APRIL 3, 1975

SPECIAL: GUIDE TO ELECTRONIC SYMBOLS/90

Specialized common carriers: can they make it?/71

New directions in data acquisition/83

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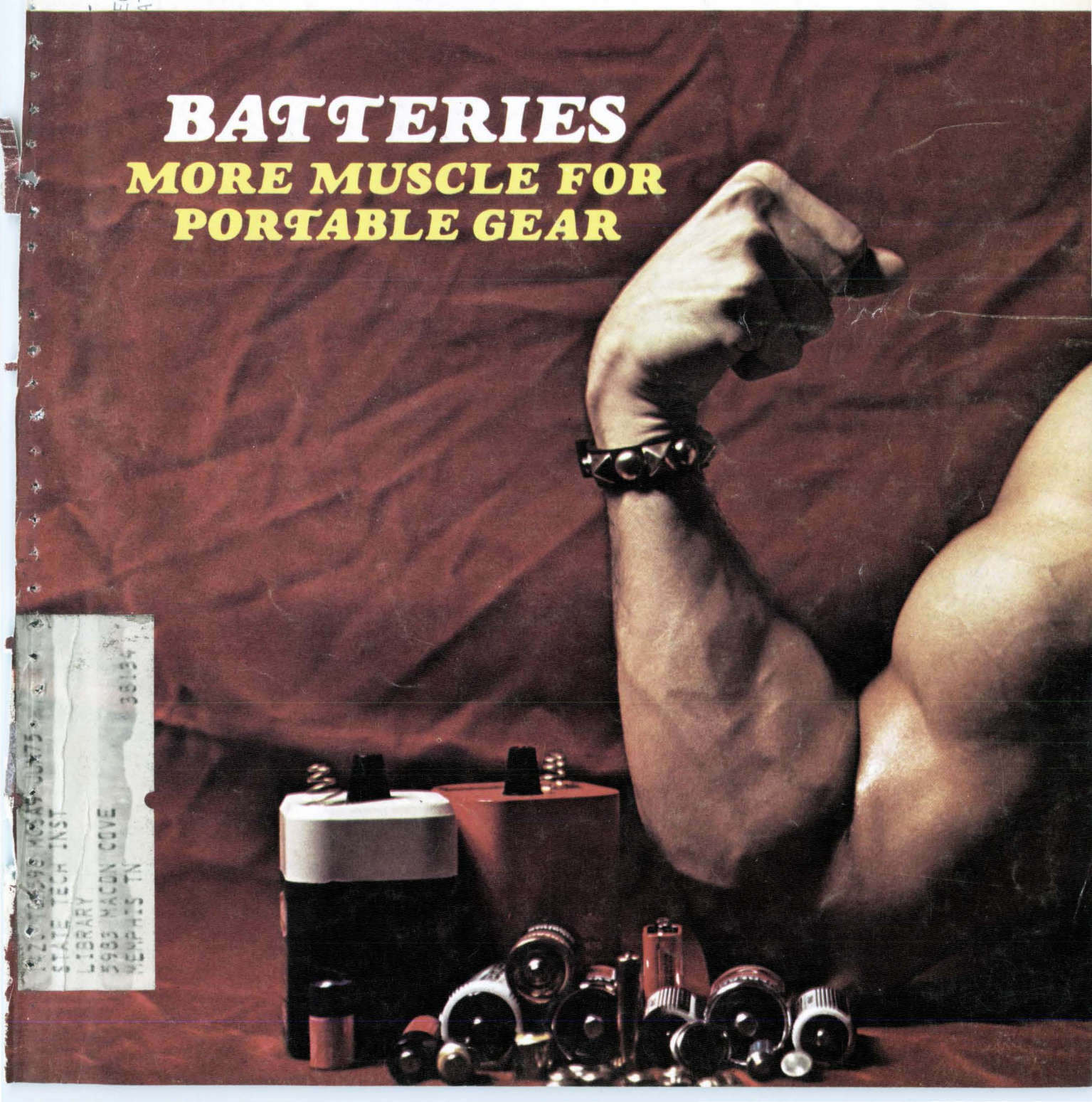


Why Parylene works where other microelectronic protection fails:

Crevice penetration in hybrids

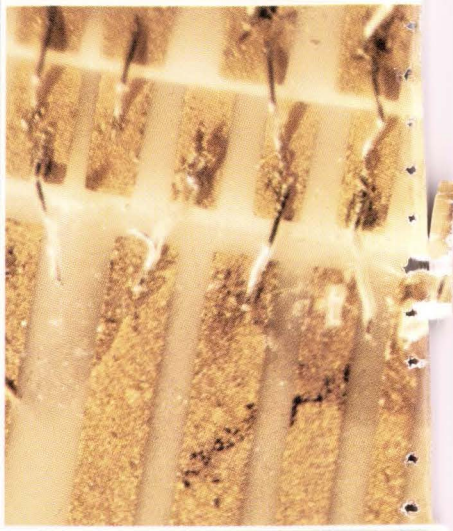
This beam lead has a 0.3 mil parylene coating all the way to the weld. Parylene penetrates deep within small crevices, maintaining clearance while putting a coherent coating under beam leaded chips and air bridges. No area is left unprotected, preventing shorts and allowing the designer great latitude in component spacing and sizing. And parylene secures loose debris while preventing breakoff of pigtails during shock and vibration loadings.

Controlled conformality

There's a uniform coating of parylene all the way around the half-mil tip of this phonograph needle. That's true conformality, and only parylene gives it, in precisely controlled thicknesses from .002 to 3 mils, in one step. Unlike spray or dip coatings, parylene won't bridge or puddle, or thin out at sharp edges, creating potential failure points. The parylene coating is completely uniform, no matter how dense or intricate the module. And because it's applied at room temperature, there's no component discomfort.

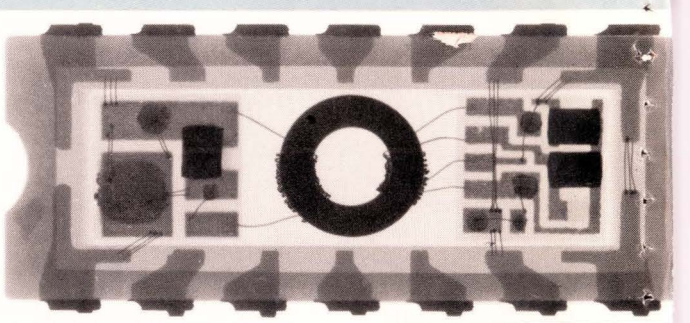
Lead Strengthening

It took up to 75 grams pull to break these 1 mil wires. Bare 1 mil aluminum wires, for instance, exhibit bond strengths of 3-5.5 grams; coated with 1 mil of parylene, pull strength increases by 60-70 grams. So wire and bond are stronger, and sideward shorts and loop collapse during extreme g-loads are prevented. Parylene coatings will penetrate the less than 1 mil clearance between beam lead bonded chips and the substrate, giving such strong coating coverage that the chip cannot be lifted without destroying it.

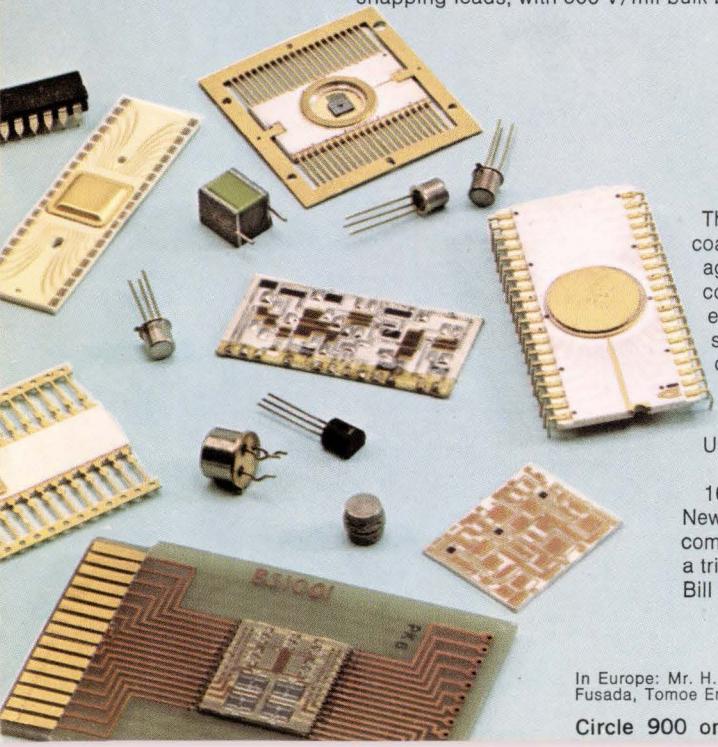


△200 C thermal shock protection

This hybrid microelectronics relay has undergone 200 45-minute cycles from −120 to 80°C, simulating earth-orbiting conditions. This X-ray shows all leads remain intact. Parylene protection was at work, on the transformer core and then the whole assembly before packaging (TO-116). There was no appearance of corona up to 5000 V_{dc} ; leakage was reduced from 10μA to <.001μA at 1000V. RTV encapsulation suffered dimensional mismatch, straining and snapping leads, with 500 V/mil bulk breakdown.



X-ray courtesy NASA Lewis Research Center and Sterer Eng. & Mfg. Co.



Broad cost effectiveness

These are some of the circuit modules now being protected with a conformal coating of parylene. Because nothing else offers parylene's combined protection against thermal cycling, shock, vibration, humidity, solvents, radiation, ionic contamination. Better barrier protection than liquid coatings like silicones, epoxies, and urethanes. On hybrids you can combine parylene with a hermetic seal for optimum environmental protection . . . and parylene alone will often do the job, and at less cost than hermetic seals. Parylene is compatible with active devices, and meets the tough requirements of MIL-I-46058C. For long term reliability, parylene provides a cost-effective solution.

Union Carbide invented the parylene system. Various patents apply; commercial use of the patented technology is licensed. Write for our 16-page brochure: Union Carbide Corp., 270 Park Avenue, Dept. RFB-65, New York, N.Y. 10017. For instant communication, and information about a trial run at reasonable cost, call Bill Loeb at (212) 551-6071.

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Circle 900 on reader service card

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Sour Note Ever have service turnaround problems?

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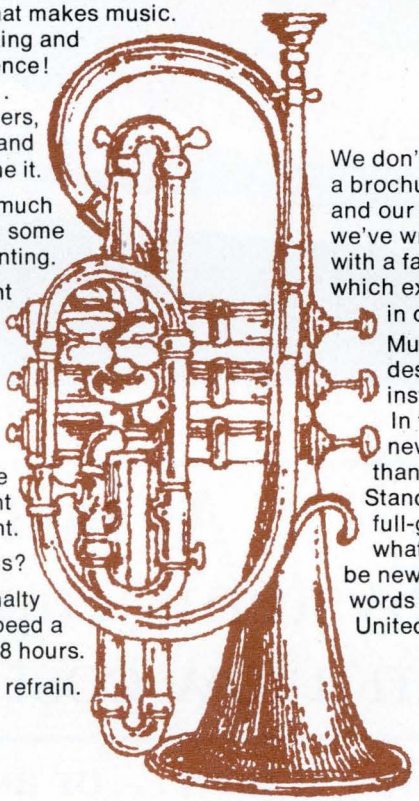

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Electronics
The International Magazine of Electronics Technology
Vol. 48, No. 7 • April 3, 1975

Highlights

Cover: Batteries pack more power per pound, 75
The appeal of low-power electronic equipment is being enhanced by new primary and secondary cells, which perform better and are packaged more simply than older power sources.

How the CIA learned of the Soviet sub, 61
Before the CIA could spend more than $300 million on retrieving it, the U.S. had to find the Soviet submarine that sank somewhere in the Pacific. That triumph is due to Sea Spider, a multimillion-dollar sonar system that has sat on the ocean floor near Hawaii for several years as part of a Navy submarine detection network.

Data acquisition verges on breakthrough, 83
The inexpensive, monolithic analog-to-digital converter, when it finally arrives, will simplify the design of data-acquisition systems by enabling signals to be digitized peripherally and not by the central processor. System applications should multiply.

Guide to circuit symbols is updated, 90
Since *Electronics* printed its last guide to circuit symbols, the technology has been to the moon and back. The changes generated by this achievement are reflected in the new guide, which is based on the work of national and international symbols committees.

And in the next issue . . .
Special issue on productivity . . . preview of the Electronic Components Conference.

Electronics

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Publisher's letter

The headline-making story of the CIA's project to raise a sunken Russian submarine reads like a cloak-and-dagger novel, with its mystery ship, its reclusive millionaire, and its heavy infusion of international intrigue. Yet perhaps the most notable part of the whole story is that the project was conceived only because United States intelligence people knew exactly where the submarine sank.

And most readers of the newspaper accounts don't realize that the submarine was pinpointed, as it was sinking, by a sophisticated electronic surveillance system. For that part of the story, turn to page 61 where Ray Connolly, our Washington bureau manager tells of the Navy's Project Caesar, which is bringing a new level of "transparency" to the murky ocean depths.

Symbols are an invaluable aid in the transfer of complex information, such as that embodied in electronic circuit diagrams. Try to visualize a schematic devoid of, say, transistor symbols. Words describing pin function, device type, and other data would have to be added, and, even then, the role of that transistor might not be clear.

But to be of real help, symbols must have a wide acceptance and become, in fact, standardized. More than a decade ago, *Electronics* last published an abridged guide to electronic circuit symbols, and since then, a lot of new ones have come into common usage. In this issue we are publishing an updated compilation of the symbols most needed in a modern schematic. The fold-out guide follows page 90.

The guide is organized into seven sections, each devoted to one major type of circuit element. The sections are semiconductors, optoelectronic devices, two-state logic devices, fundamental circuit components, transmission paths, microwave circuits, and contacts, switches and relays.

The old-standby, the battery, is facing some fundamental changes under the combined pressure of the marketplace and the unfolding possibilities of new technology. Indeed, the basic carbon-zinc primary cell is being challenged by three promising new devices: zinc-chloride, divalent silver-oxide, and lithium cells. And novel packaging ideas abound, including flat batteries and hybrid packages with more than one cell type. What's more, rechargeable secondary cells are getting a face lift.

One of the biggest forces for change, interestingly enough, is the low power consumption of semiconductor devices. Says packaging and production editor Jerry Lyman in the article on page 75: "As the increasing application of semiconductor technology reduces the requirements of electronic equipment, ever more sophisticated batteries are being developed to replace larger power sources. At decreasing prices, these batteries have several advantages over their predecessors—more power per pound, longer shelf life, higher performance over a longer temperature range, and better packaging."

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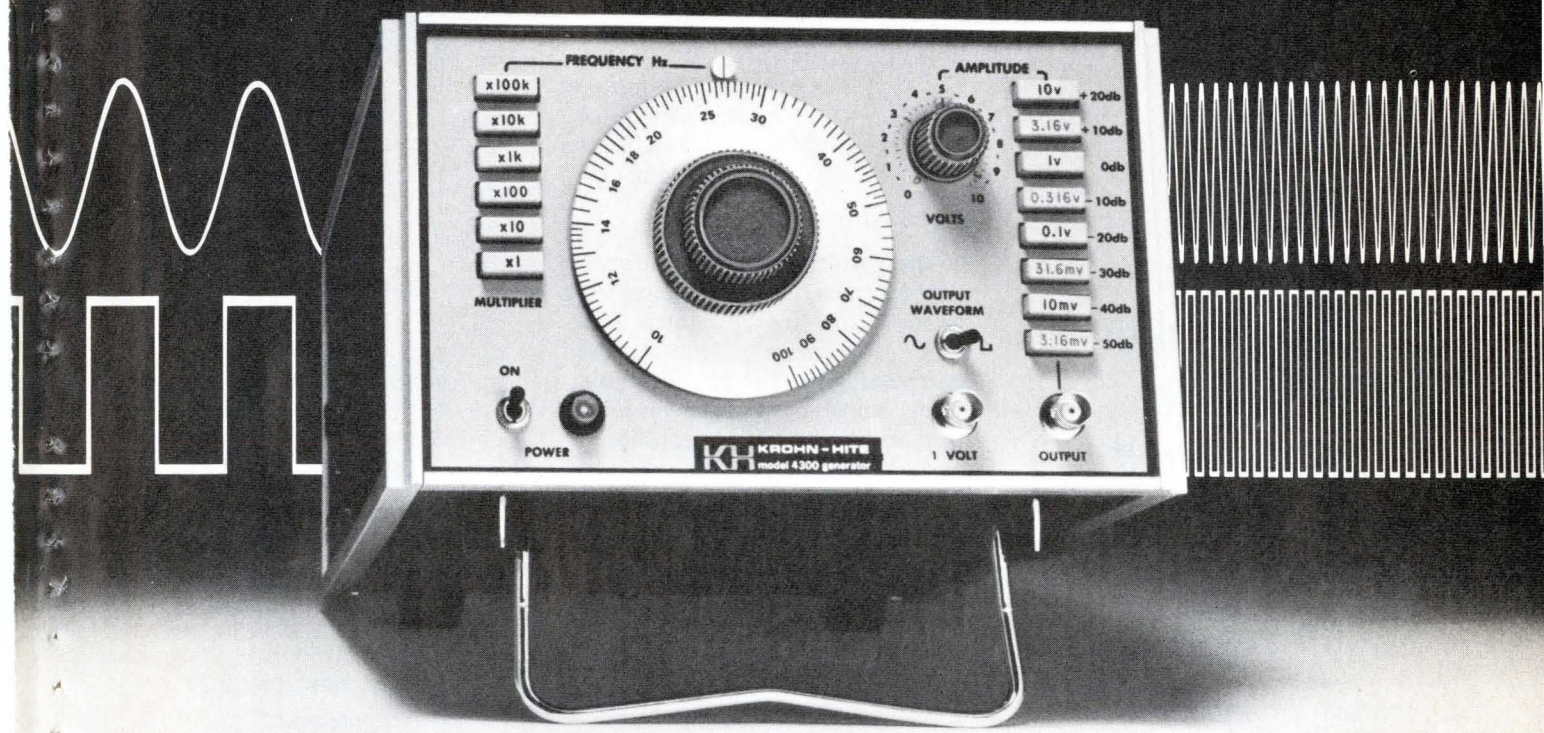

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Circle 5 on reader service card

Readers comment

D/A unit clarified

To the Editor: It should be pointed out that the D/A converter used in my circuit published in the Jan. 23 Designer's casebook (p. 86) is a multiplying DAC that is capable of accepting a bipolar reference voltage.

In addition, the third paragraph should be corrected to read, "The open loop corner frequency of the gain block is $f_p = .159/A_0R_4C$. Its unit gain bandwidth is $F_{GBW} = 0.159/R_4C$, if the amplifier rolls off at –6dB per octave."

G. H. Whitmore
Analog Devices Inc.
Microsystems Division
Santa Clara, Calif.

Just a competitor

To the Editor: Regarding the report on the ultrasonic river gauge being manufactured in the United Kingdom [*Electronics*, International newsletter, Jan. 9, p. 56], such monitoring units have been available from several American suppliers, including Badger Meter Inc. and Westinghouse, for a number of years. So this seems to be just another competitor rather than new technology.

H. David Lenci
Badger Meter, Inc.
Tulsa, Okla.

Correction

The seven-segment orange light-emitting-diode display from Siemens AG described in International newsletter [*Electronics*, Feb. 20, p. 56] needs only 10 milliamperes per segment. Also, it should say that, using the same current as the red, green, and yellow LEDs, the orange LEDs produce eight times the brightness of the other colors because of the "special chemical composition" of the gallium-arsenide phosphide layer on the gallium-phosphide substrate.

On p. 66 of the March 20 *Electronics*, the Earth Resources Technology Satellite, from which the Earth Observatory Satellite series evolved, was incorrectly identified as the Applications Technology Satellite.

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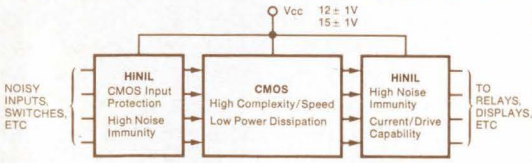

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News update

■ About a year ago, Bryant (Buck) Rogers, president of Diacon Inc., a San Diego, Calif., manufacturer of packages, announced a new ceramic IC package and predicted a bright future for it. The cerdip-family package not only sealed at 265°C, but was priced below side-brazed or co-fired packages that typically seal at 310°C [March 7, 1974, p. 26]. Since then, Diacon's package has acquired a name—Diapak—and a warm spot in Rogers' heart. "It's grown to become a substantial part of our business," he says. Rogers adds that Diapak has become especially popular for programable read-only memories and other applications where sealing temperature is especially important. The success of the line has also led to additions—the original 14- and 16-lead versions have been joined by 18-, 22-, 24-, and 28-pin configurations.

■ A minicomputer has found a home on the San Francisco-Oakland Bay Bridge. Installed last year to control traffic lights, it has been pronounced a success by Bay Bridge engineers. They say the system has eased congestion and has helped increase the number of car pools using the bridge during morning and evening rush hours. A year ago, they say, there were only 1,000 car pools; now there are 2,000. The pools are attractive to commuters because, like buses, they have a "free" lane: no stops and no tolls. The bridge can handle 8,500 vehicles at one time. If the number tops that the minicomputer system sees to it that the excess vehicles are held back for from six to 10 seconds each until congestion eases. The engineers say the average rush-hour motorist now spends on the average of 2.5 minutes less on the bridge because of the new system. The $350,000 installation, part of a Department of Transportation project, consists of a Data General Corp. Nova 1210 with 8,000 words of memory. It is located at the bridge's plaza, while magnetometers at the span's midsection record traffic volume [March 7, 1974, p. 40]. **—Howard Wolff**

You're going to go Low-Power Schottky. Right?

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Price can't stop you anymore. Part for part Advanced Micro Devices' 25LS Low-Power Schottky costs the same as or less than sweet old 54/7400 MSI.

Performance? Come on! These little devils are the fastest in the industry. (The Am25LS174 has a guaranteed frequency of 40MHz versus 30MHz for the 54LS174.) They offer twice the fan-out over the full military range and an extra 50mV of noise immunity.

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V_{OL}	I_{OL} = 4 mA				0.4	I_{OL} = 4 mA				0.4	V
	I_{OL} = 8 mA (74LS Only)				0.5	I_{OL} = 8 mA	MIL & COM'L			0.45	
V_{OH}	I_{OH} = −400 μA	MIL	2.5	3.4		I_{OH} = −440 μA	MIL	2.5	3.4		V
		COM'L	2.7	3.4			COM'L	2.7	3.4		

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Am25LS07	Six-Bit Register With Common Clock Enable
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Am25LS09	Four-Bit Register With Two-Input Multiplexer on Inputs
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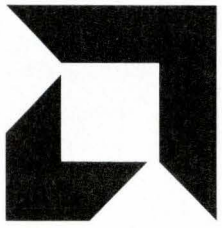
Am25LS138	One-of-Eight Decoder/Demultiplexer
Am25LS139	Dual One-of-Four Decoder/Demultiplexer
Am25LS151	Eight-Input Multiplexer
Am25LS153	Dual Four-Input Multiplexer
Am25LS157	Quad Two-Input Multiplexer; Non-Inverting
Am25LS158	Quad Two-Input Multiplexer; Inverting
Am25LS174	Six-Bit Register With Common Clear
Am25LS175	Quad Register With Common Clear
Am25LS194A	Four-Bit Register; Shift Right, Left or Parallel Load
Am25LS195A	Four-Bit Register; Shift Right or Parallel Load
Am25LS251	Three-State Eight-Input Multiplexer
Am25LS253	Three-State Dual Four-Input Multiplexer
Am25LS257	Three-State Quad Two-Input Multiplexer; Non-Inverting
Am25LS258	Three-State Quad Two-Input Multiplexer; Inverting

Coming soon:

Am25LS15	Four-Bit Serial/Parallel Adder/Subtractor
Am25LS22	Eight-Bit Serial/Parallel Register
Am25LS160	Synchronous BCD Decade Counter, Asynchronous Clear
Am25LS161	Synchronous Four-Bit Binary Counter, Asynchronous Clear
Am25LS162	Synchronous BCD Decade Counter, Synchronous Clear
Am25LS163	Synchronous Four-Bit Binary Counter, Synchronous Clear
Am25LS181	Four-Bit ALU/Function Generator
Am25LS190	Synchronous BCD Decade Up-Down Counter; Single Clock
Am25LS191	Synchronous Four-Bit Binary Up-Down Counter; Single Clock

If you have already committed to the other guy's
inferior specifications we do have a flawless imitation of 54LS/74LS.

