. of Cupertino, Calif., has developed a digital telephone system, model 100, that provides exceptional-quality voice communications without using a large bandwidth—4-kilohertz analog voice is sent digitally at only 2,400 bits per second. The microprocessor-controlled voice digitizer permits two-way conversation in real time over standard phone lines using conventional telephones, microphones, or similar equipment. The unit can also be multiplexed in parallel with other data onto a conditioned leased line, because it looks like a synchronous data terminal operating at 2,400 b/s.

The technique used to transform a 4-kHz audio input into a serial bit stream for real-time transmission is called linear predictive coding, LPC. Simply put, the audio signal is analyzed by means of a coding technique that is implemented in microprocessor architecture, and the result is a digital serial bit stream representative of the analog signal. To provide duplex operation, the system uses an analyzer in the send portion and a synthesizer, which operates independently, in the receive portion.

In the analyzer portion, an analog module provides bandpass filtering before the signal reaches the analog-to-digital converter. Subsequent digital signal processing sorts out the needed characteristics of the speech waveform: voiced and unvoiced sounds, pitch rate, power, and spectral content. The analysis algorithms, stored in read-only memory, extract these characteristics.

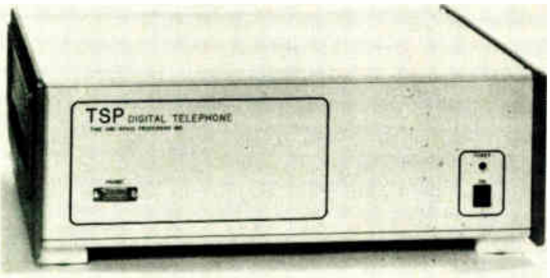
Voiced and unvoiced analysis differentiates sounds that are produced by air passing over the vocal chords and through the vocal tract from those sounds produced without that excitation. For voiced sound, the pitch extraction analysis determines the fundamental frequency of the vocal chords. Parameters of the speech signal spectrum other than pitch rate are handled by the LPC algorithm. In essence, the LPC technique estimates the next sample of speech waveform based on a linear combination of past samples to determine the weighting and assign the samples to produce the best estimate. The results of all this processing are combined in a frame of serial data for transmission via a communications interface, such as the EIA RS-232-C, the Mil 188C, or the CCITT V.24.

In the receive portion, the synthesizer uses the information contained in the bit stream to reconstruct the speech signal, first as a sampled-data time series, then through the digital-to-analog converter, and finally through an analog filter to an audio earpiece.

The microprocessor handles several chores. Although implementation of LPC in this architecture requires high-speed hardware modules, a relatively slow microprocessor can interpret as well as control program execution. Computation and decision are necessary in each of the analyses and the microprocessor must assemble the bit package in proper order and maintain frame synchronization.

Model 100, which measures 18.6 by 16.7 by 18.8 inches, sells for $14,950 in small quantities. It can be rented for $600 per month. Delivery time is 90 days.

Time and Space Processing Inc., 10430 Tantau Ave., Cupertino, Calif. 95014 [371]



Inexpensive fiber-optic system handles 9,600 b/s

Here's one of the first low-cost fiber-optic digital data sets designed especially to carry data over relatively short distances. The full-duplex system offers freedom from electromagnetic interference and provides signal-emission security for such applications as transferring data from a computer terminal to a central processor.

The data set handles rates up to 9,600 bits per second, although 50 kilobits per second is possible as an option. At 9,600 b/s, the error rate is one in 10^8.

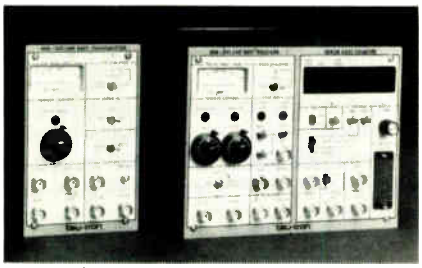
Compatible with EIA RS-232-C or CCITT standards, the data set is supplied with everything except the fiber-optic cable: integral 25-pin connector, fiber connectors, regulated power supply, and signal-processing electronics. For data links less than 150 feet long, the company recommends using Du Pont's plastic cable. For greater distances, up to 1,200 feet, it suggests Du Pont's toughened silica-fiber cable.

The data sets sell for $675 per pair of interface units, plus the cable cost. The company offers the Du Pont plastic cable at a cost of $3.30 per meter—exactly what it pays for it. Delivery time ranges from 30 to 90 days.

Optical Communications Corp., 950 Norwood Rd., Silver Spring, Md. 20904 [372]

Fast instruments test 325-megahertz PCM links

The MN-301 transmitter and the MB-301 receiver form a pseudorandom data generator and receiver for use over the range from 1 to 325 megahertz. The transmitter has provision for two different sequence lengths—127 bits and 32,767 bits. It also puts out a simple test pattern (11001100 . . .), and has provision for local and remote error injection.