Advanced L/P Schottky



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Circle 255 on reader service card

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dielectric retention from Bendix

D.R. GIVES YOU

- rear release crimp contacts—minimizes potential interfacial seal and contact damage during contact removal
- increased dielectric separation between contacts
- greater reliability plus weight savings—fewer components per connector
- hard-faced chamfered socket inserts assuring positive mating pin alignment
- improved temperature-life capability at 200°C
- optimum fuel and fluid resisting capabilities

*__dielectric retention__ (re-ten'shun), n: an innovative method of retaining removable contacts in an electrical connector, incorporating a single dielectric wafer rather than individual metal contact retention clips

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- utilize common application tooling
- intermate and intermount with existing series
- are tooled in over 30 arrangements

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Circle 12 on reader service card

Editorial

Why not make Intercon a trade fair?

In show business, a flop on Broadway doesn't stand a chance on the road. The IEEE might contemplate this lesson as, beginning next year, Intercon moves out of New York to spend alternate years in Boston.

Intercon/75 opens next week with an expected turnout of about 25,000 attendees—a far cry from the big shows of a decade ago. Since the 1969–70 recession, the IEEE has been searching for a formula to recapture the show's vitality. However, the new approach, essentially making Intercon into two regional shows, is not the answer. If the event is worth preserving, something more drastic than regionalization ought to be considered.

An alternative, one in fact previously discussed by IEEE, is to form an electronics industries fair—a single show with many tents. It could embrace a components show, a consumer electronics conference, a packaging equipment display, an automotive electronics exhibit, an industrial electronics exhibition, and an instruments show. In short, it could be a meeting ground for the fragmented market segments, all gathered together under the aegis of IEEE. Like a trade fair, one central show would allow companies to concentrate on product information and salesmanship in a marketplace atmosphere. And each section would be designed so visitors could easily find the exhibitors they wanted to see.

Are economic factors weighted against a big, central show? Not really. Other industries do it regardless of what the business climate is like. For that matter, the electronics industries abroad do it for shows in Paris, Munich, Tokyo, and Osaka. Yet in the U.S. the trend has been toward smaller, specialized exhibitions geared to specific market segments. Because these specialized conferences have filled the need for technical information exchange, an electronics industries fair might well do without a technical program, concentrating instead on applications.

What's more, the pull of a big electronics trade fair on the outside public should not be forgotten. A special public display area would show people what electronics has done to change their lives for the better and what is yet to come. Drawing general press and television news coverage, it would do much to enhance the prestige of a profession that is too little understood by the public.

The auto and the microprocessor

Electronic stocks got a short-run lift from a recent announcement that microprocessors could cut automobile gasoline consumption. That boost serves to reemphasize two points. One is that technology has an impact on the stock market. The second is that Wall Street lacks a real understanding of technology, to say nothing about its grasp of how long it takes to bring new developments to market.

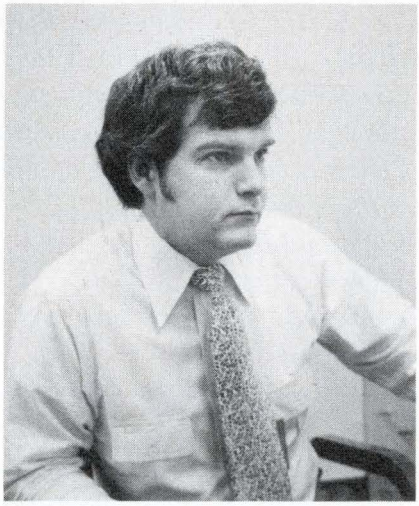
True, all the major auto firms are working on applying the microprocessor, but these efforts are still in the beginning stages, and even the most optimistic semiconductor marketing manager does not see any significant installations until 1978. And, considering the vagaries of the automobile marketplace, even this prediction is in the best-guess category.

The automobile market has long attracted the attention of electronics companies, but except for consumer electronics, profits have not lived up to promise. Many experts, looking to past experiences, view current short-term prospects with a jaundiced eye. But electronics technology is gradually working its way into the auto, and the day will come when its role (including that of microprocessor-based systems) will be unquestioned. But that day is not here yet—and it won't dawn overnight.

People

MOS boom for Intel is foremost on Carsten's mind

What Jack Carsten likes is making technology pay off—or, in his words, "helping an organization make a smooth transition past the point in the technological learning curve where it changes from a small and growing force in the marketplace into a large and dominant one."



Specialist. At Intel, Jack Carsten likes to grow with the new technologies.

That's why he has just joined Intel as vice president and director of marketing. He's come to Intel because of its leadership in new technologies, including its pioneering in p- and n-channel memories and microprocessors, as well as charge-coupled devices.

The boyish-looking, 33-year-old Carsten believes metal-oxide-semiconductor technology is going to grow spectacularly. "It's a multimillion-dollar marketplace right now," he says, "but in five or 10 years, industry sales will be in the billion-dollar range. Intel is on top of this wave now, but as it grows, it'll have trouble staying there. I think I can help in defining the strategies that will keep us on top."

A look at Carsten's record at TI seems to bear this out. From his start 12 years ago as a manufacturing engineer fresh out of college with a B.A. in physics, he advanced quickly while specializing in Texas Instruments' new technologies.

Beginning in 1965, for example, he helped establish the strategy for marketing medium-scale-integrated transistor-transistor-logic components as standard, rather than custom, products.

Three years later, he was applying metal-oxide semiconductors and large-scale integration to new products such as watches and one-chip calculators. After that, he became operations manager for all of TI's transistor-transistor-logic effort and was involved with such newer technologies as Schottky bipolar and integrated injection logic. When he left TI, he was division manager for MOS operations and had guided the company's plunge into n-channel MOS memories and microprocessors.

"I'm sure that I could have moved into higher positions of responsibility at TI if I had stayed," Carsten says. "But in doing so, I would have moved even further from what I love the most—dealing with a new technology head-on, transforming it, marketing it, and selling it."

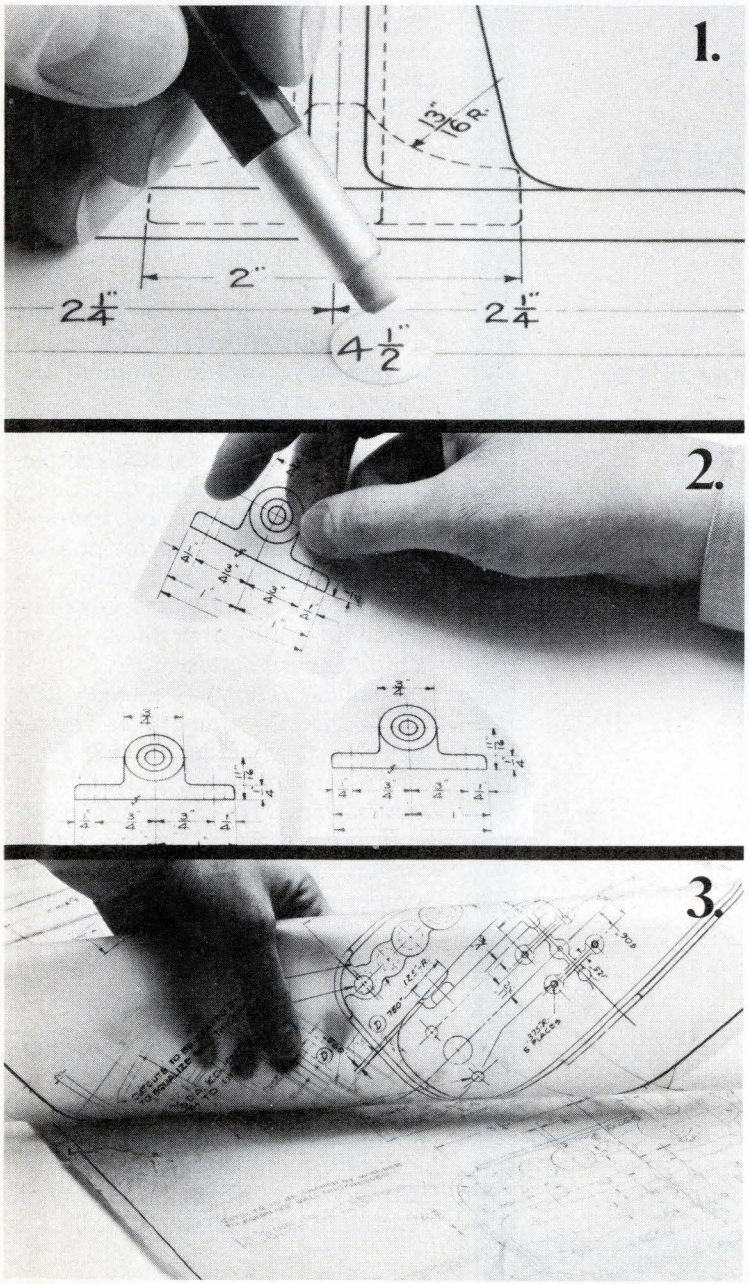
At RCA, Thomas looks for aggressive competition

Philip R. Thomas had a running start when he became division vice president for metal-oxide-semiconductor integrated circuits at RCA Solid State last month [*Electronics*, March 6, p. 26]. He had joined the Somerville, N.J., division in January as director of operation controls and systems, charged with "looking at ways of improving the company's business," and that charter hasn't changed.

"We are much more aggressive, more price-competitive," he says animatedly of the RCA MOS group. And then, smiling, he adds: "That's one of the good things that a down market does for you."

Thomas, 40, is pushing ahead with plans to develop RCA's line of

Avoid that drawn-out feeling.



Shortcuts with Kodagraph materials can save hours of drafting time, job after job. **1.** Revising a drawing? Don't retrace the whole drawing. Make a second original on Kodagraph wash-off film. Wet-erase unwanted details. Then draw in the revision. **2.** Need to repeat the same design element a number of times? Don't draw it over and over again. Draw it once. Then make as many Kodagraph film or paper copies as you need. **3.** Restoring an old drawing? Don't redraw. You'll strengthen lines and drop out stains by making photographic reproductions on Kodagraph film. For more information on photoreproduction techniques, write Eastman Kodak Company, Graphics Markets Division, Dept. R5718, Rochester, N.Y. 14650.

Kodak products for drawing reproduction.

Kodak

MOS man. RCA's Phil Thomas looks forward to n-channel and SOS production.

memory products, specifically n-channel and silicon-on-sapphire random-access memories and microprocessors. The division has set aside 70,000 square feet of its 400,000-ft² former computer facility in Palm Beach Gardens, Fla., for this production. "We'll be on-stream by the end of this year," he says. Meanwhile, RCA is operating an SOS pilot-production facility in Somerville. Under an agreement with Advanced Memory Systems Inc., Sunnyvale, Calif., RCA will produce n-MOS devices designed by AMS.

Although RCA hasn't been active in the n-MOS field, Thomas points out "the market is very large and we know we can offer a good product and be cost-competitive. SOS and n-channel have a lot in common, and that's to our advantage."

As for microprocessors made with RCA's large-scale-integrated complementary-MOS technology, Thomas says the division is through the pilot stage and is gearing up for production in its Findlay, Ohio, plant. Initially, n-MOS and SOS devices will be aimed at add-on memories and computer peripherals.

Conflict. Thomas joined RCA from Fairchild Camera & Instrument Corp., where he directed Fairchild Semiconductor's worldwide MOS business. His move from Fairchild was prompted, he says, by a conflict in management philosophies with Tom Longo, Fairchild Semiconductor's group vice president for integrated circuits. "We agreed to part—in a very friendly way, Thomas says."

Before that, Thomas, whose degrees are in physics and mathematics from the University of London, was vice president and general manager of General Instrument Corp.'s MOS division. He is credited with starting GI in the MOS business.

MEASUREMENT COMPUTATION NEWS
innovations from Hewlett-Packard

APRIL, 1975

in this issue

HP-21: New powerful pocket-sized scientific calculator at a more affordable price—$125

The smallest scientific pocket calculator in our line—the HP-21 delivers extraordinary problem solving power in the Hewlett-Packard tradition.

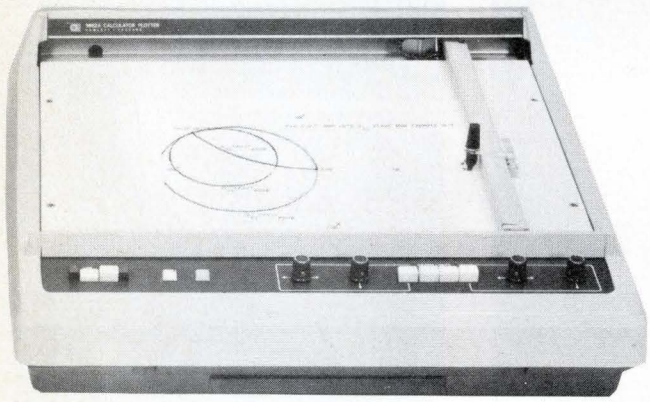
Now you can have Hewlett-Packard quality craftsmanship in a *low-price* calculator, the HP-21.

The HP-21 has more capability than our pace-setting HP-35. There are 32 pre-programmed functions and operations, including:

- all log and trig functions, the latter in radians or degrees
- full Display formating. Allows you to choose between fixed decimal and scientific notation
- underflow feature will not allow you to confuse a smaller number with a 0. Automatically reverts to scientific notation.

(continued on third page)

BAMP on a Calculator for Microwave Circuit Design



BAMP 30 and an HP 9830A calculator gives you systematic and efficient solutions in the design or analysis of high frequency and microwave circuits.

HP introduces BAMP 30 (Basic Analysis and Mapping Program), the software package now available for designing or analyzing high frequency and microwave circuits.

Originally developed for use on a time-shared computer system, the full power of BAMP is now available on a HP 9830A Programmable Calculator.

BAMP 30 is a collection of programs for obtaining the frequency-domain response of linear electronic circuits that can be built up by interconnecting two ports. BAMP 30 is a two-port program. This means:

Elementary two-ports are used as basic building blocks.

The overall or composite circuit built up by BAMP 30 is in turn a two-port.

The first result of any analysis performed by BAMP 30 is the scattering, or s-matrix, for the overall circuit. The s-matrix is stored in the 9830A Calculator as a function of frequency and can be used to compute, print, and plot numerous additional outputs.

BAMP 30 will help you design better circuits in less time. Circuit models can now be made as complex as necessary to accurately represent physical circuits, without danger of losing control over the design process. Analysis is more comprehensive and circuits can be as optimum as physical laws will allow them to be. The greater the circuit complexity, the greater the savings through BAMP 30.

If your design problem is too troublesome for manual analysis but does not warrant the time and expense of a computer, try the HP calculator-aided design solution. The BAMP 30 software pack may be ordered under Part No. 09830-71103.

To receive an Application Summary on Basic Analysis Mapping on the 9830, check Q on the HP Reply Card.

Calculator based system monitors complex variables; boosts productivity

Monitoring the pH and precisely controlling the amount of caustic that should be used to neutralize the acid in order to prevent damage to the bacteria in a municipal sewage plant is shown below as HP helps control the effluents from the manufacturing plant in Loveland, Colorado.

The new HP 3050B Data Acquisition System is coupled with a programmable calculator providing a system that replaced multiple recorders previously required throughout the facility.

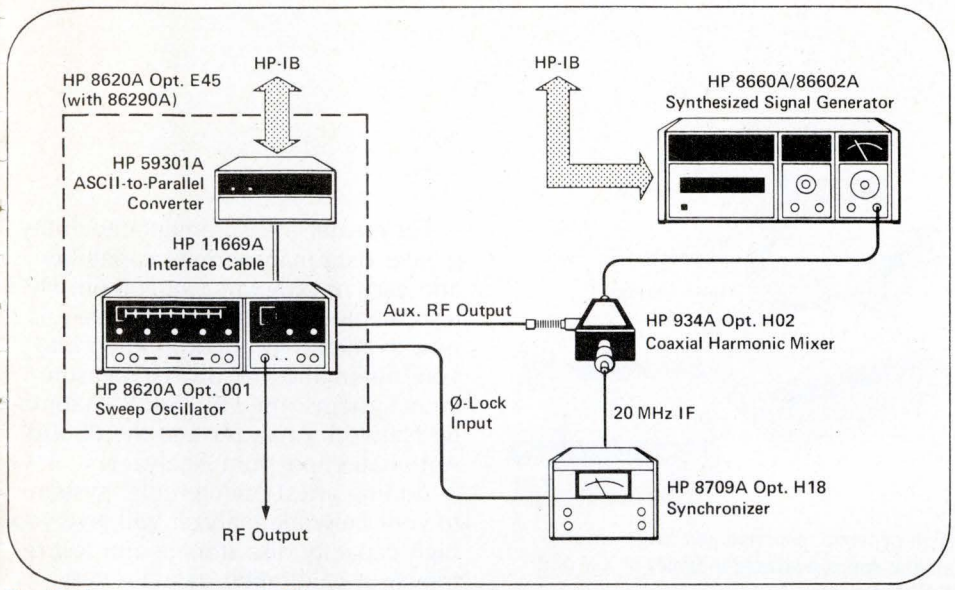
The system is programmed for precise pH levels. It continuously monitors pH and indicates an alarm condition when the limits are not in specification.

Measuring multipoint physical parameters to monitor or analyze phenomena and control devices will provide many varied applications of the HP 3050B System. Transmission of the data may be possible over thousands of miles using the HP-IB Common Carrier Interface and an optional modem.

For more information and other ideas on applications where data acquisition, analysis and control are critical, check E on the HP Reply Card.

On-site data acquisition with remote control and analysis.

Interface Bus compatible Solid State Sweeper has new options



Synthesizer accuracy to 18 GHz is easily obtained via the HP-IB.

Now the HP Interface Bus can be used with HP 8620 sweepers to achieve calculator control of frequencies from 3 MHz to 18 GHz. The 8620A Opt E45 sweeper with appropriate RF plug-in becomes a source with 1000 points per band programmability. The HP 86290A, our new 2 to 18 GHz plug-in, is ideal for HP-IB systems because of its flexibility, excellent frequency accuracy and linearity. The bus-controlled 8620A/86290A can quickly step through as many as 3000 frequencies—typically with ±5 MHz accuracy. For higher accuracy, add the HP 5340A counter plus D/A converter to automatically correct frequency to within 100 kHz. Even greater precision (to 25 Hz) can be obtained by phase-locking the sweeper to the HP 8660 synthesized signal generator and programming both the sweeper and 8660 via the HP-IB. Precision power level control of the sweeper is also possible using the new 436A digital power meter. (See sixth page)

These plus other practical microwave signal sources are described in our data sheet.

For more information on the HP Interface Bus controlled sweeper mainframe, check O on the HP Reply Card.

(continued from page one)

NEW Scientific Calculator—

- 10-digit display and 2-digit exponent
- 4-register arithmetic. Allows you to add, subtract, multiply and divide in the storage registers.
- performs basic data manipulations: $1/x$, y^x, $\sqrt{x}$, $x \gtrless y$, π, e^x
- converts polar to rectangular coordinates and back again
- calculates a common antilog (10^x) with a single keystroke
- RPN logic system
  - continuous and immediate display
  - all operations are sequential—backtrack if you make an error
  - re-use numbers without re-entering them
- completes pre-programmed functions in 1 sec. or less
- error display if you key in an impossible instruction
- five total memory registers

The HP-21 solves long and complex equations. Challenge it with your numerical problems—personal or professional.

The HP-21—a quality calculator.

For more information, check A on the HP Reply Card.

Mini DataCenter now gives computer power directly to the users

Hewlett-Packard now makes it possible to distribute computer power directly to the people who need it, when they need it.

The HP 3000CX Mini DataCenters are designed to meet the needs of stand alone and distributed computer networks with cost-saving efficiencies. You now can have distributed power for your department, region or division—serving the needs of manufacturing, administration, science, engineering, and real time applications.

The four 3000CX models (50CX, 100CX, 200CX, 300CX) implement timesharing, multiprogramming, and virtual memory operations. This is accomplished by separating programs into code and data modules, processing segmented programs into several modules, and stacking data to meet the needs of executing programs.

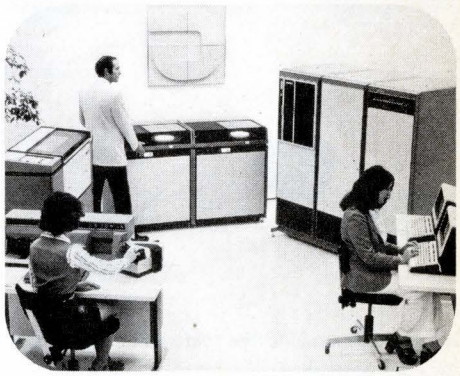
Several users can run their own programs concurrently using BASIC, RPG, COBOL, FORTRAN, or HP's SPL.

Input-output spooling capability is permitted at terminal or batch devices. Mini DataCenters offer a communications subsystem to link CX Series systems to each other and to larger computers as well.

A 32-bit LSI ROM microprocessor is at the heart of every Mini DataCenter. This microprocessor implements 182 instructions, has a cycle time of 179 nano-seconds, utilizing overlapped microinstructions to provide as many as 5.27 million operations per second.

Choose from the four 3000CX models to fit your job, your site, and your budget.

For details to help you choose the model best for you, circle D on the HP Reply Card.



For extra capability, the next logical step in automatic testing

HP's distributed systems capability has been expanded by the addition of a new, complete interface package to link Automatic Test Systems to a distributed system network.

The package includes both software and hardware for automatic microwave network analysis, spectrum analysis, and general purpose stimulus response measurement systems.

Linking the HP 9500 and 8500 systems to a central computer system (HP 9600E series) gives you the advantages of stand-alone intelligent systems functioning as a distributed system satellite.

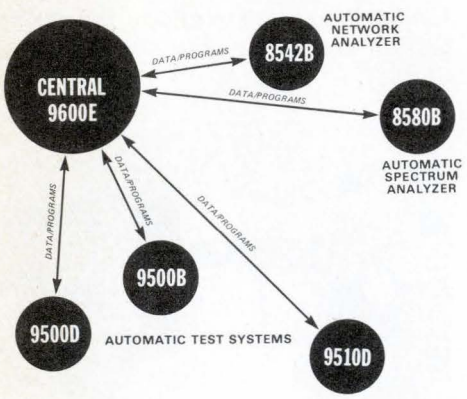
The satellites can each request off-line data manipulation and report generation at the central.

The central system supports the automatic test system satellites by providing mass storage, greater efficiency in program preparation, and shared peripherals.

The distributed system satellites provide specific automatic testing capabilities including precision microwave phase and amplitude measurements, computer controlled spectrum analysis, and computer controlled testing of a wide range of modules from DC to 18 GHz.

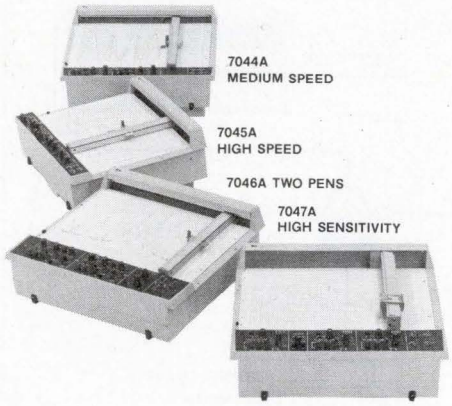
If you have automated your testing already and have stand-alone 8500 or 9500 series systems in your operation, investigate the expanded capability you can have with this new distributed systems package.

For details, check M on the HP Reply Card.



Link your automatic test systems to a distributed system network.

New more sensitive X-Y recorder expands choice to meet your needs precisely



High dynamic response and tough environmental specs available in family of X-Y and X-Y/Y recorders.

The new 7047A recorder, with high sensitivity and unique input circuits, is the newest addition to our family of 11 × 17" X-Y recorders. Starting with the 7044A medium speed, the 7045A general purpose, and the two pen 7046A, you now have a wide choice if you want high quality recordings without sacrificing ruggedness or reliability.

A wide range of quick-changing signals can be reproduced accurately and dependably. If you need speed, the 7045A and 7047A offer Y-axis acceleration exceeding 7620 cm/sec² (3000 in/sec²).

Abritrary full scale voltage ranges may be established with the vernier control in conjunction with the calibrated dc ranges.

These recorders are equipped with front panel polarity switches to reverse pen direction, eliminating the need for reversing the input leads.

The trouble-free Autogrip electrostatic holdown platen solidly grips any size paper up to 11 × 17" (28 × 41.9 cm) including European DIN A3. Disposable pens are available in four colors.

Options available include the Time Base (standard on the 7047A), Event Marker and Metric Scaling.

For detailed specifications, check K on the HP Reply Card.

Now, disc capability enhances microwave measurement systems

For greater measurement capability, greater data management capability and ease of program preparation, HP's test-oriented disc operating system is now available for incorporation into your automatic microwave measurement systems: the HP 8542B Automatic Network Analyzer and the 8580B Automatic Spectrum Analyzer.

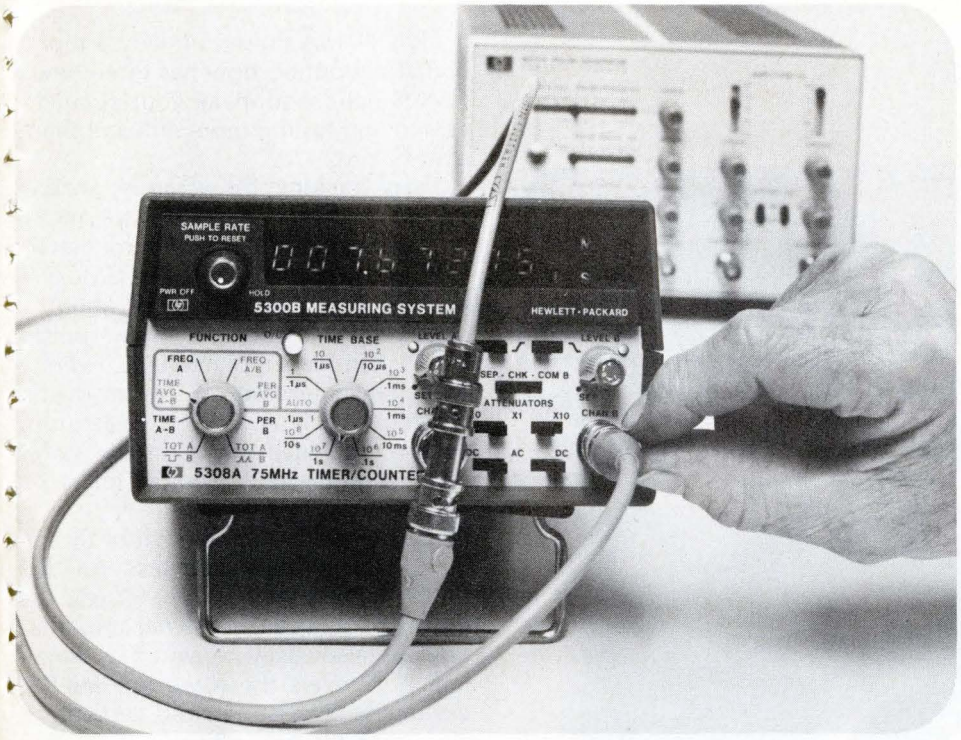
Adding a test-oriented disc system to your network analyzer will give you high capacity disc storage and fast retrieval of calibration data and test procedures by means of single statements.

Or, adding a test-oriented disc system to your spectrum analyzer will enhance your capability to generate application programs. In applications such as spectrum management, a disc will provide storage for the large amounts of needed data.

For more information on the test-oriented Disc System for the 8542B Network Analyzer and for the 8580B Spectrum Analyzer, check N on the HP Reply Card.

Increase measurement thruput with easy storage and fast retrieval of both programs and stored data.

Counter sets new mark for capability and compactness with economy



Measuring the electrical length of a coaxial cable using Time Interval Averaging on the 5308A Counter.

For the most electronic counter/timer capability available in such a small package and at such a low price—see the new 5308A 75 MHz Counter/Timer module. Not only does this instrument offer the frequency, frequency ratio, period, period average, time interval, scaling and totalizing capability of full rack width universal counter/timers, it also offers sub nanosecond time interval averaging plus unique HP features in the area of automatic ranging, totalizing, and trigger level setting.

AUTO RANGING: Now, you can auto range time interval averaging and frequency ratio measurements in addition to frequency, and period average. Furthermore, the Time Base selector can be left at Auto most of the time, even for the non-auto ranged functions. This is because in Auto these functions go to their highest resolution range, wherein the eight-digit display can totalize up to 10^8 counts or measure periods or intervals to 10 sec.

TOTALIZING: The stop and start signals for totalizing are conditioned by the same versatile slope, level and attenuator controls that apply to time interval measurements. Also, events on Channel A can be totalized while Channel B is low, or between events on Channel B, as needed in bit-error-rate counting, for example. Use it as an electronic stopwatch, too with ranges from 100 sec (1 μsec resolution) to 10^{10} sec.

TRIGGER LEVEL SETTING: LEDs indicate triggering and are pulse stretched so even a nanosecond input pulse gives a visible blink, as in a logic probe with pulse stretching. Trigger levels are switch-presettable around 0 volts or TTL or ECL levels for convenient measurement and troubleshooting of digital circuits. Also there's access to trigger level circuits for precise setting via external voltmeter, and a gate signal for scope Z-axis modulation.

Since the 5308A is part of HP's snap-together 5300 Series measurement system, you can snap on any of the other seven modules to convert to other instruments, including a 1100 MHz counter and digital multimeter. Or, add to any combination: a battery pack, D/A converter and/or HP Interface Bus module.

For detailed specifications, check I on the HP Reply Card.

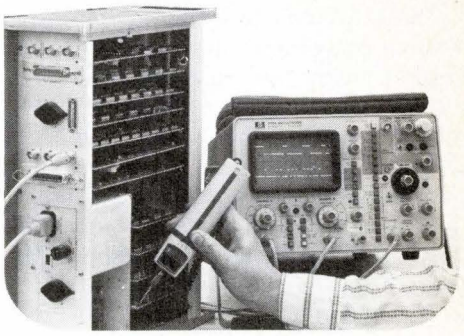
Two new HP scopes offer dual-delayed sweep

The dual-delayed sweep technique exclusively available in the new HP 1722A microprocessor and 1712A oscilloscopes give you improved accuracy for precise interval measurements in digital circuits. Now you can have improved accuracy and repeatability for such time measurements as rise times, propagation delay, clock phasing, and other high-speed applications with resolution to 100 picoseconds.

The 1712A displays two intensified markers which are two delayed sweeps displayed alternately. The first delayed sweep is controlled by the TIME INTERVAL START pot. The time between markers is scaled according to the main sweep, and delivered as an analog voltage to outputs at front and rear. Thus, the 1712A can be used with any DVM for direct readout of time intervals.

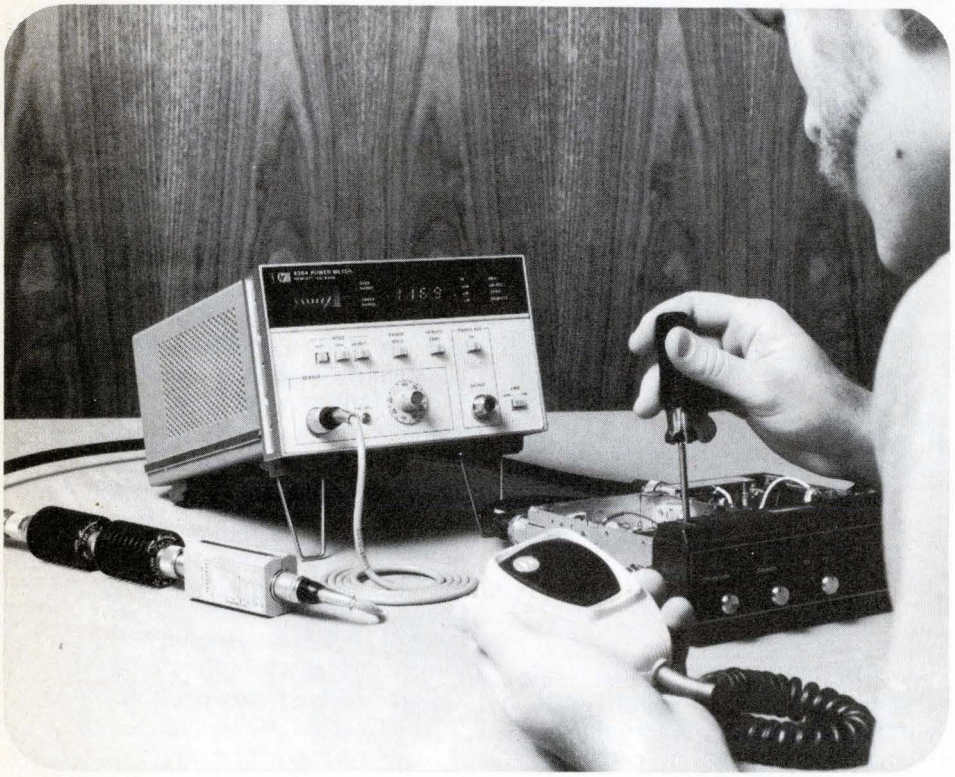
Dual-delayed sweep with its digital readout capability helps to avoid measurement errors of forgetting or selecting the wrong graticule line, reduces the chance of misreading a dial, and calculation errors. Dual-delayed sweep is also auto-zeroing, making calculations or manual zeroing unnecessary.

For details on this dual-delayed scope, check C on the HP Reply Card.



With dual-delayed sweep, two markers select time period to be measured and a proportional voltage output is provided for DVM readout.

New programmable autoranging power meter offers new level of accuracy and ease of operation



A new digital microwave power meter, the HP 436A, has built-in firmware 'intelligence' to switch automatically among its five power ranges, to translate its reading into watts, dBm or dB Relative, to recognize which of several possible sensors is connected and calibrate its display accordingly, and to locate the displayed decimal correctly.

The 436A measures either absolute or relative power and displays the results in either watts (mw, μw, and nw) or dBm. Relative power is displayed in dB relative to a reference value set by push-button.

Instrumentation uncertainty is less than $\pm 0.5\%$ (1% in range 5) of reading. Power and frequency range depend on the sensor used; it may be from 100 kHz to 18 GHz in a power range from -30 dBm to $+35$ dBm. All thermocouple sensors of the 8480 series are compatible.

Readings are indicated on a large 4-digit LED display. Autoranging makes operation "hands off" but may be disabled with a push-button to "hold" a given power range. In addition to the digital display, an analog meter indicates fast-changing power levels and permits tuning and adjustment of power output.

The 436A is fully programmable (except CAL FACTOR). Interface for control and readout may be via the HP Interface Bus or BCD. With these capabilities, the 436A power meter will be a powerful addition to most mini-systems used in microwave production test applications.

This completely new instrument is designed to stay out of the user's way while doing his job. It is an ideal general purpose power meter for the RF and Microwave engineer.

For details, check B on the HP Reply Card.

New CMOS options extend versatility of high voltage pulser

HP's 8015A Pulser, already a top digital performer, now has three new CMOS options to make your circuit design and testing more efficient than ever before.

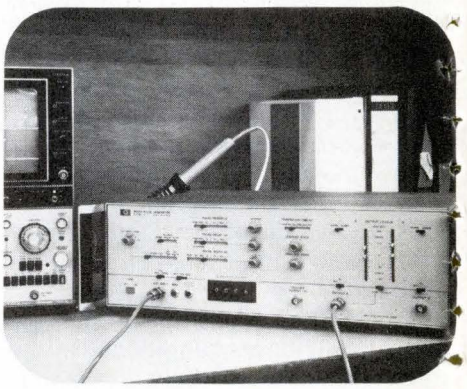
Level tracking, for example, enables you to control the 8015's pulse amplitude with an external DC control signal. With the 8015A tracking the CMOS power supply, you can forget about circuit damage caused by input pulses larger than the supply voltage, even when power is removed. Testing over a range of supply voltages is easier, too, because you need only adjust the power supply and the pulser output follows automatically.

Direct access inputs to **each** of the 8015A's linear **output stages**, provided by the second new option, let you use the 8015A as an analog signal amplifier. You can also easily convert TTL signals to CMOS levels, thereby extending the usefulness of existing word generators and other TTL equipment.

The **TTL output** option is especially useful whenever CMOS and TTL IC's are used together. The option gives you an extra pulse output with preset levels set for TTL compatibility.

The 8015A itself is a 50 MHz, 16 volt pulser with transition times fully variable down to 6 ns. Its two independent output channels may be delayed with respect to one another to make setup time measurements or to generate two-phase clocks. They may even be added to provide 30V test pulses.

For details, check L on the HP Reply Card.



Pulse burst is generated upon receipt of trigger pulse. Length is determined by thumbwheel switches.

A new 5V, 100A switching supply stays cool under stress

HP's new 500-watt modular supply, the 62605M, combines the high efficiency and small size of an advanced 20-kHz switching regulator with an integral forced-air cooling system that eliminates conventional heat sinks.

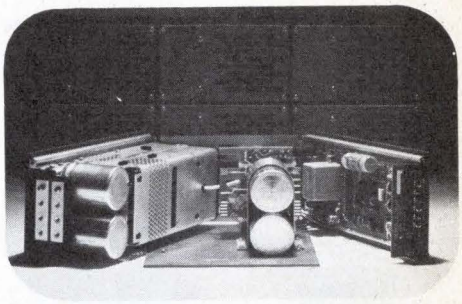
The result is an efficient, compact and trouble-free power supply. The supply is regulated to 0.1% with ripple and noise of 15 mV rms, 50 mV p-p (20 Hz to 20 MHz). It will output 5 volts at 100 amps continuous from 0 to 40°C, with linear derating to 60 amps at 70°C. All of this is packaged in a 5" × 8" ×11½" case weighing only 14 pounds (6.4 kg).

Operating costs are reduced due to the supply's higher efficiency. Additional savings may be realized from the reduction in supplementary in-cabinet cooling and the power it uses.

For reliability, "cool-operation", small size *and* lasting value consider the HP 62605M.

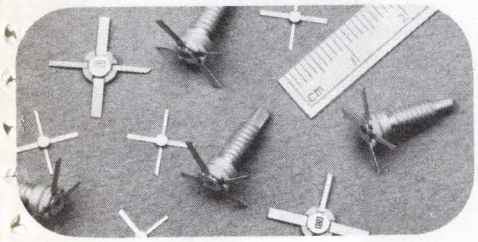
For full details about this new power supply's many advantages, check J on the HP Reply Card.

Modular power supply with overvoltage, overcurrent, overtemperature and reverse voltage protection.



HEWLETT-PACKARD COMPONENT NEWS

New transistor for high reliability applications



New transistors offer guaranteed tuned gain and meet military standards for environmental and test.

HP offers two new general purpose microwave transistors. Model 35828E, a small signal NPN bipolar transistor with guaranteed tuned gain at 2 GHz, is available in the H Pac 70 GT, a rugged metal-ceramic hermetic package.

The Model 35829E, optimized for high gain at 2 GHz, utilizes a co-fired alumina package. For both transistors, the tuned gain is guaranteed under fixed optimum source and load conditions simplifying the designer's job in extracting the maximum performance from the devices.

For specifications and reliability data, check F on the HP Reply Card.

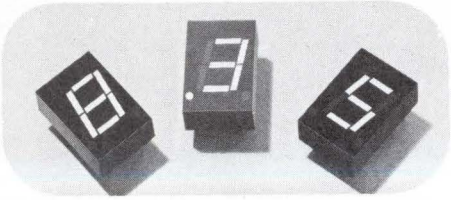
High intensity displays in three colors

The new HP 5082-7650 series LED displays, available in high efficiency red, yellow and green, are five times brighter than our previous .43" displays at the same operating current. High brightness means they can be read easily in outdoor applications. The new high efficiency red (635 nm) has been shifted towards the orange to enhance readability.

At an operating current of 20 mA per segment, luminous intensity per segment is 1720 microcandelas.

For improved readability, the bodies of the displays are color-coordinated to hide the unlighted segments.

For more information on these displays: 5082-7650 High efficiency Red, 5082-7660 Yellow, 5082-7670 Green. check H on the HP Reply Card.



High-brightness, low-power displays, readable up to 20 feet.

Sharp on/off transition in new voltage sensing LED

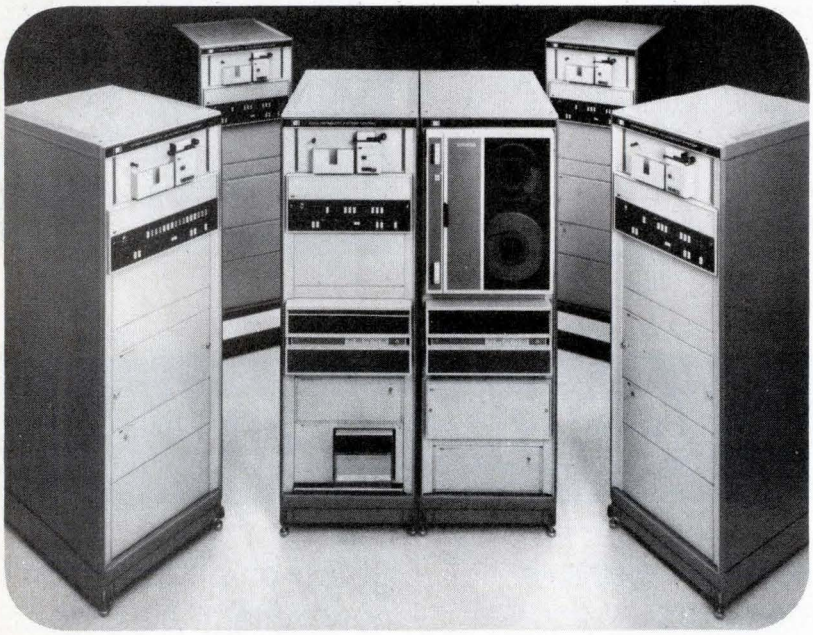
Designed for use as a built-in push-to-test battery voltage tester for cameras, radios, test instruments and other appliances.

With very high sensitivity to the threshold voltage, the new HP 5082-4732 VSLED is ideal for applications where precise voltage level indication is required, including V-U meters, logic level indicators, and other voltage indicating arrays.

This solid state lamp combines an IC and a red GaAsP LED in a standard red diffused T-1 LED package that snaps on sharply at a nominal 2.5 volts, ±10 millivolts. The effective threshold voltage can be increased to any desired level with the use of a resistor, diode or zener in series.

For rating and characteristic information, check G on the HP Reply Card.

New satellites and new central computer expand HP Distributed System capabilities



Five new minicomputer satellite systems and a new system specially configured to function as the central can now be incorporated in HP distributed systems. With these additions, 9600MX series measurement and control systems, 8500 series microwave network and spectrum analyzer system, and 9500B and 9500D series automatic test systems can all serve as distributed systems satellites. Interface between satellites and the new 9700A distributed systems central system is via high-speed data communications hardware and distributed systems software. The central supports the working-level operations of the satellites with disc-based storage for programs and data, and data processing assistance.

HP distributed systems make it practical and economical to automate large-scale operations in science and industry with minicomputers, with implementation accomplished in easy stages, satellite-by-satellite. Because each satellite can function on its own, unaffected by the failure of another, the distributed systems network provides better reliability and faster response to local needs than a big computer. At the same time, interconnection gives big-computer advantages—disc-based program development that doesn't interrupt productive operations at the satellites, central program storage, sharing of data processing workloads, and multi-satellite access to a large common data base.

The 9700A central can communicate with IBM 360/370 systems at EDP centers, tapping the tremendous processing power and extensive library of data processing and report generating programs there.

Today, over 50 companies use HP distributed systems for computer-aided manufacturing, lab automation, materials handling, product testing, and process control. You can, too. For many applications, distributed minicomputer systems that think and work together offer many advantages including faster response to the needs of the distributed application, better reliability, and easier implementation.

For more information on linking your HP systems, check P on the HP Reply Card.

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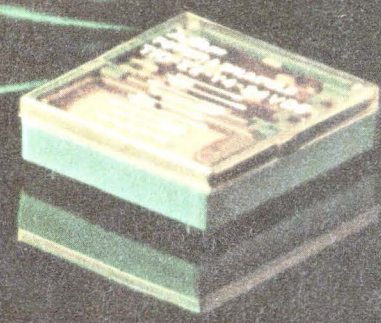
Canada-6877 Goreway Drive, Mississauga, Ontario, L4V 1L9, Ph. (416) 678-9430.
Japan-Yokogawa-Hewlett-Packard Ltd., Ohashi Bldg., 59-1 Yoyogi, 1-chome, Shibuya-ku, Tokyo 151, Ph. 03-370-2281/92.

New from Potter & Brumfield



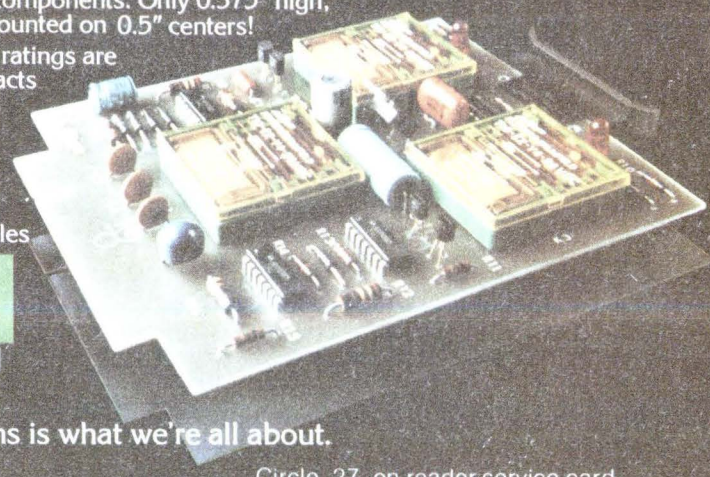
The lowest profile 3 amp relay we've ever offered!

The P&B T10 Series relay is lower than many other circuit board components. Only 0.375" high, it's ideal for high-density applications. Permits pc boards to be mounted on 0.5" centers!

T10 relays provide 0.1 to 3 ampere switching @ 30VDC. Coil ratings are 6, 12, 24, and 48VDC. Permissive make, gold-flashed silver contacts are noted for low contact bounce, long operating life. Bifurcated contacts for low level switching are available on special order.

Designed for low cost general purpose applications, the T10 is ideal for use in tele-communications, copy and reproduction machines, computer and peripheral equipment.

For additional information, contact the Potter & Brumfield sales representative or authorized distributor nearest you, or write Potter & Brumfield Division AMF Incorporated, Princeton, Indiana 47671. Telephone 812 385 5251.



AMF
Potter & Brumfield

Solving switching problems is what we're all about.

Circle 27 on reader service card

NORLAND INSTRUMENTS
Announces the newest generation of test and measurement instrumentation.

The NI 2001 Programmable Calculating Oscilloscope

Here is the ultimate instrument for the acquisition, processing and manipulation of electrical data. It completely eliminates the need to compromise your requirements with a jumbled array of separate instruments. The NI 2001 is a *complete* unit that combines all the capabilities of a digital oscilloscope and a microprocessor in a single mainframe. It brings you flexibility, convenience, accuracy and reliability you won't find anywhere else.

This — the first programmable calculating oscilloscope — is the product of many years of technological research and instrumentation engineering. With the advent of microprocessor technology, Norland Instruments engineers were quick to recognize the power available to the instrument designer and first applied a microprocessor to the Norland line of medical instruments. That experience ultimately led to the use of microprocessor technology in the development of the NI 2001 — the first truly new generation of test and measurement instrumentation for the industrial and scientific user.