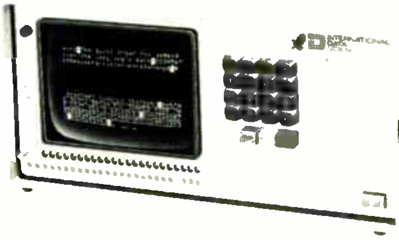


The receiver features automatic synchronization, variable threshold adjustment, and a 4-digit counter to display bit-error rate or total bit errors. The counter, which has a binary-coded-decimal output port for connection to a printer, can be used independently. Pricing on the ultrahigh-frequency modules is as follows: $3,900 for the MN-301 transmitter, $6,000 for the MB-301 receiver, and $875 for a mainframe that contains power supplies and cooling for the two plug-in modules. Delivery time for all the equipment is 8 to 10 weeks.

Tau-Tron Inc., 11 Esquire Road, North Billerica, Mass. 01862. Phone (617) 667-3874 [377]

Flexible tester diagnoses data-transmission problems

The Hawk 4000 Datatrap is a microprocessor-based piece of test equipment designed to help the user diagnose data-communications problems quickly. An interactive device, it can monitor, transmit, and receive data



between a modem and a terminal. The unit can trap and store 2,000 characters for later study, with the data displayed on a 9-inch 512-character screen.

The system operates with BISYNC, SDLC, HDLC, and all ADCCP standard protocols. It can handle full-duplex asynchronous data rates from 75 to 19,200 bits per second and synchronous line rates up to 75,000 b/s. Because its switch functions are contained in software rather than hardware, the Hawk 4000 Datatrap is highly resistant to obsolescence. It sells for $9,975 and has a delivery time of 60 days.

International Data Sciences Inc., 100 Nashua St., Providence, R. I. 02904. Phone (401) 274-5100 [376]

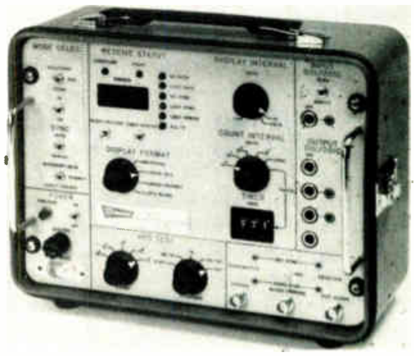
660-nanometer signals cut only 40 dB/km by optical cable

Model PFX-S120R fiber-optic cable features a maximum attenuation of 50 decibels per kilometer at 820 nanometers and 40 dB/km at 660 nm. Enclosed in a black jacket for increased resistance to ultraviolet radiation, the cable combines high strength with good flexibility: a 1-meter length of PFX-S120R can support more than 65 kilograms, and can be wrapped around a 3-millimeter mandrel five times without breakage. The cable replaces a previous product with the same model number, which had maximum attenuations of 85 dB/km at 820 nm and 50 dB/km at 660 nm. The earlier cable also lacked the pigmented covering. Like its predecessor, the new PFX-S120R sells for $4 a meter; minimum purchase is 50 meters.

E. I. du Pont de Nemours and Co., Plastic Products and Resins Dept., Wilmington, Del. 19898. Phone C. Ronald Ferguson or Kenneth S. Kamm at (302) 774-7850 [373]

PCM carrier analysis tester checks 3.152-Mb/s systems

Designed to check out transmission systems and components that operate at 1.544 and 3.152 megabits per second, the model 273A carrier analysis test set is suitable for use with such Bell System transmission systems as T-1, T-1C, multiplexed T-1, and the Digital Data System, as well as with Lenkurt Duobinary. In addition to detecting bipolar violations and logic errors, the set transmits signals compatible with the Bell System's T-1 and T-1C test patterns. It can be used for isolating problems in the central office because it can receive on cable up to 4,000 feet



long. The model 273A has a selectable bridging or terminating receiver. The transmitter can inject bipolar violations for circuit identification and for the testing of automatic protection switches.

Bowmar/ALI Inc., 531 Main Street, Acton, Mass. 01720. Phone (617) 263-8365 [374]

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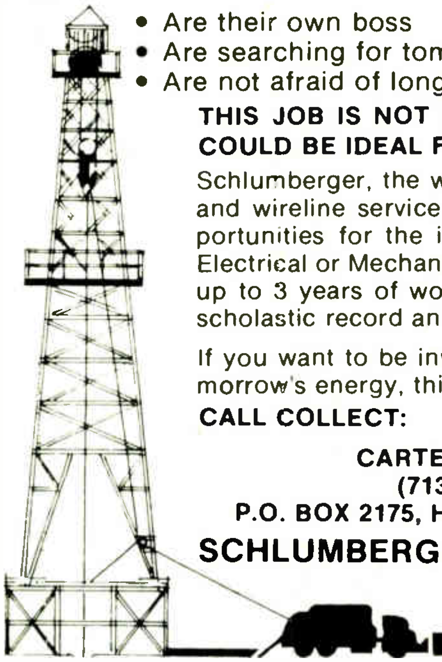