The NI 2001 gives you the precision of a digital oscilloscope for data acquisition and display *plus* the built-in capability of a microprocessor for data reduction. You can make exact calculations of rise times, integrals, differentials, peak areas, RMS values, peak-to-peak measurements, n-point averaging, and an almost unlimited range of other operations. It increases your productivity by letting you measure, display, digitize, store and process data faster and more accurately than ever before. The NI 2001 will analyze data and, through conditional branching, function as a decision making instrument. It is easily programmable — without computer instructions — so repetitive operations can be completely automated. Its mainframe, through modular design, has provisions for a wide range of plug-in modules to let you expand your system to meet individual requirements. It can even be interfaced to control other equipment.

Now, consider the economics. Surprisingly, the NI 2001 mainframe is $8,500. The instrument shown here, with monitor and two single-channel plug-ins, can be yours for $13,400!

You've waited a long time for an instrument as versatile as the Norland Instruments NI 2001. Wait no longer. To arrange for a demonstration and complete information, send the reader service card or write Norland Instruments, Department A-1.

See the NI 2001 at IEEE INTERCON, April 8-10, Coliseum, New York, Booth 2732-4.

NORLAND INSTRUMENTS
A Subsidiary of Cordis Corporation
Norland Drive, Fort Atkinson, Wisconsin 53538 U.S.A.

For information circle 28 on reader service card.

For demonstration circle 29 on reader service card.

Meetings

Southeastcon '75, IEEE, Sheraton Center, Charlotte, N.C., April 6–9.

Intercon—IEEE International Convention, New York Coliseum and Americana Hotel, New York, N.Y., April 8–10.

Intermag—International Magnetics Conference, IEEE, Imperial College, London, England, April 14–17.

International Circuits & Systems Symposium, IEEE, Marriott Motor Hotel, Newton, Mass., April 21–23.

Reliability Software International Symposium, IEEE, International Hotel, Los Angeles, April 22–24.

Society for Information Display International Symposium, SID, Shoreham Americana Hotel, Washington, D.C., April 22–24.

International Optical Computing Symposium, IEEE, Mayflower Hotel, Washington, D.C., April 23–25.

National Relay Conference, NARM and Oklahoma State University, Stillwater, Okla., April 30–May 1.

American Ceramics Society Electronics division Meeting, Sheraton Park and Shoreham Americana Hotels, Washington, D.C., May 3–8.

Carnahan Conference on Crime Countermeasures, University of Kentucky and IEEE, Lexington, Ky., May 7–9.

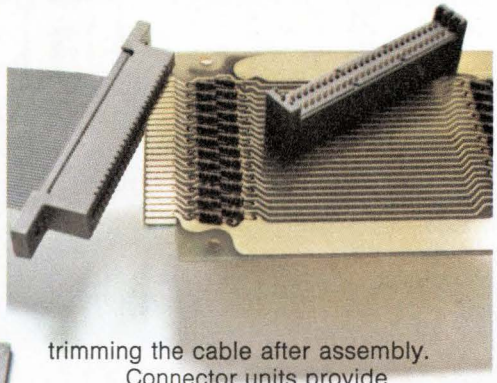
International Microwave Symposium, IEEE, Rickey's Hyatt House, Palo Alto, Calif., May 12–14.

Electronic Components Conference, IEEE, EIA, Statler Hilton Hotel, Washington, D.C., May 12–14.

Electrical and Electronic Measurement and Test Instrument Conference, IEEE, Skyline Hotel, Ottawa, Canada, May 13–15.

Audio Engineering Society 51st Convention, AES, Los Angeles Hilton, May 13–16.

Design with the complete flat cable/connector system.



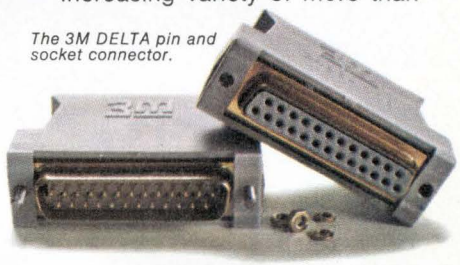
trimming the cable after assembly.

Connector units provide positive alignment with precisely spaced conductors in 3M's flat, flexible PVC cable. The connector contacts strip through the insulation, capture the conductor, and provide a gas-tight pressure connection.

With cable, connectors and assembly tools from one design and manufacturing source, you have added assurance the connection will be made surely, with no shorts or "opens."

And "Scotchflex" now offers you more design freedom than ever. From stock you can choose shielded and non-shielded 24-30 AWG cable with 10 to 50 conductors, and an ever-increasing variety of more than 100 connectors to interface with standard DIP sockets, wrap posts on standard grid patterns, printed circuit boards, or headers for de-pluggable applications. 3M's DELTA "D" type pin and socket connectors are now also available. For full information, write Dept. EAH-1, 3M Center, St. Paul, MN 55101.

The 3M DELTA pin and socket connector.



Assembly-cost savings are built in when you design a package with "Scotchflex" flat cable and connectors. But more important, 3M Company offers you the full reliability of a one-source system: cable *plus* connectors *plus* the inexpensive assembly aids that crimp the connections quickly and securely (with no special operator training required).

The fast, simple "Scotchflex" assembly sequence makes as many as 50 simultaneous multiple connections in seconds, without stripping, soldering or

3M COMPANY

3M's "Scotchflex" line.

"Scotchflex" is a registered trademark of 3M Co.

Digital introduces PDP-11/70. The system all other 11's have been leading up to.

Not just fast, completely fast.

The System is here from Digital. It's PDP-11/70—and it's fast beyond anything of its size or price ever built.

This complete system is designed for speed inside and out. Not just the CPU, but the software, the cache memory, the I/O channels, the disks, the peripherals—the entire package.

The 11/70, with its 32-bit

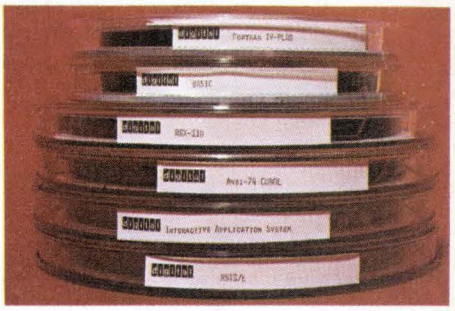
architecture, is a real-time system, a batch system, and a timesharing system simultaneously. And the incredible low price—from under $100K—means that enormous computer power is about to appear in places it's never been before.

System processor speed. The heart of the PDP-11/70 is a 300 nanosecond central processor connected to system components by high-speed 32-bit data paths (that perform automatic parity checking on both data and address transfers). And by adding a double-precision floating point processor, you can divide two 64-bit numbers in just 9 microseconds.

System memory speed. The integral memory management unit provides memory relocation, protection, and expansion to 2 million bytes of extremely reliable core memory. A standard 2K-byte, 240-nanosecond bipolar cache memory acts like a high-speed buffer between main memory and the processor. The result: an effective memory cycle time under 400 nanoseconds, but at core memory prices.

System peripheral speed. High-speed peripheral controllers plug directly into the central processor using high-speed 32-bit data paths for fast data transfer. Disk transfer time, for example, can be as fast as 4 microseconds for 32 bits. Disk capacity, using the high-speed interface, can be expanded to 700 million bytes of on-line storage.

Complete system software. The PDP-11/70's new multifunction operating system, IAS (Interactive Application System), allows concurrent timesharing, real-time and batch. IAS supports a mix of languages including ANSI-74 COBOL, extended BASIC, Macro assembler, and a powerful ANSI standard FORTRAN IV-PLUS that's



designed for the fastest execution time possible.

And for dedicated timesharing applications the popular RSTS/E system has been enhanced to accommodate 63 simultaneous BASIC-PLUS users with concurrent batch COBOL operation. For real-time applications, field-proven RSX-11D provides multiprogrammed real-time operation with concurrent batch in the background.

The System is here from Digital. PDP-11/70. Completely fast. For full details contact your local Digital sales office or send the coupon below to Digital Equipment Corporation, Maynard, Mass. 01754. (617) 897-5111, Ext. 2540. European headquarters: 81 route de l'Aire, 1211 Geneva 26. Tel: 42 79 50. Digital Equipment of Canada Ltd., P.O. Box 11500, Ottawa, Ontario K2H 8K8. (613) 592-5111.

digital

☐ Please have a Digital sales engineer call on me.
☐ Please send me literature on the PDP-11/70.

Potential application_____

I am considering a new ☐ or replacement ☐ system.

Other system(s) now performing on this application_____

Other system(s) in my company or organization_____

Name_____

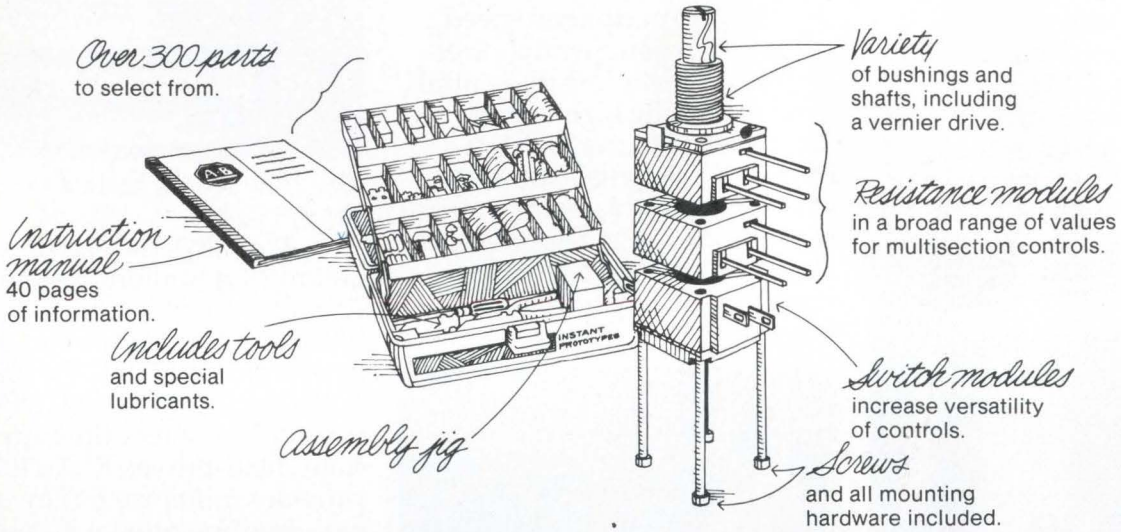
Department_____ Organization_____

Address_____

City_____ State_____ Zip_____

Assemble prototype pots instantly.

New MOD POT Instant Prototypes equips you to put together virtually any pot you could want. And when you're ready for production, our distributors can quickly supply volume quantities to factory standards. Order a MPIP from your Allen-Bradley electronics distributor. $97.50 apiece. Or, ask him for complete information on MOD POT . . . publication 5217.



Quality in the best tradition.

ALLEN-BRADLEY
Electronics Division
Milwaukee, Wisconsin 53204

Circle 34 on reader service card

EC104

Common specs sought for 16-pin 4-kilobit RAM

In an attempt to get true second-sourcing of Mostek Corp.'s 16-pin 4,096-bit RAM for Control Data Corp., manufacturers have been trying to work out a common spec. Mostek, Intel Corp., Fairchild Semiconductor, and Motorola Semiconductor have been asked to ship 50 to 100 parts each by May 1. **Significantly, the parts are to be compatible electrically and functionally,** as well as in pin configuration.

The trickiest spec will be for power dissipation, since each part is built by a different process. Timing and threshold of transistor-transistor-logic input must also be common. The four are said to be working with the data sheet of Mostek's MK4096-6: 550 milliwatts maximum active power dissipation, 24 mW standby; random access at 250 nanoseconds, 400 ns cycle time; and TTL inputs of 3 volts. **"Each supplier will be able to furnish some volume that meets these specs,"** a Mostek official says.

Meanwhile, Leslie Vadasz, engineering vice president at Intel, says his company will have parts by the May 1 deadline. The first ones already are off the line, and Intel will begin sampling by the middle of this month. Since Mostek's part was first, says Vadasz, it will be the standard, and Intel's specs will conform to those guidelines.

At Fairchild, a spokesman says that the company hasn't come to an agreement. Thomas Longo, vice president and general manager for the IC group, has voiced a "basic unhappiness with the proposals on the specifications," says the spokesman.

Police to test Rockwell's unit to identify voices

A prototype automated voice-identification system that matches voice samples reliably enough that its evidence is expected to be admissible in court is about to be completed by Rockwell International's Electronics Research division. Company and Federal officials say subjective visual analysis of voice prints by trained technicians, which other systems use, is not admissible.

The Rockwell system, which will be tested later this year by a West Coast police department, **is based on analysis by a Data General computer of the " 'distances' between pairs of like vowel sounds in two samples,"** Rockwell says in a report to the National Institute of Law Enforcement and Criminal Justice, the Federal agency that helped finance the project. " 'Distances' are then compared to form a single numerical measure of the similarity."

Identification takes as long as 45 minutes because each voice sample undergoes 60 analyses, including fast Fourier transform. But the key to the system is the graphic terminal. A headset is connected to an analog-to-digital converter that feeds a graphic display. A terminal operator isolates a segment of speech that best represents one of 13 standard letter pairs, such as the "ir" in "girl," and the machine does the rest.

IMP to appear in bipolar form on one board

National Semiconductor Corp. will soon supply its p-MOS IMP-16C microprocessor in a compatible, single-board bipolar version. The 50-package design, which is **built with standard Schottky MSI parts, "is seven times faster than the first IMP-16C,"** says Gene Carter, marketing manager for microprocessors. For customers who like the IMP and want the extensive software available, but need better performance, the bipolar IMP is the first of National's products that uses an

edge-sensitive 64-bit random-access memory—the 86S68. That part boosts performance of the stack and accumulator registers because it's triggered on the address signal's leading edge instead of during an interval.

National is also working on a Schottky-LSI IMP design that, says Carter, "could reduce the number of packages to three or four for a full 16-bit machine." The company is deciding whether to implement the LSI design with a bit-slice approach or to horizontally integrate the microcomputer functions into a few integral chips—a 16-bit arithmetic/logic unit, a 16-bit register, a 16-bit stack, and so on. In any case, the LSI version is promised in 12 to 18 months. Another microprocessor under development is a single integrated injection logic chip for lower-performance controllers.

Study proposes new Intelsat-5 communications

New communications techniques proposed for the Intelsat-5 series of satellites could more than quadruple transmitting capacity and result in a bonanza to equipment suppliers, **but cost earth-station owners a bundle.** These are the conclusions of a study to be presented this month at a satellite-communications technology conference in London.

Installing dual orthogonal polarization gear, which gives twice the signal capacity in the same bandwidth as before, will cost $100,000 to $1 million for each of a minimum of 20 stations. In each of the three ocean-coverage areas, at least 30 new earth stations will be needed for higher 11-14-gigahertz transmission at $2 billion to $5.5 billion each. Other new techniques include time-division multiple-access approaches and the use of spot-beam transmission. The company manages communications systems worldwide.

Inselek ending SOS production

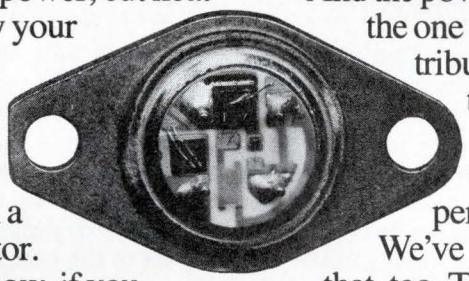
Inselek Corp, Princeton, N.J., is closing its production facility. The company filed a Chapter 11 petition under Federal Bankruptcy laws earlier this year [*Electronics*, Feb. 6, p. 46] after the silicon-on-sapphire technology in which it specializes failed to find a large enough market niche. "We're in a controlled-liquidation process," says Joseph R. Burns, president. He says Inselek is no longer manufacturing and is supplying SOS devices out of inventory. **"I'm currently negotiating with a few semiconductor houses to sell them technology," says Burns,** adding that he probably would stay on as a consultant under any licensing arrangement he might sign.

Addenda

Teradyne Inc. will introduce a board tester at the IEEE Intercon show **that can handle digital, analog, and hybrid boards.** Dubbed the L-125, it treats analog portions as functional blocks and tests digital inputs and outputs digitally. Price isn't set, but it should be close to that of Teradyne's digital board testers that start at $65,000. . . . It's official. Rockwell International's much-talked-about campaign to sell digital-watch modules to assemblers is under way, and the company says **it has contracts from some large firms** in the watch business. The module features a lighted liquid-crystal display with 45° viewing angle, C-MOS quartz-crystal circuitry, 10 microamperes' power consumption (15 milliamperes when lighted) on a 1.5-volt silver-oxide battery.

Build a switching regulator in half the time.

You know that a switching regulator can quadruple the efficiency of your power supply. It'll save power, cut heat loss, simplify your design, save board space, weigh less, and maybe cost less than a linear regulator.



But until now, if you wanted a switching regulator, you had to start from scratch. It took a lot of time and a lot of effort.

Our power switching circuit is the breakthrough you've been waiting for.

The power circuit is the trickiest part of the switching regulator to design, since it involves choosing the commutating diode and switching transistors, then fiddling with the circuit to get the best drive and bias conditions.

We've taken care of all that. And the power circuit is the one that can contribute most in terms of improving the regulator's performance.

We've taken care of that, too. Thanks to our special design and packaging, you can expect faster response time and lower noise than you could design in yourself. And because of the faster switching time, you can reduce the size and cost of other components and operate at frequencies up to 100KHz.

Our PIC-600 Series power switching circuits are available with positive and negative outputs, in current ranges from 5 to 15 amps and voltage capabilities up to 80 volts.

To make your life even easier, we've got a 24-page booklet that'll tell you everything you need to know about designing a switching regulator. It's the only booklet of its kind available, and it's free. To get yours, along with detailed specs for our power switching circuits, circle our number on the reader service card.

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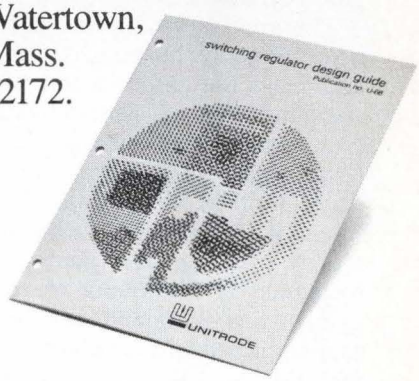


UNITRODE

Circle 37 on reader service card

Chrysler autos to get electronic spark advance next year

Firm says clean-emission standards can be met with $20 to $25 system built with ICs and discrete components

There's lots of talk lately about microprocessors and centralized automobile-engine control. But for the near future—at least until the end of the decade—talk it will remain [*Electronics*, April 18, 1974, p. 65].

Until then, however, other kinds of semiconductors are getting into engine control functions. One example is a new system from Chrysler Corp. that adaptively controls the sparking function. Used in conjunction with the company's standard electronic ignition, the Chrysler lean-burn system advances or retards the spark applied to the engine's cylinders.

The aim, says Chrysler, is to ensure complete burning of the fuel and meet the same clean-emission standards that 1975-model cars are obtaining with exhaust-gas recirculation and catalytic converters, yet do so for $30 less per car. Besides the cost advantage, "we're seeing clearly about a 10% gain in performance, and about a 6% or 7% gain in fuel economy" over similar cars equipped with catalytic converters, says Earl W. Meyer Jr., assistant chief engineer for engine electrical engineering at Chrysler in Detroit.

The first lean-burn system implemented with integrated circuits and discrete devices will show up on the large V-8 engines in 1976-model Imperials and Chryslers and will be optional on large Plymouths and Dodges—an estimated 200,000 cars. By the 1977 model year, Chrysler hopes to use it on most, if not all, of its production, Meyer says.

Details of the electronic package are a closely guarded secret. It's reported, though, that Chrysler has started buying parts and will be using a quad operational amplifier, a quad comparator, a complementary-MOS counter, and discretes in each one.

Seven inputs. The company turned to electronics because lean burn requires seven inputs, including throttle position, rate of throttle change, temperature, basic timing, engine speed, and engine load. "Electronics is much more able to deal with seven inputs than mechanical hydraulics or pneumatics," Meyer points out. In conventional sparking systems, a flywheel governor in the distributor reacts to engine speed and advances the spark, while a spring-loaded vacuum diaphragm measures manifold vacuum and moves a magnetic pickup on the distributor to advance the spark.

Total cost of the electronics is $20 to $25 in volume, and this does not seem to be a cost squeeze. "With regulators and electronic ignitions, there was either a penalty or a bare tradeoff with warranty cost versus initial expense, so implementation was very cautious and very slow," Meyer says. "In the emission area, we're not dealing with $2 or $3, but closer to the better part of $100. We

Pressure sensor posed problem

Cheap enough pressure sensors are still a problem for Detroit. For its lean-burn spark-advance system, Chrysler wanted a sensor accurate to within 1%, and semiconductor makers were projecting a $5 price. "We said we'd pay it because there was no alternative," says Chrysler's Earl W. Meyer Jr. But the quotes on the sensors came in at $6, $7, $9, and up.

"When the prices were already too high and moving in the wrong direction, we were motivated to develop our own," he says. "We re-evaluated what we were doing and decided our specs were somewhat excessive. But loosening our specs didn't make the job any easier, using the techniques the suppliers were using."

So Chrysler designed a modification of the vacuum-diaphragm device on its present distributor. The company put in a better diaphragm and connected it to an electronic sensor that is nothing more than a ferrite core and coil of wire—a technique similar to, though simpler than, the approach proposed by Licon (see p. 39). The result is "probably closer to a 4% sensor than the 1% device we originally thought we needed, but it costs about $1, and it does the job," says Meyer.

Including electronics to drive the sensor and detect the impedance variation, the projected cost is still less than $2, he says.

Meyer still hopes to get a 1% sensor, and Chrysler is trying to build an under-$2 pressure sensor using an aneroid capsule purchased from TRW Inc. and designing the electronics in-house. Other sensing functions for lean burn are done conventionally. The engine-speed signal, for example, can be taken either from the distributor's flywheel governor or directly from the magnetic pickup.

can afford to spend $10 to $30 on electronic controls that replace other ways of getting the same emission results."

With its electronic approach, Chrysler hopes to eliminate not only catalytic converters, which reduce carbon monoxide and hydrocarbons, but also exhaust gas recirculation equipment that now controls oxides of nitrogen. And since oxidation catalysts make the exhaust system run hotter by using more oxygen, Chrysler can save even more by dumping extra heat shields, as well as the high-capacity cooling systems and air pumps often used to supply the catalytic converter with oxygen.

Last month, the firm started running three cars with electronic spark advances at the Chrysler proving grounds to demonstrate 50,000-mile durability to the Federal Environmental Protection Agency. □

Automotive

Transducers based on switch designs

By extending the ferrite-core technology used in its switches and keyboards, the Licon division of Illinois Tool Works Inc. has developed a family of simple, inductive sensors for automotive applications.

William S. Barron, product manager at the Chicago-based firm, says auto makers are testing prototypes of a proximity sensor on antiskid systems in both cars and trucks. Licon is also sampling prototypes of a linear-displacement transducer that can monitor throttle positions, and this sensor has also been packaged behind a bellows as a pressure transducer for determining manifold vacuum or barometric pressures for engine-control systems. Within the month, Licon will ship a prototype angular-displacement transducer to a diesel-engine manufacturer, and yet to come is a temperature sensor.

Projected prices, Barron notes, are at least competitive with those of other designs being proposed to Detroit. The pressure transducer will sell for less than $3 in million quantities, he says and the proximity sensor, at about $3 in 100,000 quantities.

Each Licon keyboard switch contains a ferrite core with a continuously pulsed primary winding and a passive secondary-output winding. Magnets on the switch plunger saturate the core while the switch is open, so the output pulse is small. But depressing the switch moves the magnets away from the core, and the output voltage is increased.

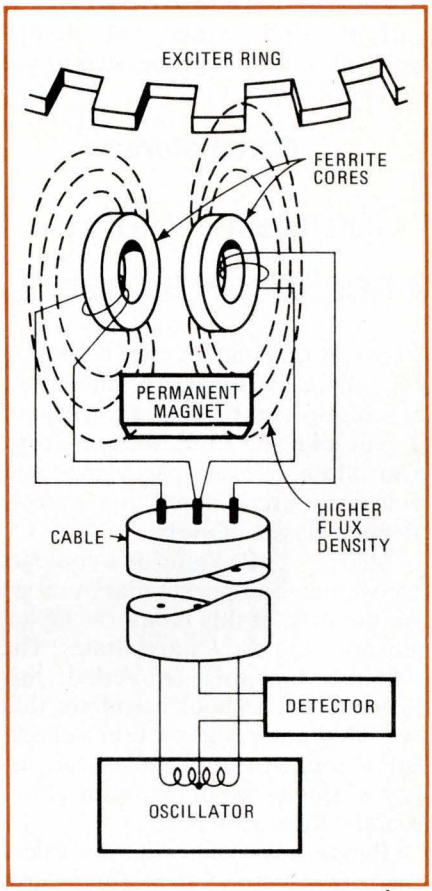
Borrowed effects. The company relies on similar magnetic effects in its new transducers, which use inductor pairs as differential sensors that are insensitive to temperature changes. Also, the transducers all use electronics that enable the output to be counted at a distance from the sensors, says Edward F. Sidor, manager of new-product development.

A driver oscillator provides the sensor with an ac excitation signal, usually between 250 kilohertz and 1 megahertz. The pair of sensor inductors, wired in series on ferrite cores, serves as the two active arms of a four-arm bridge. Sensor output, an amplitude-modulated carrier, is fed to a detector to provide a dc signal that can be processed however the user wants.

"We're looking at phase, synchronous, and product detectors to determine what performance we can get for the least cost," Sidor says.

The Licon sensors use at most a few turns of high-gauge wire. In contrast, variable reluctance coils and linear variable differential transformers use thousands of turns of fine wire that must be wound accurately. This requirement makes them difficult to manufacture and rather fragile in the rough automobile environment.

In the antiskid system, for example, a proximity sensor determines wheel speed by counting teeth on an exciter ring mounted on a car wheel. When the wheel is still, one of the two inductors is positioned over a gap, and the other is over a tooth. A permanent magnet biases the cores. As the metal teeth on the exciter ring pass the sensor, the magnetizing-flux density increases, changing the impedance of the torroidal inductor, Sidor explains.



Skid control. Licon sensor relies on a pair of differentially connected ferrite cores to sense the speed of a vehicle's wheels.

The inductance of one core increases as the inductance of the other decreases, so the voltage output of the bridge circuit crosses zero every time a tooth passes the sensor. Since the sensor reacts to differences in flux, rather than absolute flux density, it is unaffected by changes in temperature and distance between the sensor and exciter ring. Even low rotating speeds can be detected by the zero-crossover output of the sensor.

The more conventional variable-reluctance-coil proximity sensor, on the other hand, generates an absolute voltage output that decreases as the wheel slows. At low speeds, the

output often cannot be distinguished from noise generated in the system, Sidor says. □

Calculators

'Compact,' 'diary,' checkbook all count

Personal calculators are becoming still more personal. In three new machines—two from Sharp Corp. of Japan and one from Mostek Corp., Carrollton, Texas—packaging and functions are tailored for sharply defined classes of users.

Sharp's calculator-in-a-compact for women and pocket-diary unit go on the market this month in Japan, Europe, and the United States. The Mostek machine, unveiled this week, is a checkbook calculator that will hold and display a user's checking-account balance for a year, using a single set of batteries [*Electronics*, March 20, p. 26].

Power conscious. Sharp's calculator-in-a-compact features new technology in the form of a single flexible printed-circuit board that includes all components, wiring, keyboard contacts, and display-connector contacts. Both Sharp machines are made possible by the low power drain of liquid-crystal displays and complementary-metal-oxide-semiconductor circuits.

The calculator-in-a-compact is an eight-digit, four-function unit with clear-entry and clear-all capability. It will sell for about $45 in the U.S. The pocket-diary unit, which also includes percent and sign-change keys, is ticketed at about $35.

The "compact" is very small, only 19 by 79 by 71 millimeters when folded or 9.5 by 79 by 142 mm when opened. Weight, including power cells, ranges from 115 to 127 grams depending on case material. Two Mallory MS 76 silver-oxide cells provide 25 hours of operation. Power drain is a low 0.02 watt, about 1/20 that of Sharp calculators using green fluorescent displays. The polyimide flexible substrate is the same type of plastic often used in computer harnesses and connectors. The substrate is bent double when the calculator is closed, but it has successfully passed tests during which it was flexed approximately 100,000 times.

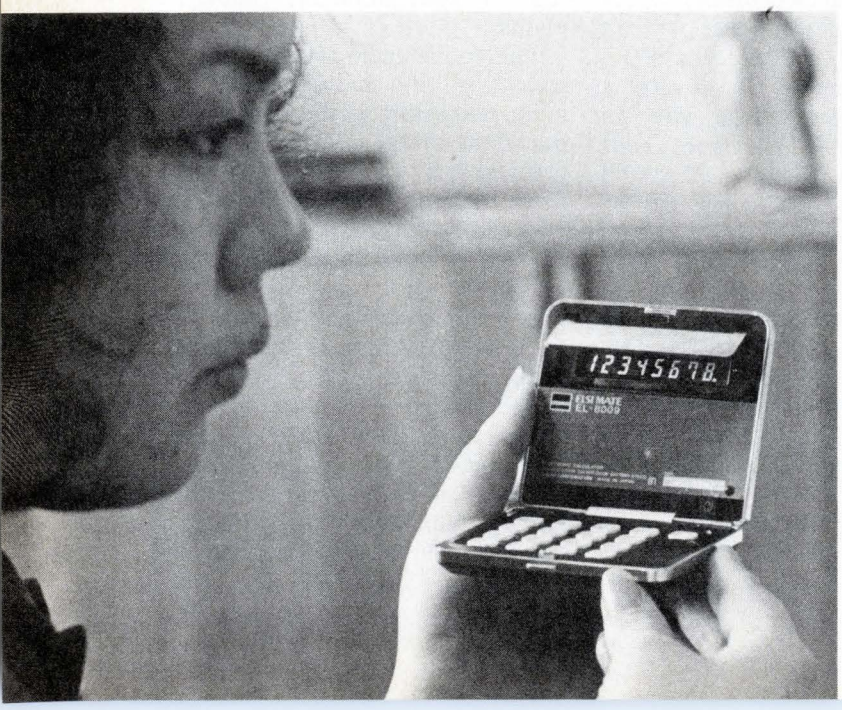
The calculator in the pocket diary is only 9 mm thick by 76 by 129 mm. Its pc board is thinner than usual, but of normal pc-board material. Two nickel-cadmium cells will operate the calculator with its 0.025-w power drain for about eight hours. Alternatively, two Mallory RM 625 mercury cells will operate the calculator for about 35 hours.

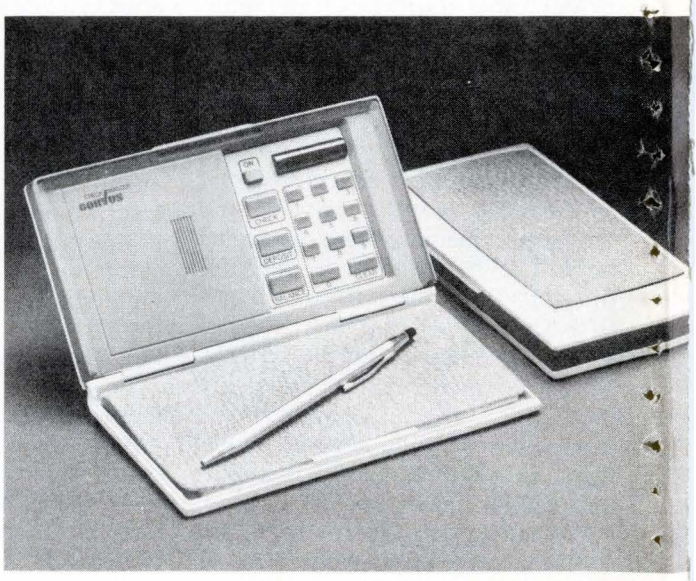
Mostek's CheckMaster, meanwhile, offers proof that the company can make p-channel MOS devices that dissipate almost as little power as complementary MOS. The $39.95 unit is a two-function machine with memory. The checking-account balance is maintained continuously in the memory and is displayed when the "balance" key is depressed and triggers the memory-recall function. Adding to and subtracting from memory is handled with "deposit" and "check" buttons; Mostek has used what is essentially reverse Polish notation to eliminate the "equals" key.

Low-drain memory. Key to the design of the chip is a gated-clock, static shift-register memory that draws less than 25 microamperes when the calculator is off. "We went to a static shift register to eliminate much of the timing circuitry that is superfluous to storing data," comments Robert C. Farrier, designer of the chip.

"We use an extra gate to connect the output of each flip-flop in the shift register back to its input, so it looks like a cross-coupled latch as opposed to a two-phase clocked flip-flop," he says. The memory is

Stylish. Adding new wrinkles to the design of calculators is unit from Sharp Corp. (left) made to resemble a woman's compact, and Mostek Corp.'s CheckMaster is a two-function machine designed specifically for balancing check books.





clocked only when it is being accessed.

In addition to minimizing the amount of logic the memory requires, Farrier used very long depletion loads to reduce the power drain in the power-up mode. "Within that register, we had to make sure that no one device drew too much power," he says. Of about 500 loads in the circuit, only about 50 are unswitched, and ion-implantation gives each of those as high a resistance and as low a power consumption as is consistent with the circuit's speed requirements.

As a result, the chip needs less than 1.5 milliamperes even when the calculator is on. CheckMaster operates from six 1.5-v AAA alkaline batteries. □

Business

Sarnoff speech sets market off

"Not since the speculative binges of the 1960s can we remember such a dramatic reaction to a non-announcement." That's how Benjamin M. Rosen, a long-time semiconductor-industry analyst for Coleman & Co., New York, assessed the stock market's response to RCA Corp.'s March 20 announcement that microprocessors would reduce gasoline consumption drastically in passenger cars.

The momentous statement covered less than two paragraphs in the middle of a nine-page text. But when RCA chairman Robert W. Sarnoff said that a "miniature electronic device"—a microprocessor—is achieving significant gasoline savings in tests by major automobile makers, the market value of the company's stock was boosted—at least temporarily—by 3⅜ points or about $225 million.

Mileage. Sarnoff told the conference at Indiana University's School of Business that, on the basis of preliminary tests, microprocessors will boost mileage by up to 40% in standard-size and large cars. Said Sarnoff, "working with the automotive industry, as we have, the electronics industry should be able to mass-produce these microprocessors by the millions at a cost of no more than $100 a unit."

In contrast to the $200 million-plus boost in the value of its stock, Rosen calculated that RCA could expect to gain about 20% of the potential $15 million to $20 million automotive microprocessor market, or a smallish $2 million to $5 million in sales. But this will not happen before 1978 at the earliest, Rosen contends.

Somewhat abashed at the uproar the speech created, RCA lined up Gerald B. Herzog, staff vice president for RCA Technology Centers at Princeton, N.J., to talk with the press about microprocessors. He didn't produce any specific applications contracts, pointing out that the "automotive field was certainly a good application area" for microprocessors, and that Sarnoff was speaking in general. "Everybody's doing work on microprocessors," Herzog noted.

News release. Although buried in his text, Sarnoff's microprocessor comments were the highlight of a new release prepared by the RCA public-relations staff and sent to the highly competitive news-wire services, which disseminated it almost immediately. Securities analysts and major investors picked it up. And when the stock of RCA and other microprocessor manufacturers started to climb, many investors jumped on the bandwagon in what James Magid, vice president in the research department of Drexel Burnham & Co., for years a semiconductor-industry follower, calls "speculative excess." □

Medical electronics

Faulty parts afflict pacemakers

Pacemakers have killed heart patients, declares the U.S. General Accounting Office. And the investigative arm of Congress says that the Federal Food and Drug Administration has failed to regulate the electronic-pacemaker industry adequately since malfunctioning units first turned up in 1971. "According to FDA records, seven deaths and two injuries were attributed to defective pacemakers," GAO revealed after a two-year study that was requested and made public last month by Sen. Abraham A. Ribicoff (Dem., Conn.), chairman of the Senate Government Operations Committee.

Of the 123,000 units implanted for electronic stimulation of weak hearts, more than 22,300 have had to be monitored periodically to ensure their pacing frequencies stay within set limits. Because of faulty transistors and resistors and incomplete epoxy seals, hundreds of patients in the last two years have undergone additional surgery to replace pacemakers that were likely to malfunction. Officials explain that loopholes in the law permit corporations not to notify FDA about potential pacemaker malfunctions,

so that the total number of unsafe units is not known.

General Electric's Medical Systems division, Milwaukee, however, paid the cost of replacement surgery for 274 patients whose physicians in late 1971 found them to have malfunctioning units, say Government and industry sources. These units and others on hospital shelves had printed-circuit boards that short-circuited because of moisture-generated copper growths, says the GAO.

GE refuses to comment, but industry sources say that body fluids penetrated incomplete epoxy seals of implanted units. GAO assailed inadequate inspection of GE production lines and criticized FDA for limited regulation of the lines.

Problems. FDA officials, for their part, admit that various problems beset pacemakers. "We haven't seen any consistent flaw in the industry. It's partially true, though, that companies were victims of bad parts," says FDA's David Link, director of the Bureau of Medical Devices and Diagnostic Products.

Although officials of Cordis Corp., Miami, another pacemaker manufacturer, refuse to comment, an industry source says moisture trapped in transistors during their manufacture caused erratic operation of many Cordis units. More than 19,000 Cordis units are on an FDA list that warns physicians of the possibility of malfunctions. Part of this list (and added just last December, according to GAO) are 4,000 units in which FDA faults resistors supplied to Cordis by C.T.S. Berne Inc., Berne, Ind.

C.T.S. supplied Cordis with a new resistor more vulnerable to moisture than its predecessor, according to industry sources. Neither Cordis nor C.T.S. was aware of this until complaints from physicians poured in, but an FDA official says better life-testing techniques would have revealed the problem earlier.

More warnings. Physicians' complaints also prompted Medtronik Inc., Minneapolis, last year to recall 343 units with improperly fitting battery contacts. The batteries were mounted externally, however, and the units could be readily repaired.

Two European companies, Biotronik Inc. of West Germany and Vitatron Medical Inc. of Holland, also had problems. They warned physicians of possible malfunctions in 1,345 and 506 units, respectively, due to incomplete epoxy seals and faulty batteries. FDA says it does not know how many of these units were recalled.

The GAO report notes that Congress failed last year to pass amendments to the Food and Drug Act that would have added to FDA's regulatory authority over medical devices. But it also says that FDA failed to act effectively within its limited mandate. FDA retorts that it lacks manpower for complete inspections and needs additional funding for test laboratories. □

Military

AF Tacan sets going solid-state

Vacuum-tube-type sets for tactical air navigation (Tacan)—short-range systems that use range and bearing information generated on the ground for precise fixing of an aircraft's position in the air—have been flying in Air Force planes since the early 1950s. But only this month will the service award a contract that will start the replacement of the outmoded sets with a virtually solid-state design.

Meanwhile, Hoffman Electronics Corp., El Monte, Calif., has been delivering solid-state Tacans to the Navy for five years. The company now has approximately 2,000 Navy orders in house at an estimated $25,000 per set for its AN/ARN-84 (V), according to program specialist Ed Micozzi.

Two companies, finalists from earlier competition, are in line for the Air Force award—Collins Radio Co., Cedar Rapids, Iowa, and General Dynamics' Electronics division, San Diego. The eventual return will be big. The Air Force alone plans to buy 8,500 sets to retrofit about 90% of its aircraft inventory. At a projected price of $10,000 per set, this could add up to $85 million. Foreign sales could mean $100 million more.

Equally divided. While the Air Force has been dangling its 8,500-unit requirement before industry competitors, Micozzi points out that Hoffman has already picked up orders for 1,000 sets from the service for a modified version of its more

Tacan warranty aims at high reliability

Industry and consumers have for years been the beneficiaries of reliability warranties obligating the manufacturer to repair equipment that fails within a specified period. But not so the military—at least not until a contract to be awarded this month to build new solid-state Tactical Air Navigation sets for the Air Force.

The Air Force calls its new contractual requirement, which is being watched closely by the other services, "a reliability-improvement warranty." Covering the estimated 8,500 sets that will be built, it sounds like what a consumer might expect from the manufacturer of a color-television set. The Air Force contract requires the manufacturer to repair units that fail during a 48-month period because of defects in design, materials, or workmanship. The Air Force is looking forward to more than merely getting a hand in making repairs.

Except for reliability warranties a few years ago that involved a small number of gyros and radio sets, the Air Force, as well as the other services, do their own repair work. And this often, in effect, could pay a contractor to do a poor job. "In the past if we got poorly made units, we had to repair them and buy parts from the contractor," ESD's Maj. Frederick Nohmer says, adding, "a lot of difficulty with reliability is in prior workmanship and materials."

sophisticated Navy Tacan.

The Air Force procurement from Hoffman has thus far been about equally divided between systems for its own aircraft and for planes being sold under foreign military sales agreements, Micozzi says. Prices of these units range between $15,000 and $19,500, depending on specifications, and probably average out at about $16,000.

The Air Force has long wanted to buy solid-state sets, but initial price has been an inhibitor. Mean time between failure on the tube-type Tacan is only 50 to 100 hours, and ways to improve this are uneconomical. The Air Force estimates annual maintenance costs for the tube sets at $25 million.

In 1971, however, the Air Force decided to develop a high-reliability Tacan set with a significantly reduced life-cycle cost that included a $10,000 price tag and an MTBF of 1,000 hours, an order of magnitude improvement.

In late 1972, contenders for the development contract, which also included ITT Corp. and Hoffman, were asked to design to this cost. And in April 1973, development contracts were awarded to Collins and General Dynamics.

Standard set. The new solid state unit will be a standard Tacan set with no significant change in performance requirements, says Major Frederick J. Nohmer, chief of navigation and landing systems at the Electronics Systems division, Hanscom Air Force Base, Mass. It is a line-of-sight unit with a range of about 370 miles, but in the solid-state version the number of ultra-high-frequency channels that are provided in the range from 962 megahertz to 1,213 MHz is doubled to 252.

Collins is building the ARN-118(V), a digital ranging unit with a varactor-tuned receiver, all solid-state except for the transmitter tubes, which must handle a typical power output of 1,000 watts. General Dynamics' unit, the ARN-119(V), uses an Intel Corp. 8-bit microprocessor in its signal-processing section. □

Transportation

Westinghouse trades charges with BART

With Westinghouse Electric Corp. drastically cutting back its on-site staff, the fight between San Francisco's Bay Area Rapid Transit District and its principal electronics supplier enters a new round.

The planned-for cutback puts a larger share of maintenance responsibilities onto BART's shoulders, and there's even more trouble ahead for the ill-starred commuter system unless it trains its staff to maintain the computer-controlled cars. That's the opinion of W.E. Johnson, vice president and general manager of Westinghouse's Transportation division, which supplies the train-operation equipment.

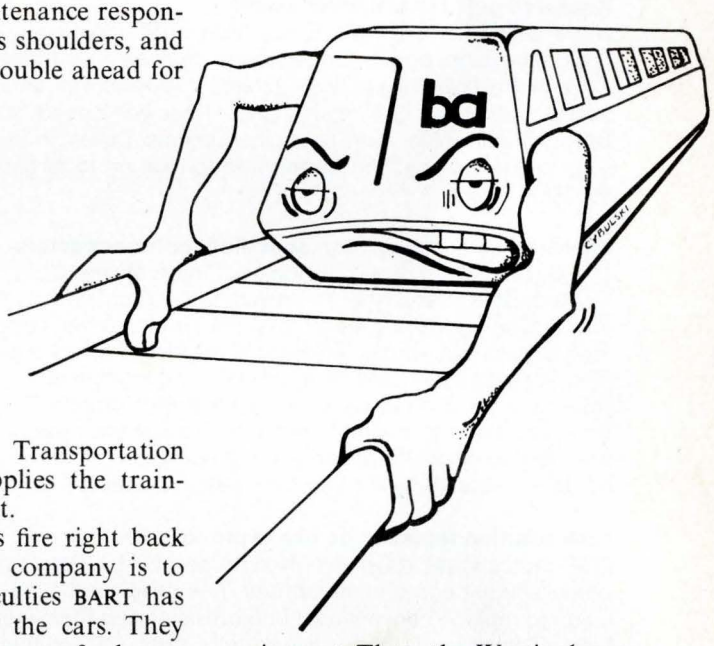
But BART officials fire right back that the Pittsburgh company is to blame for the difficulties BART has had in maintaining the cars. They accuse Westinghouse of sloppy quality control.

The latest move in a controversy that has been raging almost since the BART system was built is Westinghouse's chopping of its on-site technical staff from 40 to four by July. Johnson says that BART isn't close to being ready to take up the slack. "They don't have competent people to fix these cars," he asserts.

BART's figures show that more than half of the 396 cars delivered so far were out of service in early March. R.W. Carroll, BART's director of maintenance, concedes he has trouble maintaining the cars, even though he has a staff of 236, of whom 180 are technicians and engineers.

Among other functions, the automatic equipment controls car speed between stations and reports each train's progress to a control center. The computer-run wayside equipment in the $40-million Westinghouse system is functioning properly, and is not at issue. In November, BART sued Westinghouse for $109 million for losses BART says it sustained when the train-control equipment didn't operate as promised.

In another move, just last month BART's board of directors voted to start redesigning the on-board



equipment. Then, the Westinghouse gear eventually could be entirely replaced. In addition, the board voted not to award a $1.5 million contract to Westinghouse for equipment on 26 additional cars.

BART's Carroll says his maintenance problems stem from design problems and high failure rates. "If the failure rate were normal, we could maintain the system with the staff we have," he says.

Moreover, Westinghouse is charged with refusing to furnish the detailed specifications, including parts lists, needed "to make it reasonable to maintain the equipment," according to another BART official. The lack of documentation prompted BART's move to replace the Westinghouse hardware.

But Howard Miller, West-

inghouse Transportation division's engineering manager, doesn't agree with BART's view of the documentation problem. "We were originally supposed to provide test equipment to identify faults down to the lowest replacement unit—a printed-circuit board in most cases. Then these boards were to go back to us for repair. But BART changed its mind and decided it wanted to be able to put in resistors, capacitors and other components itself."

Westinghouse was concerned about workmanship standards that BART would maintain, particularly in fail-safe portions of the system, Miller explains. "We were negotiating a price for supplying such standards, and the extra documentation, when the law suit was filed."

Westinghouse also points a finger at an organizational detail that could have contributed greatly to the present difficulties. BART management insisted that Westinghouse communicate only with the engineering consultants it had hired for the design and construction phase of the system, says Miller. And when his staff pointed out what it thought were several "glitches" in the specs, the consultants more often than not advised Westinghouse to follow the original designs.

"This is all fully documented," says Miller, who points out that the consultants are also being sued by BART. "We're not clean," adds Johnson. "We recognized there were equipment problems. But we fixed them. Believe me, no one wants this system to operate properly more than we do." □

News briefs

Rockwell gets laser-seeker award

A five-year $7.9 million Air Force Aeronautical Systems division contract to design, develop, qualify, and perhaps produce a laser seeker for the Maverick and Hellfire missiles was awarded to Rockwell International's Missile Systems division, Columbus, Ohio. Rockwell edged out Martin Marietta Corp., Orlando, Fla., and Texas Instruments, Dallas, in the competition. The laser seeker will enable the missiles to lock on to targets designated by a separate laser.

Intermodulation distortion specified for broadcasters

The Collins Radio group of Rockwell International Corp. is introducing the first broadcast transmitter to provide a specification for intermodulation distortion. The figures are less than 0.5% for stereo transmissions and half that for monaural broadcasts. Collins is relying on a redesign of the fm exciter that modulates the transmitter carrier. Two independently controlled sets of varactors—new, more sensitive types from Motorola Semiconductor Products—are used to maintain linearity. Equipment designers have generally not worried about specifying intermodulation distortion because this has not been required by the Federal Communications Commission.