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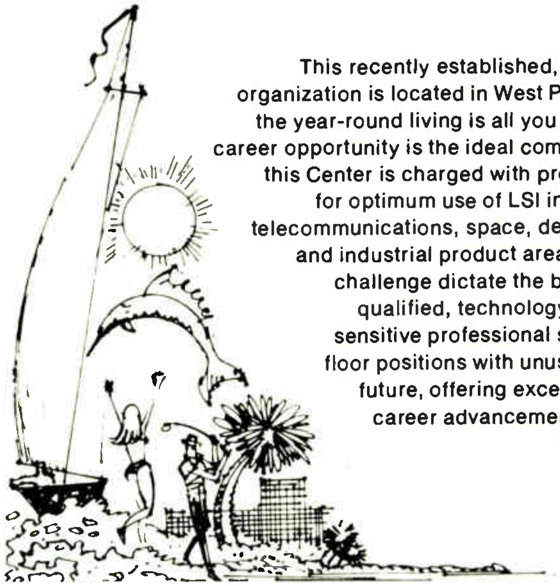

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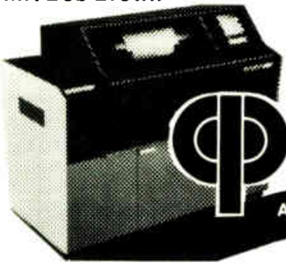

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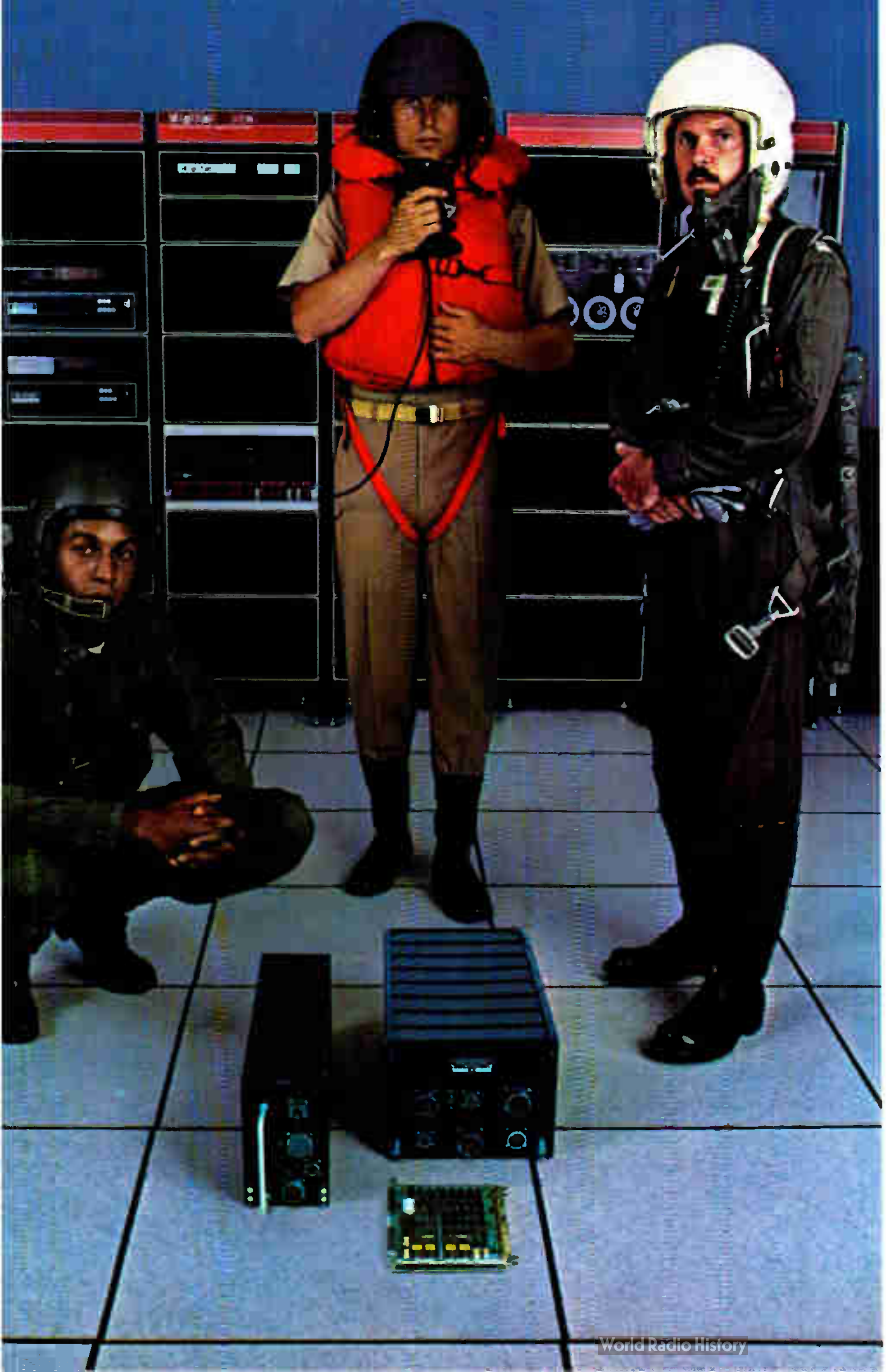