New solution replaces pc board photoresist

The Photocircuits division of Kollmorgen Corp., Glen Cove, N.Y., a major printed-circuit board manufacturer, has developed a low-cost aqueous solution to replace conventional photoresists used to delineate the board patterns. Composed of non-noble metallic salts, the solution, designed for the additive board-making process, is applied to a blank board and then activated by light much like photoresist. But while the new solution can be used to print high-density boards, its price of 12 to 15 cents per square foot is about the same as that of liquid photoresist used for medium- and low-density boards. (Dry-film photoresist for high-density boards is about 35 cents a square foot). Eventually, Photocircuits hopes to reach the 3 to 4 cents per square foot price of screened photoresists used for the simplest boards.

Langstroth to head EIA West Coast operation

Frank D. Langstroth has been named vice president for West Coast operations for the Electronic Industries Association. The EIA says it will open a West Coast office in Los Angeles, effective April 1, under Langstroth's direction. The new EIA officer, a veteran of 50 years in the electronics industries, retired earlier in the year from the Magnavox Corp., where he had been serving as vice president for legislative affairs in the Washington office.

Tektronix plans 3-week shutdown

Instrument-maker Tektronix Inc. will be shutting down its Beaverton, Ore., plant for at least three weeks. About 9,000 employes will be asked to extend regular national-holiday days off through the year. Low incoming-order rates was the reason cited for the shutdown.

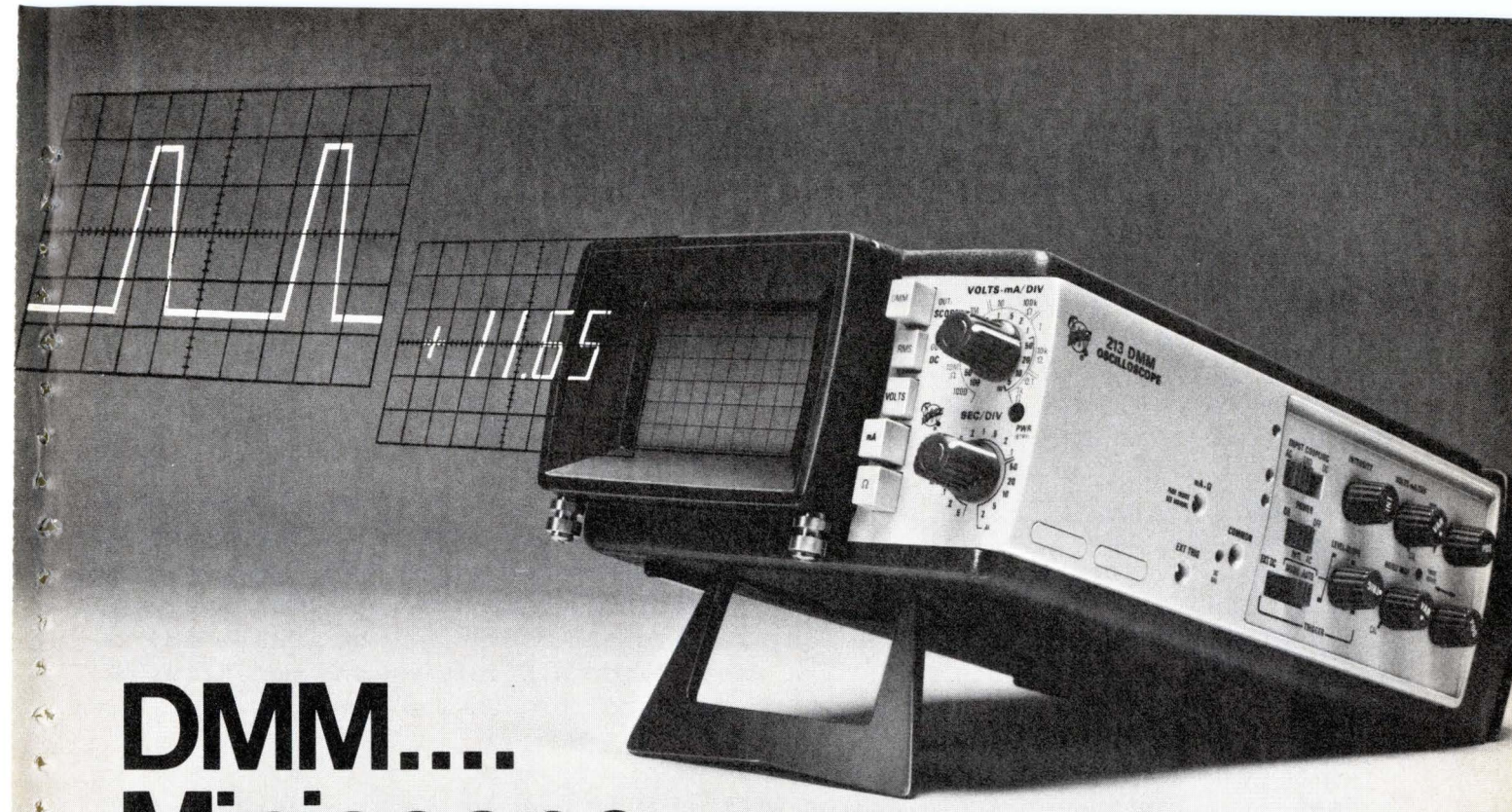
Solid state

Motorola, Intel agree on 16-k RAMs

Too many packages and pin-outs may have slowed market growth in 4,096-bit random-access memories—but they won't hinder sales of future 16,384-bit RAMs if two major memory makers have their way.

Long before their products are due on the market, Intel Corp. and Motorola's Semiconductor Products division have settled on a standard 16-pin dual in-line package based on recently announced 16-pin 4-k memories. These in turn used Mostek Corp's multiplexing scheme and package connections.

The decision followed talks between William W. Lattin, director of engineering at the Motorola division, and Leslie L. Vadasz, vice president of engineering at Intel. They emphasize, however, it is not a second-source pact. Lattin says, "It's an informal agreement based on what happened with the 4-ks. We retarded the 4-k RAM business up to a year by my estimate due to the proliferation of pin outs. Our customers have had to design multiple boards and expend a considerable



DMM.... Miniscope.... both in one handheld unit

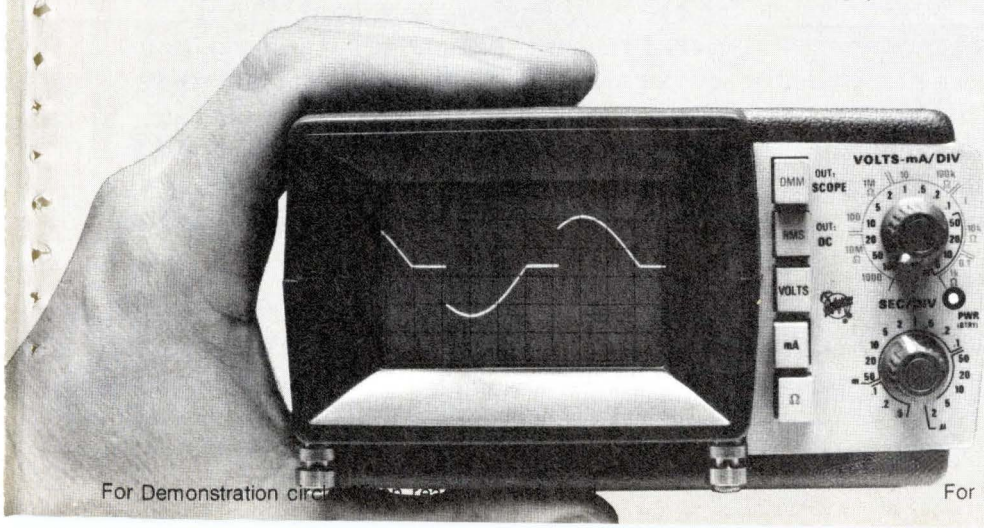
You no longer have to settle for only a DMM or suffer the inconvenience of carrying two separate instruments. The new TEKTRONIX 213 DMM/Oscilloscope provides the instrumentation needed to reduce service costs by performing more of your servicing on site, on the first call. And it weighs only 3.7 lbs. This precise, full function, 3½ digit DMM and 1 MHz oscilloscope in one compact (3.0 × 5.2 × 8.9 in.) package fits easily in your briefcase or tool kit. During operation the 213 can be hand held, rested on the equipment under test, or even carried on a convenient neck strap.

Included in the extensive measurement capabilities of the 213 are precise dc voltage from 0.1 V to 1000 V full scale, dc current from 0.1 mA to 1000 mA, true rms voltage and current over the same ranges, and resistance from 1 KΩ to 10 MΩ full scale. In the oscilloscope mode, the 213 displays both voltage (5 mV/div to 100 V/div) and current (5 μA/div to 1000 mA/div) waveforms.

With its easy portability and internal battery power (3.5 hours operation), the 213 DMM/Oscilloscope is equally at home at the top of a ladder, on a catwalk in a processing plant, in a moving vehicle, in an office environment, or at a remote field location. And rugged construction insures that the 213 will withstand rough handling.

At only $1200, the 213 adds outstanding versatility to the Tektronix 200 Miniscope Series. Other instruments in this line include both single and dual-channel 500 kHz oscilloscopes, a dual-channel 500 kHz storage oscilloscope and a 5 MHz oscilloscope for higher frequency applications. All of these Miniscopes share the 213's advantages of small size, light weight, internal battery power, rugged construction, double insulation, and integral voltage probes and power cord.

For detailed information on this complete DMM and Oscilloscope in one small, handheld package, contact your local Tektronix Field Engineer, or write Tektronix, Inc., P.O. Box 500, Beaverton, Oregon 97077. In Europe, write: Tektronix Ltd., P.O. Box 36, St. Peter Port, Guernsey, Channel Islands.



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SCIENCE/SCOPE

Now undergoing sea trials aboard a U.S. Navy destroyer escort is a fully automatic air defense system built by Hughes. Designated the Improved Point Defense/Target Acquisition System, it is the first to integrate infrared sensors with conventional radar and correlate the returns. IPD/TAS will give single ships the reaction speed they need to defend against low-flying aircraft that "pop up" over the horizon.

A more accurate inventory of the world's food crops will be a major assignment for Landsat II, the new earth resources technology satellite launched by NASA in January. Photographs by the satellite's Hughes-developed Multispectral Scanner (MSS) will enable agricultural scientists to measure acreages and predict yields, and to determine the long-term relationship between yields and climatic patterns. The new technique was called "a promising and potentially vital contribution to rational planning of global production" at the recent World Food Conference in Rome.

Landsat II's continuous-strip photos will also be used to locate air and water pollution, map strip-mine and forest-fire devastation, locate underground water supplies, update maps and navigation charts, locate geologic formations indicating the presence of petroleum or minerals, monitor urban developments, and evaluate fishery resources. Data from the MSS photos can also be fed directly into computers.

A way of conserving U.S. R&D dollars by adapting an already designed European air defense system was made possible recently when the Hughes-Boeing proposal to build a short-range, all-weather air defense system was selected over three competitive proposals. The SHORADS system is equally suited for installation on tracked or wheeled vehicles or fixed installations to defend against low-flying aircraft.

Hughes needs Training Engineers to prepare civilian and military personnel to efficiently operate and maintain the AIM-54A Phoenix Missile System. Training Engineers conduct classes at Hughes' California sites and domestic and foreign locations. BSEE or Physics degree and U.S. citizenship required. Please send your resume to: D.J. Wingate, Hughes Aircraft Co., Support Systems Division, P.O. Box 90515, Los Angeles, CA 90009. An equal opportunity M/F employer.

Industrial waste heat can be put to work by the new Hughes Heatbank^{tm} heat recovery unit, a compact, self-contained, passive heat exchanger with no moving parts or external power requirement. It is designed to heat an incoming airstream, using the otherwise wasted thermal energy from a warm exhaust airstream. Applications include industrial furnaces, paint-drying and processing ovens, food drying, petroleum refining, and glass, plastic, and papermaking processing. For information, write: Hughes Thermal Products, 3100 W. Lomita Blvd., Torrance, CA 90509.

Creating a new world with electronics

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amount of their resources on engineering test and evaluation in a down economy. We've made it difficult to use the 4-k RAM. We don't want that to happen on the 16-k."

Vadasz adds that Motorola and Intel were not discussing performance, only pinouts and general specifications. He says the dynamic RAMs will be organized as 16-k-by-1-bit devices with the same standard n-channel power supplies as 4-k devices (+12 volts, −5 V) and the same compatibility with input and output levels of transistor-transistor logic (though some designs may require a high-level clock input).

"We want the 16-k RAMs to be evolutionary developments from the 4-ks, not completely different," Lattin says. But neither he nor Vadasz will say when they will arrive. □

Computers

GAO study says agencies slight minis

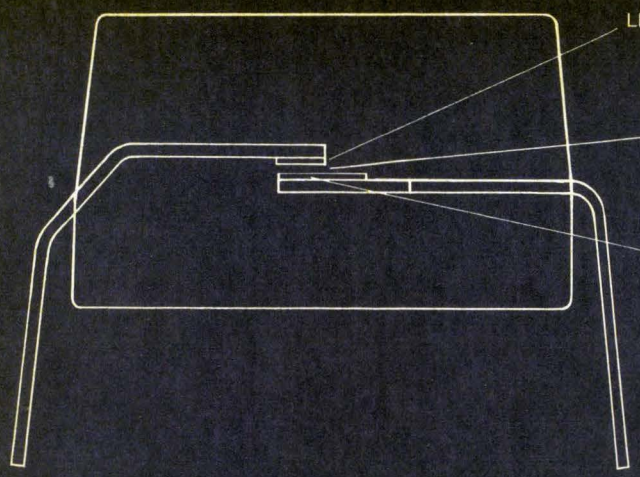
Minicomputers are not being widely applied by the Federal government because procurement practices favor larger systems when agencies enter the data-processing market, according to the General Accounting Office. Big computers have the advantage that present Government procurement practices "make it just as hard to get a mini as it is to get a big machine," says GAO's Walter Anderson, associate director for financial and management studies at the Congressional investigative office.

These and other conclusions of GAO's nearly completed study of minicomputers and their use in Government were disclosed by Anderson at the March meeting in Washington of WEMA, the California-based association of electronics companies. According to the former Univac executive and past president of the American Federation of Information Processing Socities, the study will not become available until after it has been sent for comment to participating Federal agencies. At this time it will also be presented to Congress for possible hearings—a process that Anderson expects might take as long as six months. GAO, he said, "did document a lot of case histories" showing that "a lot can be done with minis" to meet the computing requirements of many Federal installations now using larger processors.

In the most recent inventory of Federally owned special-management computers priced at $50,000 or less, Digital Equipment Corp. led the market with 1,036 installations, or 39% of the 2,655 installed. Trailing far behind was Univac with 208, Honeywell with 139, and Xerox Data Systems with 123. Control Data Corp. had 58, IBM Corp. 36, and Burroughs Corp. only 5. The remaining 1,050 were provided by all other makers combined. In the general-management category of $50,000-or-less computers, the Government said it owns 180 Univac models, with Digital Equipment second at 150.

Inquisition. Anderson called for the Government to begin to define solutions to its problems with computer acquisitions and to treat "a procurement crash" as one of the possible answers. Likening the process to the Federal Aviation Administration's investigation of aircraft accidents, Anderson said, "we would take the worst cases first where there have been bad procurements through a procurement inquisition—a 'crash' inquiry." Such investigations might determine, he said, "if it was faulty equipment or 'pilot' error. We might even find out who the 'pilot' was on the procurement."

As a second recommendation, Anderson suggests restructuring the language of Federal requests for proposals "by smoothing them out so the Government can buy more for more useful use" in data processing. This idea, he says, is in the works at GAO. In dealing with requests for proposals, he observes, "It becomes almost a foreign-language translation, going from what the agency head wants back to the RFP." □



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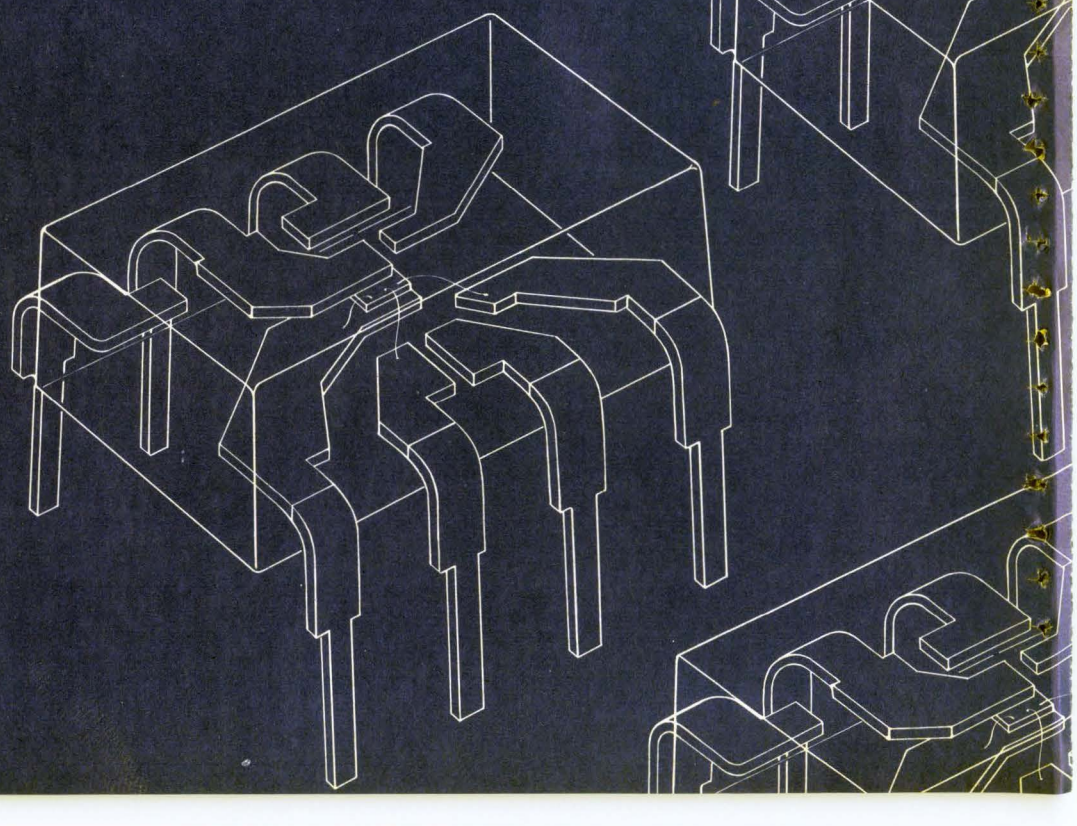

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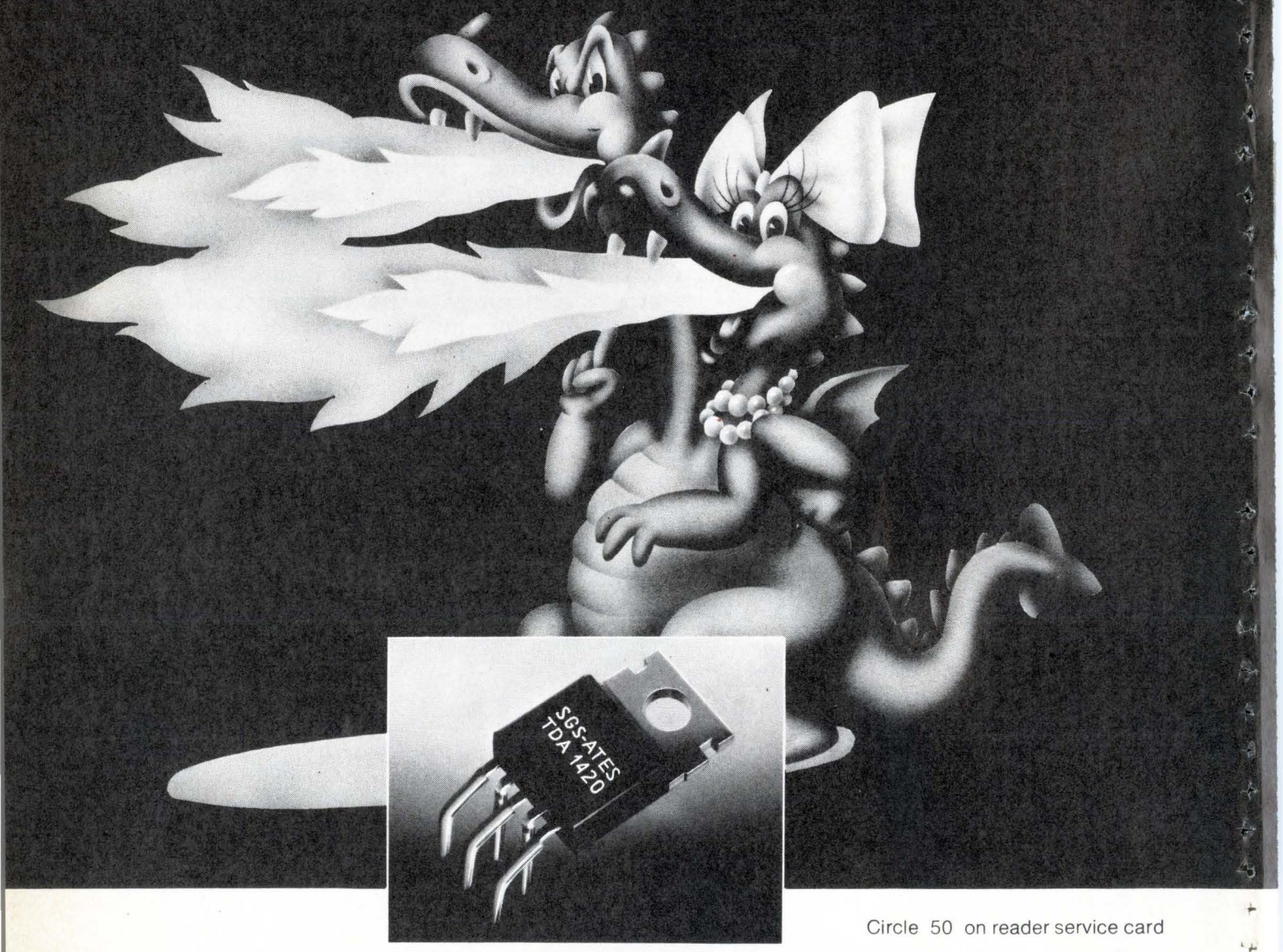

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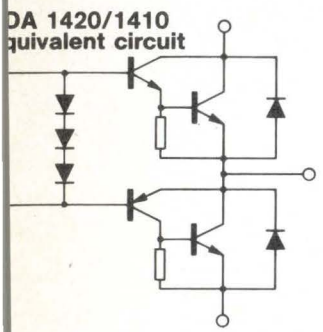

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Washington newsletter

Bill would allot $120 million for electric vehicles

U.S Rep. Mike McCormack (D-Wash.) and five other congressmen would make thousands of Americans test drivers of prototype electric-powered vehicles. **The congressmen have just proposed legislation to spend $120 million on a three-year research, development and demonstration program to explore the viability of electric vehicles.**

The program would be managed by the Energy Research and Development Administration, and would include government purchase of up to 10,000 test vehicles for use by selected members of the general population. How selected? "By an equitable process such as a lottery in each congressional district," McCormack says. **Of the proposed funding, $40 million would go for research on improved batteries and electronics for long-life, extreme-environment uses** such as silicon-controlled rectifiers.

DOT eyes Univac for sole-sourcing $30-million order

The Department of Transportation **has given the FAA permission to issue a request for proposals by the end of this year to the Univac division of Sperry Rand Corp. for $30 million worth of computers.** The computers are wanted to provide redundancy for the FAA's Automated Radar Terminal System-III installations at the nation's 30 busiest air traffic control centers. Senior DOT officials had spent six weeks agonizing over the question of whether to permit the FAA to sole-source the procurement, but, in the end, they say they had no choice. "If we open-bidded the procurement," explains one source, "it would take five years for another company to build the computers" to the same specifications as the Univac units already in use.

Police aid due for delivery, but others delayed

The District of Columbia police department next month will receive its first prototype hand-held terminals from Electro Magnetic Sciences Inc., Atlanta, Ga. These—and others to be delivered this summer by Burroughs Corp., Paoli, Pa.—**will be used by beat patrolmen to access computers for stolen property information.** The experiment is being funded by the Law Enforcement Assistance Administration.

The LEAA meanwhile has delayed plans to issue a request for proposals for wrist-watch-type transmitters that would issue coded distress signals. Officials say the plans ran into some snags, and the RFP will be out in early 1976 instead of this year. George Shollenberger, advanced technology division chief for the LEAA, says the RFP will call for a "few thousand units" having large-scale integrated circuits. Public housing residents in two communities—Elizabeth, N.J., and Kansas City, Kan.—would be the first to test the devices for summoning police.

Tempers cooling over MLS issue? FAA hopes so

Officials at the Federal Aviation Administration are hoping that **a new cooperative development agreement between the U.S. and Great Britain may mean better relations at the June meeting of the International Civil Aviation Organization.** An international brawl was threatening in the wake of the FAA's selection last December of the scanning-beam microwave landing system rather than the doppler MLS favored by the UK. British officials thereupon indicated they might scuttle future Anglo-American technical agreements. Now, however, an agreement for joint development of a digital beacon system for air traffic control

[*Electronics*, Feb. 6, p. 35] has been signed, which FAA officials say is evidence that the British are softening their strident anti-scanning beam attitude.

British Civil Aviation Authority officials, however, deny any cooling off in their opposition to scanning beam. They say **the CAA will fight for doppler scan in the ICAO "to the limit of its resources."** They add that the agreement on the digital beacon system has nothing to do with British anger over the whole affair.

UMTA scrambles to save transit in Morgantown

The Urban Mass Transportation Administration is trying to salvage its Morgantown, W.Va., personal rapid-transit project by asking for more money for the system, whose cost has already ballooned from an original $13 million estimate to $64 million. **UMTA officials want up to an additional $50 million to expand the system from its present three-station, 45-car status to a five-station, 75-car system to make it economically viable.** That viability is mandated in UMTA's contract with the University of West Virginia, which would ultimately operate the system.

But UMTA has a tougher chore ahead than demonstrating to the university that the system won't lose money. It's got to ask Congress next month for permission to dip into a fund normally reserved for improving urban bus and rail systems. After pledging not to ask for more than the currently estimated $64 million in research and development funds, **UMTA will ask Congress to change the system's status from R&D to operational, a technical subtlety that would give UMTA a way around its earlier pledge and into a capital grant fund to finance the expansion.**

Studies lukewarm to automation in retail uses

Two studies commissioned by the National Science Foundation have drawn generally lukewarm conclusions in certain areas of electronic automation. One study, by J. Francis Reintjes of the Electrical Engineering department at MIT, says automation within the retail food industry isn't doing too well. **"In the retail food business," Reintjes says, "the potential of modern automation technology far exceeds its present utilization.** Automation is not reducing direct labor [costs in warehouses] sufficiently to offset the capital cost of the equipment."

A cautionary tone is also adopted in a report on the future growth of electronic funds transfer systems. Edwin D. Cox of Arthur D. Little Inc. says the **financial returns for such advanced systems in the near future "would not be sufficiently favorable to a businessman."** One of the key problems, Cox says, is attracting sufficient transaction volume to warrant the rapid buildup of a system.

Addenda

A Congressional committee will recommend a steep increase over White House requests in photovoltaic cell R&D spending. The Ford Administration wants $12.8 million, but **the House Science and Technology Committee would raise that to $29.5 million—an increase of 130%.** The spending would be for fiscal 1976. . . .

House Democrats are also promoting a $20 million hike in NASA's budget for fiscal 1976 to enable the agency to buy computers capable of real-time data reduction for wind tunnels at the Ames and Langley research centers.

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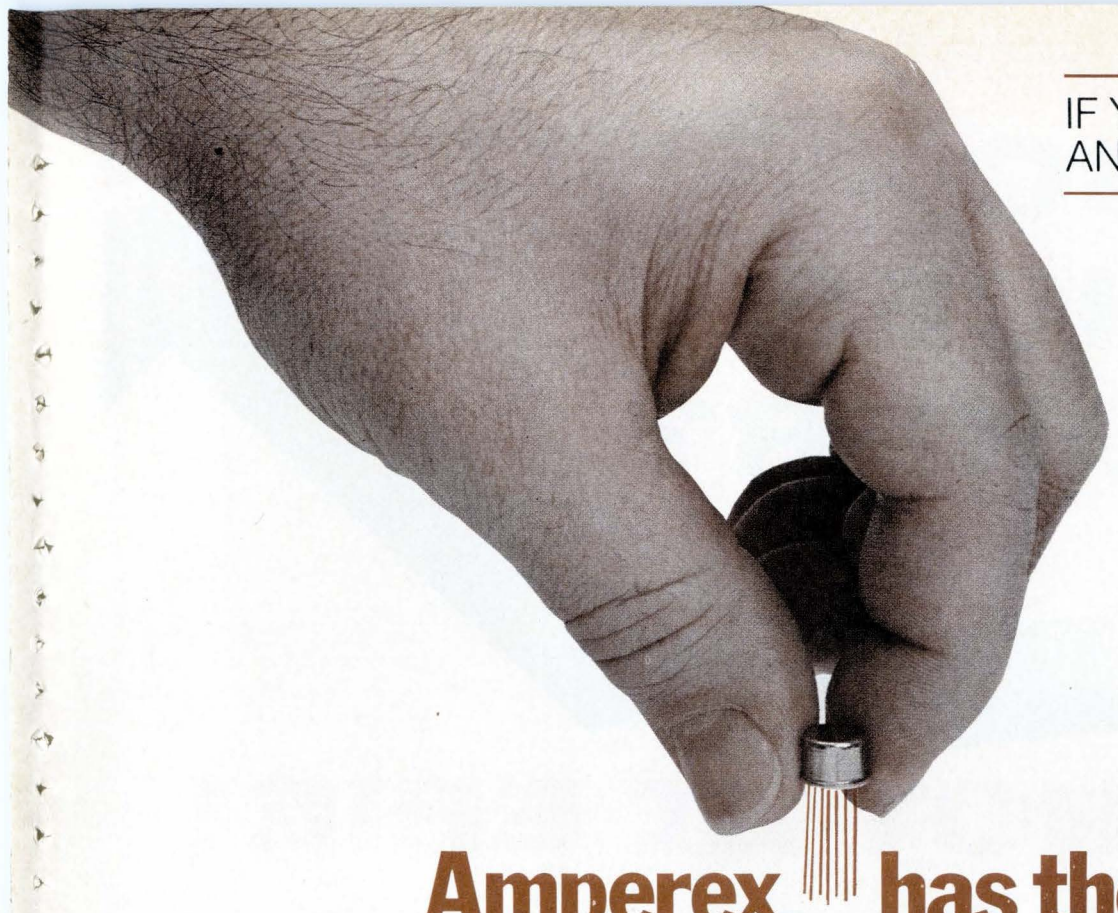

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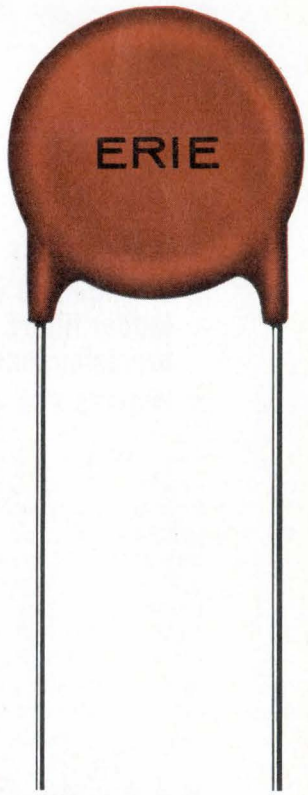

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Electronics international

Significant developments in technology and business

Computers dominate advances shown in technology at Leipzig exhibition

Judging by what happened at the recent Leipzig Spring Fair, the major electronics thrust in Eastern Europe is toward industrial applications of computers. An ambitious top-priority venture during the past few years has culminated in production of a series of central processors that are compatible both in hardware and software. In this series, called ESER (a German acronym meaning unified system for electronic-computer engineering) or ES (from the Russian for unified system), all computer models built by the six Comecon countries are upward-compatible.

At Leipzig, there was much talk about how the new computers are spreading to various industrial applications. "Demand is high," says an official of VEB Robotron, the 20,000-man combine in Dresden that produces East Germany's ES-1040 and some of its peripherals. "Production is running way behind demand."

By 1974, the official says, 25 1040s, large computers with a memory capacity of 1,024 kilobytes, had been readied, "and the target by May of this year is a total of 60." Most of the machines are for export to other Socialist countries.

Besides being a stand-alone multipurpose machine, the ES-1040 can be used as the heart of a computer hierarchy. These systems are being used for management in food-processing and petrochemical plants, as well as in construction and production of automobiles and machinery.

Production. Meanwhile, claim East German industry officials, production of the third-generation ESER series is well under way at more than 100 plants throughout the bloc of nations coordinated and led by the Soviet Union in the project—Bulgaria, Czechoslovakia, East Germany, Hungary, and Poland. Involved in system and peripheral-equipment fabrication are a reported 200,000 workers and engineers in these six countries.

From the Soviet Union come the two largest models of the series, the ES-1060 which has a capacity of 2,048 kilobytes, and the ES-1050, with a capacity of 1,024 kilobytes. Both are said to use emitter-coupled-logic circuitry. The 1060 performs some 1.5 million operations per second, while the 1050 handles one third as many. Next in line is East Germany's ES-1040, a computer with a capacity of 1,024 kilobytes and capable of handling 380,000 operations per second. Based on TTL circuits, the machines' cycle time is 0.9 microsecond.

Products of Soviet/Polish and Soviet/Bulgarian joint developments are the ES-1030 and ES-1020, two medium-size machines that also are built with TTL circuitry. Czechoslovakia's contribution to the ESER project is the ES-1020A, with a capacity of 16 to 64 kilobytes. Hungary's ES-1010, a small computer with a capacity of 8 to 64 kilobytes, also uses TTL. □

Around the world

System sets camera exposure in 2 ms

Manufacturers can now install electronic controls to calculate exposure and set shutter speed in their single-lens-reflex cameras without modifying the present structure of the bodies or lenses. Matsushita Electric Industrial Co., developer of the $20 kit, says its electronic circuitry automatically sets the length of exposure—from 0.0005 second to 4 seconds—according to the lens aperture and film speed. At least one customer has selected each of the two sensor locations—one behind the mirror, and another near the view-finder eyepiece. Since Matsushita's system measures the light at the preset aperture in 2 milliseconds, it is not necessary to modify the camera structure to accommodate devices that calculate exposures from light intensities measured while the lens is wide open.

Color-TV sets to get surface acoustic-wave filters

The high production costs of surface acoustic-wave intermediate-frequency filters for color-television sets has long held back their use. Now France's Thomson-CSF has cut to $1 to $1.50 costs for quantity production, which is to begin by the end of the year. About 300,000 a year are scheduled—about the number of color sets turned out by Thomson-Brandt, Thomson-CSF's parent company. Sescosem, a division, is building an i-f amplifier to compensate for insertion loss. The small, highly linear SAW filter, packaged in a TO-8 metal can, became economically feasible in 1972, when the price of 2-inch lithium-niobate wafers plunged by a factor of 50 or more.

Plessey to produce pyroelectric arrays

Britain's Plessey Co. is starting production of 32-element pyroelectric arrays for military use in short-range battlefield detection. The company also plans to market the arrays for such civilian applications as industrial and burglar-alarm systems and industrial processing. The new arrays, which cost about $2,400 each, are made of a rugged, specially doped ceramic composite of lead-zirconate-titanate. Intended for burglar alarms, small pyroelectric detectors are packaged in TO-5 cans and sell in small quantities for about $84 each, including amplifiers. The detectors take advantage of the pyroelectric effect resulting from the change of spontaneous polarization that is caused by temperature changes.

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Computer pacts appear safe after Spanish shakeup

Agreements for Japanese and U.S. companies to produce computers in Spain don't seem to be jeopardized by a new shakeup in the Instituto Nacional de Industria, which was instrumental in forging the pacts. INI has a new president—the fourth in two years. He is Juan Miguel Antonanzas, a former executive of International Telephone & Telegraph.

INI, an $8 billion industrial holding agency, is seeking **government approval of plans for Japan's Fujitsu and Sperry Rand's Univac division to manufacture computers in Spain for local use and for export** [*Electronics*, March 6, p. 47]. The plans call for a combine to build small Fujitsu computers and peripheral equipment under exclusive license and for Univac to produce parts of its medium-scale computers and peripherals. Univac signed an agreement in principle with former INI president José María Guerra Zunzunegui.

The Fujitsu deal is further along. **A company called Secoinsa, for Sociedad Española de Communicaciones e Informatica SA, is building a $20 million plant and plans to begin production in 1977.** Fujitsu owns 30%, another 27% each is held by INI and Spain's telephone company, Compañia Teléfonica Nacional de España, and the remaining 16% is divided among eight Spanish banks. The computer is to be imported at first.

France to test fiber-optic link on telephone net

An experimental short-range fiber-optic transmission link will be tested later this year by the government-operated French telephone system. **The link, which will operate at the 8-megabit-per-second rate used for the 120-channel pulse-code-modulation trunk lines, will tie the satellite ground station at Pleumeur Bodou in Brittany to Lannion some six kilometers away.** The system's research organization, Centre National d'Etudes des Télécommunications has a major facility at Lannion.

This first CNET optical link will have a light-emitting diode for the transmitter and a p-i-n-diode detector, linked by 100-micrometer-diameter glass fibers, supplied by Corning Glass Works. For follow-on experimental systems, CNET hopes to shift to laser transmitters and French-made fibers. Although they still haven't checked out all the cost factors, CNET officials suspect that optical links will first be feasible for trunks no more than six kilometers long between urban exchanges.

'Smart' terminal from Nixdorf is aimed at banking

Aiming at the burgeoning market for banking terminals, West Germany's Nixdorf Computer AG has introduced an intelligent terminal, the 8864, and hopes to install "several hundred" systems this year. Announced in several West European capitals, the 8864 automates repetitive operations and provides individual service for customers.

Observers rate the 8864 superior to the IBM Corp. 3600 terminal system in versatility and on-site data-processing capabilities. The Nixdorf machine, which provides remote batch processing, data capture, and local processing, can maintain a conversational link with a central computer. **Different programs can be operated simultaneously at 16 work stations—for example, at tellers' counters and at officials' desks.**

The microprogramable central processor has a cycle time of 125 nanoseconds. The work stations can be equipped with a wide range of

peripherals, including cash dispensers, statement printers, light pens, identity-card readers, and check readers. Optional displays can be used either for data-input control or inquiries.

Computer exports to be financed by Japanese bank

The Export-Import Bank of Japan is financing sales of two ultralarge Japanese computers to the U.S. on a deferred-payment basis. **These computers, the first two Amdahl 470V-6 models, are being manufactured by Fujitsu Ltd.** A loan of about $3.5 million, which is only part of the total price, is to be repaid over a three-year period at interest rates said to be similar to those charged for plant exports. Financing is needed for computers because they are rented, rather than sold.

Even Japanese manufacturers are unable to support rental of computers and normally sell them to Japan Electronic Computer Co., a government-sponsored organization that rents computers to users. The bank says it will provide financing for other computers if they meet its conditions, as these two did. The bank's computer-export financing is one facet of a government plan to aid the industry after computer-trade regulations are completely liberalized at end of this year.

EMI's Bughound sold to detect listening devices

Charging that as many as 10% of all UK businesses are or have been victims of electronic bugging, EMI Ltd. has introduced a battery-operated detector called Bughound. **Described as a "do-it-yourself device for the confidential executive," the 20-ounce detector will sell for $240 in the UK and Europe now and will be marketed in the U. S. later.** EMI claims that the unit is cheaper and easier to operate than others.

Japanese develop speedy short-haul facsimile system

A facsimile system that will send a letter-size page in only three seconds with a resolution of five lines per millimeter has been developed jointly by two Japanese companies. They are Matsushita Graphic Communication Systems Inc. and broadcast network NHK, which has installed a number of transmitters and receivers in its main building. Applications, however, will probably be limited to such one-site installations because a bandwidth of 240 kilohertz is required. The transmitter has an electron scanner, a fiber-optic face plate, prism, cathode-ray tube, and photomultiplier, while the receiver uses a fiber-optic bundle to reproduce the image. The system requires paper coated with zinc oxide, similar to that used in many office copiers.

Despite boycott threat, Sony seeks language-lab plant

Despite the threat of an Arab boycott, Japan's Sony Corp. has applied to the Saudi Arabian government for permission to produce language laboratories for use in Middle East countries. Sony concedes that one reason for this move is to head off a threatened boycott, but it would not have considered setting up the plant unless it promised to be profitable. Sales of language laboratories, which are booths containing tape recorders, amount to about $15 million in this area. **Sony says it has no idea why it is being threatened by a boycott, unless it is because of its share in a record venture in Japan with CBS Inc.,** New York, which is said to be on boycott list. Sony says that its products are sold in Israel, but it has no plant or special business interests there.

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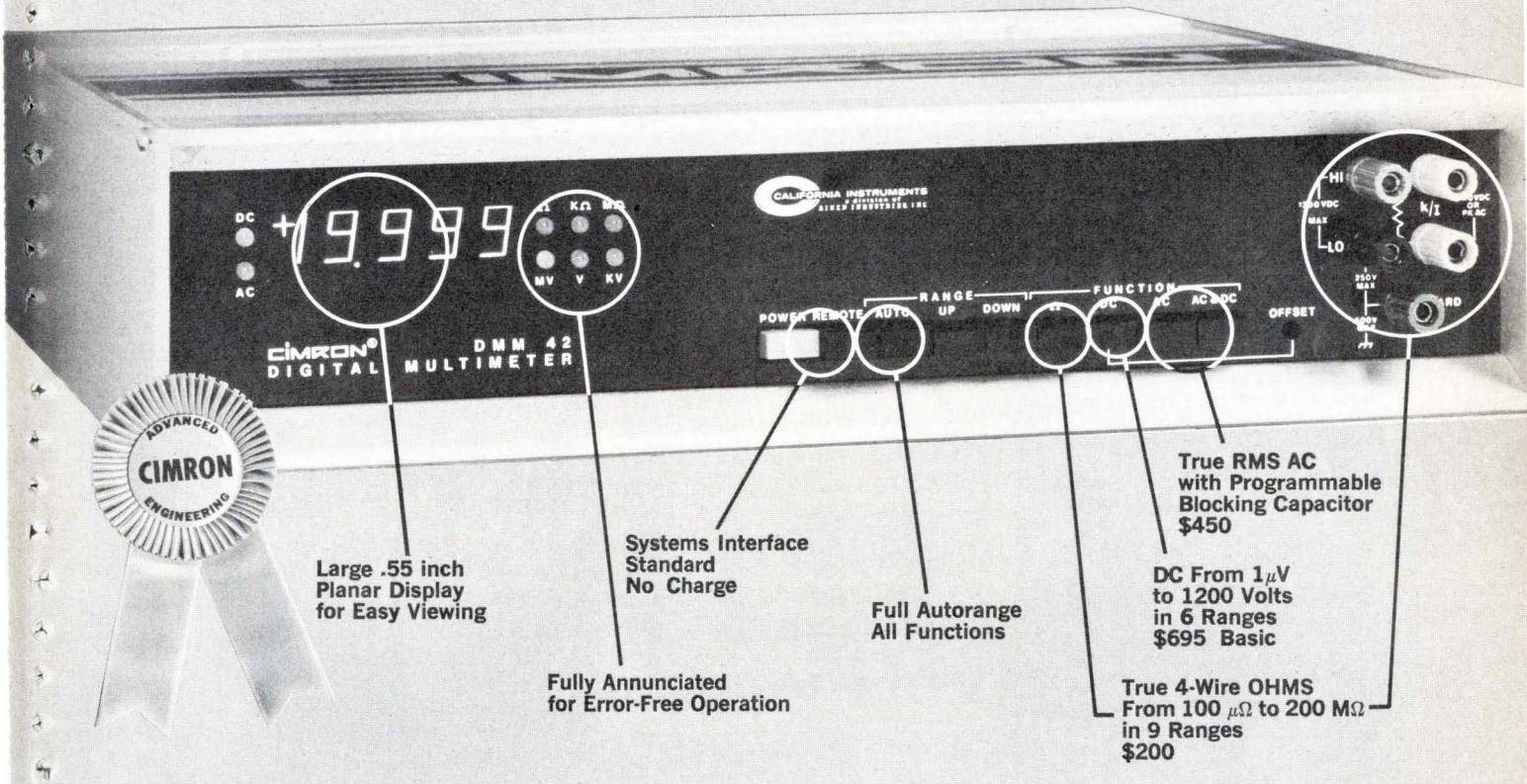

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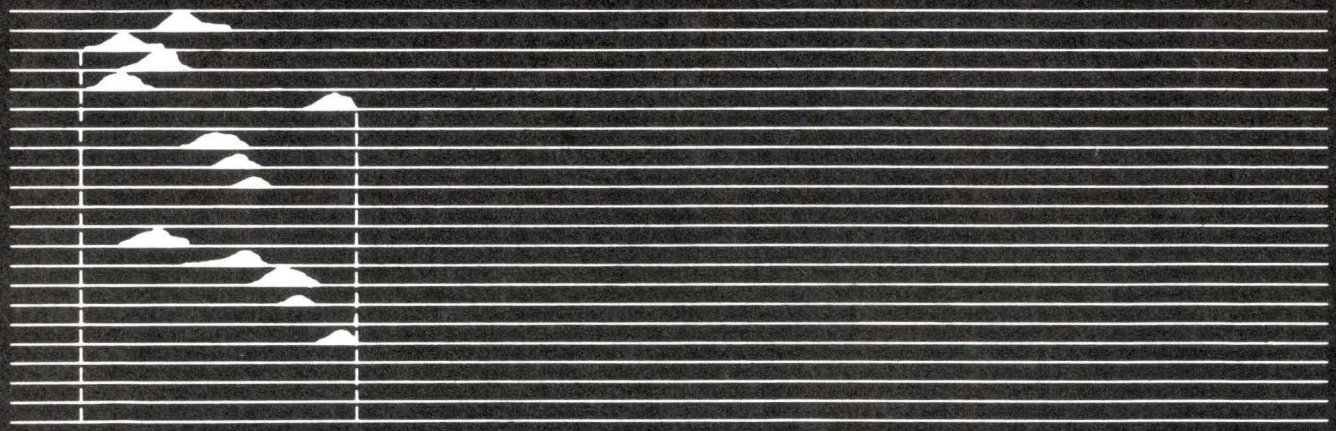
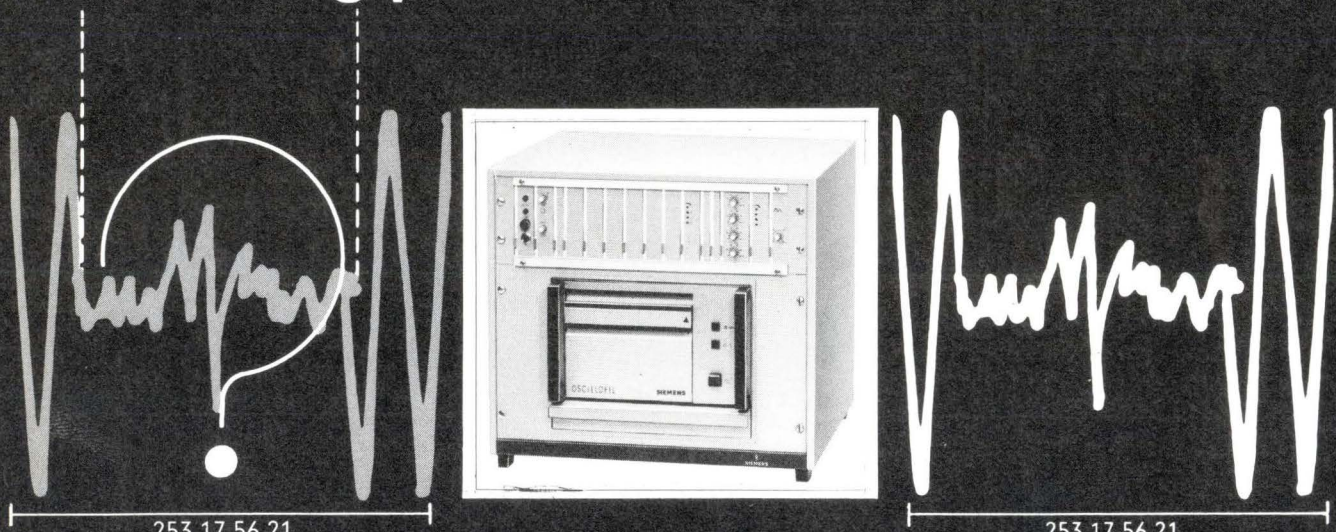


Seizure of Nominal Value Deviations – considering previous events



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Sonar started CIA on its sub caper

Western Electric's Sea Spider, part of growing worldwide undersea detection network, heard explosions and crushing of Soviet boat

by Ray Connolly, Washington bureau manager

"We hear you." That advertising slogan for AT&T evoked knowing smiles among the U.S. Navy's antisubmarine-warfare specialists when the telephone company began using it not long ago to enhance its troubled business image. For the Navy men, the slogan recalled Sea Spider—a multimillion-dollar product of AT&T's Western Electric Co. that sits silently in 16,000 feet of water off the Hawaiian Islands listening for submarines.