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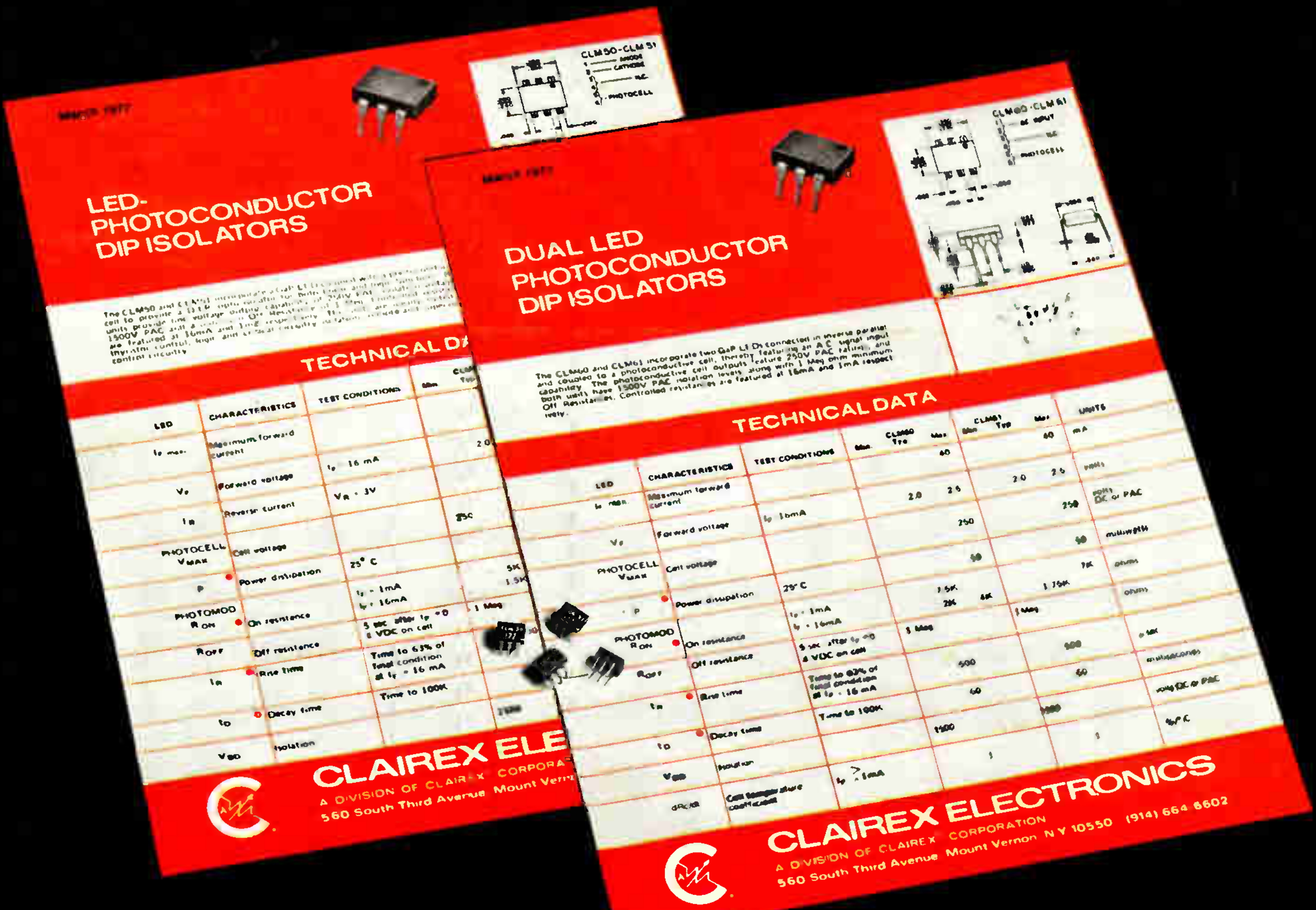

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