Without its Sea Spider bottom-mounted sonar, the Navy would not have detected the series of unexplained explosions aboard a submerged Soviet diesel submarine some 750 miles northwest of Hawaii in the summer of 1968. Nor would the Navy antisub men have been able to distinguish the sounds of the hull crushing as the boat plunged to the bottom.

What happened then is history, of course, only recently made public. The Central Intelligence Agency had stepped into the picture not long after the Navy assessed the Sea Spider data at what is now the Joint Intelligence Center on Oahu. The CIA then contracted secretly with Howard Hughes' Summa Corp. in 1970 to build the 35,000-ton Glomar Explorer at the Sun Shipbuilding and Drydock Co., Chester, Pa., for an estimated $250 million. Along with that, millions more were spent on a massive covered barge.

Transparent

• *"In 20 years the oceans will be transparent," a senior official in the Directorate of Defense Research and Engineering told a recent visitor. "Space," he asserted, "will be the next refuge" for strategic weapons after the rapidly improving electronics of underseas surveillance systems have made the missile platforms of the U.S. Poseidon and Trident submarine fleets vulnerable.*

How vulnerable to detection the world's submarines have become already was suggested in press accounts of the Central Intelligence Agency's Project Jennifer that sought to salvage a lost Soviet sub.

With the approval of the National Security Council's 40 Committee, a plan to raise the wreckage of what NATO has dubbed the G, or Golf-class, Soviet boat was approved. This became the CIA's Project Jennifer.

The cover story for the Glomar Explorer, with its huge underwater claw, was that Summa Corp. planned to mine the world's oceans for manganese and other rare and costly metals. The estimated cost of the project through the summer of 1974, when part of the Soviet hulk was successfully raised, is $345 million.

Caesar. But those five-year outlays on a single CIA recovery program don't come close to the Navy's ASW spending for electronics in a single year. Of the $372.1 million identifiable in the Navy's ASW spending program that ends June 30, some $78.3 million will go to upgrading Project Caesar—the worldwide undersea monitoring network of which Sea Spider is a part—on which Western Electric Co. has been the key contractor for 20 years.

The Sea Spider net, which became operational only a couple of years before it documented the Soviet sub disaster, technologically was the toughest task for WE's Guilford Center at Winston-Salem, N.C., where the bulk of the Caesar system's engineering goes on. The difficulties presented by water pressures in the Pacific at 16,000 feet, and problems of leakage and erratic performance on the chain of sonars, interconnecting coaxial cables, and signal repeaters, proved far greater than those of the initial Caesar system in the Atlantic. Put into operation between 1960 and 1962, Western Electric's Caesar chain along the Atlantic coast has the benefit of a continental shelf that permitted mounting on the bottom at no more than one quarter the depth necessary in the Pacific.

WE's Guilford Center, supported by its Whippany, N.J., operation and Bell Laboratories, overcame these problems. The evidence became public with the disclosure of the success of CIA's Project J. Even officials at Bell Labs, normally reluctant to discuss their military missions, speak proudly of their underseas sonar surveillance contributions in a newly published authorized history, "Mission Communications," by Prescott G. Mabon.

Those sonars, which bear the military nomenclature AN/FQQ plus a model number, have been supplied largely by Western Electric, al-

though there have been other contractors. For example, the FQQ-1, an early model, was built by Rixon Electronics Inc., Silver Spring, Md., and the FQQ-10 is a product of Hazeltine Corp., Greenlawn, N.Y. Another, known as Fishbowl, the FQQ-8, came from General Electric, while cabling and logic microcircuitry were subcontracted respectively to Simplex Wire & Cable Co., Newington, N.H., and Westinghouse Electric Corp. at Baltimore. The systems were cabled into shore-station computers built by Control Data Corp. Nevertheless, it was Western Electric and Bell Labs, responding to the technological challenges of the Naval Research Laboratory and the funds of the Naval Electronic Systems Command, that provided the leadership for the program.

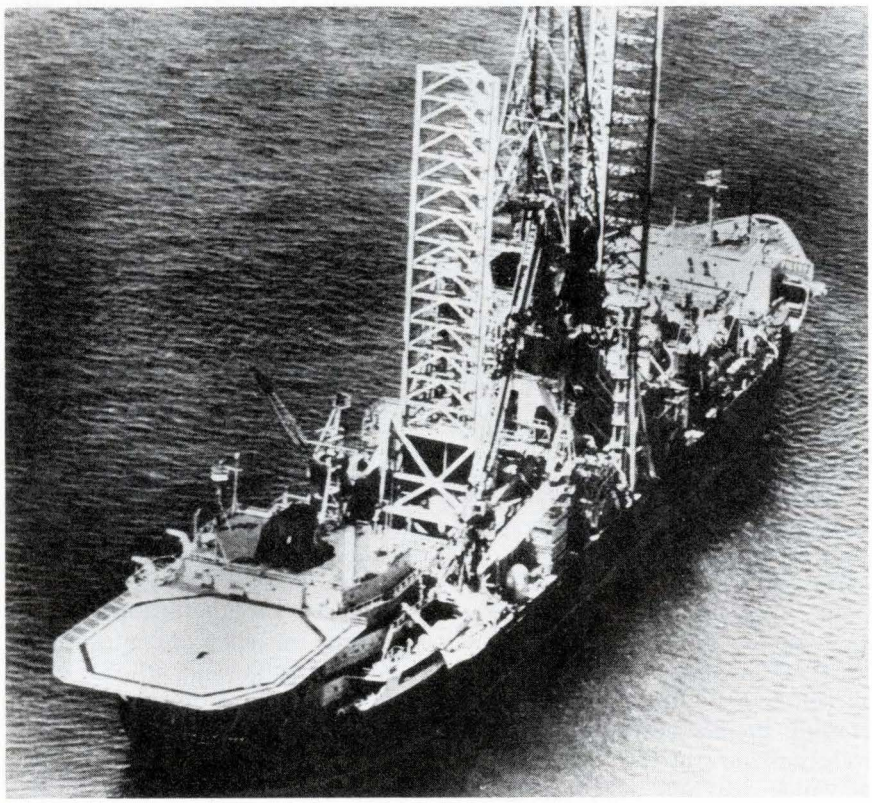
Azores. And the program is far from over. In addition to Caesar—with its installations along the coasts of the Pacific and the Atlantic—the detection system has been extended down into the Caribbean under the code name Colossus. Western Electric, which subcontracts an estimated half of its ASW manufacturing, is also prime on the NATO program known as the Azores Fixed Acoustic Range. By means of several towers 100 feet tall with weighted bottoms, the system tracks submarine traffic entering or leaving the Mediterranean. Three towers ride 20 feet apart in a triangle atop sea mounts.

The great depths of the Pacific installations along the U.S. coast, Hawaii, and elsewhere, demand more extensive maintenance than sites on the Atlantic shelf. But to upgrade Pacific installations, the Navy is moving toward bottom-mounted towers like those in the Azores. Officials report that plans are well into the engineering-development stage for towers 300 feet tall that would be towed to sea—perhaps aboard the Glomar Explorer's massive barge—and positioned on the bottom by flooding the four legs of each tower.

The Navy-contracted hardware of Western Electric and its subcontractors are "literally everywhere," contends one source. Others support this assessment. In addition to the Azores system, which operates with a small Naval communications station on the Azores island of San Miguel at Ponto Delgarda, the Pentagon—sometimes in conjunction with NATO—is operating systems off the coasts of Portugal, Britain, Denmark in the Baltic Sea, Turkey at the Mediterranean's eastern end, and in the west in the waters that are bordered by Tunisia and the islands of Sicily and Sardinia. The Navy also is well along with plans for and, in some cases, preliminary test installations in waters off the Aleutian Islands, Taiwan, Okinawa, Korea, and the Philippines.

System role. As the Navy expands its Caesar effort into a worldwide monitoring net, it plans to integrate it into the World Wide Military Command and Control System, which is 35 computer systems interconnected by cable and satellite for command purposes. The Navy has $6.2 million in its current budget for system hardware to be installed at the Joint Intelligence Center at Hawaii. Vice Adm. Walter D. Gaddis, deputy chief of naval operations for logistics, identified this and other outlays for underseas intelligence programs for the Senate last year. In addition to the $78.3 million Caesar Backfit effort, the following programs were indentified:

- $44.8 million, an increase of 54%, for the Undersea Surveillance Systems to support 22 Naval installations that gather and process intelligence data.
- $64.6 million, a 4% increase, for "oceanography," the Navy's cover for classified ASW efforts, much of it for development of new technologies for acoustical and geophysical analysis.
- $14.1 million, an increase of 18%, for intelligence-support equipment, including acoustic, electronic, and optical sensors. Included in this sum is $3.2 million primarily for laboratory equipment used in data analysis.
- $38.2 million for the General Defense Intelligence Program to support programs of the Director of Naval Intelligence, including analyses of Soviet submarines and sensor technology and its relationship to U.S. antisubmarine-warfare programs. □



Sub seeker. The Glomar Explorer, built by the Hughes-owned Summa Corp., was used in the CIA's sub-raising project. Cover story had the ship exploring for rare metals.

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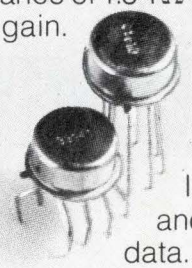

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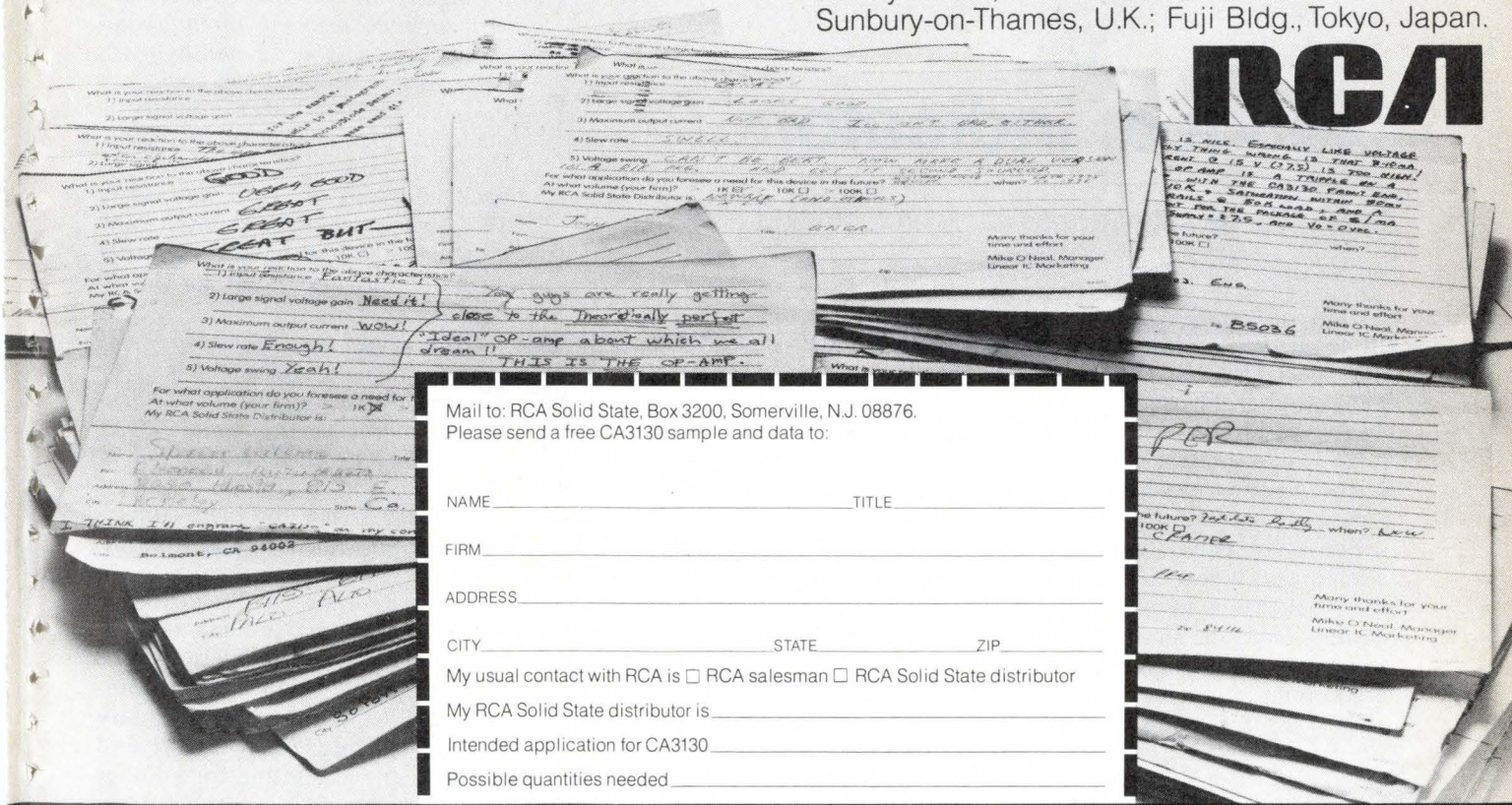

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Management

Needed: indicators

RCA's Vonderschmitt finds semiconductor industry lacks data for forecasting slumps, recoveries

In boom times, when capacity cannot meet demand, semiconductor manufacturers are plagued by double and triple ordering. To compound the confusion, they seem unable to discover whether their devices are heading for customers' inventories or equipment. This situation makes it next to impossible for them either to anticipate a slump by cutting back on production or to foresee a recovery in order to crank up dormant production lines.

Why is this so? The editors of *Electronics* asked Bernard V. Vonderschmitt, vice president and general manager of RCA Corp.'s Solid State division, whose responsibility was broadened recently to include all infrared devices, cable-television equipment, lasers, optical and power tubes, and charge-coupled devices from RCA's former Electronic Components division. This adds $50 million in 1974 sales to the Solid State division's $200 million. His answers follow.

Q: When the turnaround comes, how much of the new-order activity will result from stocking depleted inventories?

A: Replenishing inventory will, of course, play a key role in new orders for the next several quarters. Consider this: because there was so much excess semiconductor capacity, purchasing agents began living with only two to three weeks of inventory—even on critical components, where inventory levels were traditionally kept at three or four times that level. The pipeline simply shrank. That meant that something like eight weeks of inventory was worked off before any new ordering could start. It was during this period of inventory adjustment that semiconductor suppliers couldn't ship a thing to that customer. So the semiconductor industry took a worse bath than equipment manufacturers, not so much because of a recession in equipment sales but to a large extent because of a change in inventory ground rules.

Q: Do you think inventory levels have changed permanently?

A: No, the trend will start going the other way—though probably not back to the 10 weeks' level.

Q: Of course, hindsight is always the best vision, but couldn't a component supplier smell this inventory decompression coming 12 months ago?

A: Well, I suppose you could say that the semiconductor industry is made up of a bunch of incredible idiots. In retrospect, when you go back and look at 1973 and early 1974, when we had about a 50% growth, we should have known that it's absolutely impossible for this to be a real growth rate.

Q: But when the turnaround comes again—whether at the end of the year or early next year—won't the same inventory spiral begin again? Won't semiconductor suppliers be filling phantom orders?

A: That's the problem—differentiating real consumption from inventory rebuilding. Again, both things will occur. Look at it this way. Say there's a genuine 10% increase in consumption by year's end, and at the same time, customers want to boost their inventory cushion—say, double it by the end of the year—accounting for another

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Our CA3130 gets many of its winning ways from four very capable relatives. Four RCA op amps that can fill special requirements you may have. If you need programmable linear gain control, check the CA3080. For high crossover frequency plus high slew rate, there's the CA3100T. For high output current and easy programmability, the CA3094E. For low power supply drain, the CA3078T.

The CA3130 is the ideal choice when you're looking for a good measure of all of these characteristics in one device. That's what makes the CA3130 so great. Its versatility comes from the unique combination of MOS/FET, bipolar and COS/MOS on the same chip. And its surprisingly low 1K price of 75¢ makes it a natural for your high-volume products.

Beyond the table, here's more typical data about the CA3130:

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Input Current: 5 pA.
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Input Offset Voltage: 0.8 mV (CA3130B).
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RCA

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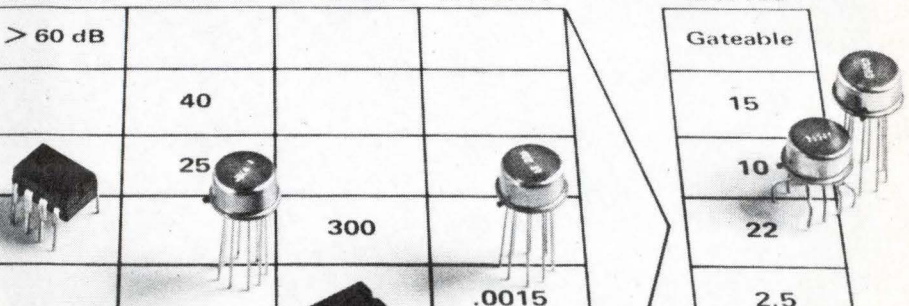
Gateable plus programmable gain control	> 60 dB				Gateable
Unity gain crossover frequency, MHz		40			15
Slew Rate, V/μsec		25			10
Output, mA (peak)			300		22
Power consumption, mW				.0015	2.5
Single supply voltage required, V				1.5	5.0
Price (1K), $	0.55	1.50	0.90	1.25	0.75



RCA. A full house in linear ICs.

Circle 65 on reader service card

10% increase in new orders. Suddenly, overnight, we're facing a 20% or more increase in new orders. Now bear in mind that this industry is operating at a substantially reduced capacity, so that if that number even goes much above 15% for very long, there will be shortages, double ordering, and we're right back on the roller coaster again.

Q: Do you think the answer is more market research by semiconductor suppliers?

A: That has to be part of the answer. Somehow or other, the semiconductor people must develop tie-ins with enough of their users. They have to know when parts go on the inventory shelf and when parts are shipped out of the factory in new equipment.

Q: Would you support an independent reporting service or clearing house to provide this type of industry service?

A: I think that would be a good thing. We need somebody to collect shipment data from the semiconductor people, and we need somebody to collect shipment data from their major customers—at least a broad enough sampling of their major customers—on an up-to-date monthly basis. Then, knowing what the semiconductor content of the equipment is, you can get a good idea of whether the parts you're shipping are going into inventory building.

Q: With so little hard data, how can you predict the upturn? How do you sense real consumption so you can turn on the production lines by just the right amount?

A: You really need something that telegraphs what's going to happen. You have to be two or three months ahead of the trend—both in the downturn and in the upturn.

Q: How are you doing this?

A: We monitor certain industries—consumer, industrial equipment—but they tend to be a very small segment of our total business. For us, one of the most helpful indicators is distributors because they talk to a very broad cross-section of users. So we look carefully at the movement of our products off distributor shelves. These guys are talking to 10,000 small electronic-equipment manufacturers, and I think they probably represent a better pulse than anybody else.

Q: Do you think the industry is learning from these cyclic rides or do you think the ups and downs are simply in the nature of the business?

A: No one really knows. We learn something from each cycle—although one is never exactly like the others. You see the data, and you don't react because it's damn tough to temper production in the face of tremendous and growing order backlogs. But I have to say in retrospect that we saw some signs, frankly, early in '74—in the March-April-May time frame—that were indicators of decline. There were things there that we didn't heed properly. We'll be a little sharper next time and react faster. □

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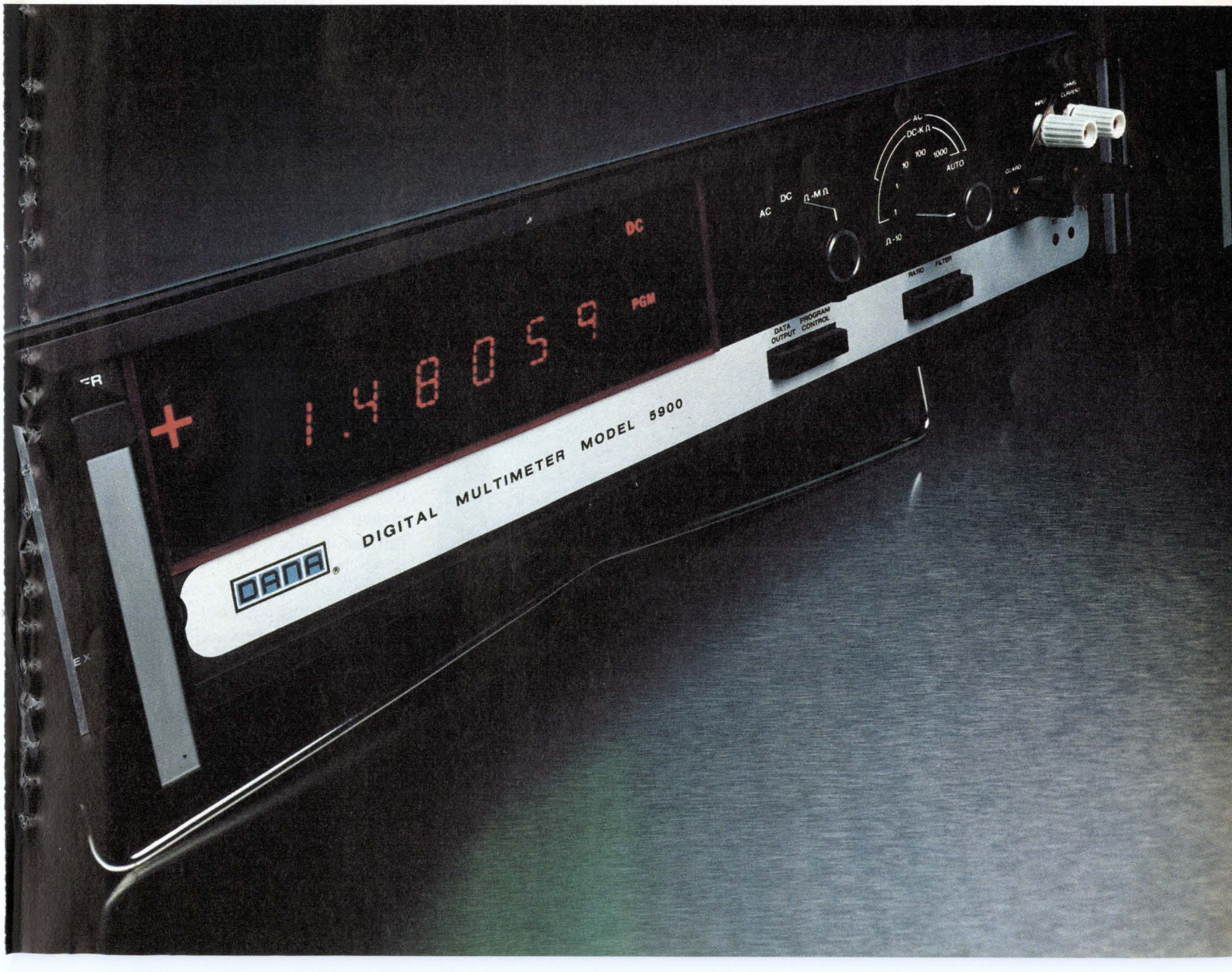


Companies

AMD strives to regain momentum

Semiconductor maker believes that work force cuts, incentives for salesmen, and revised product mix are doing the trick

by Bernard Cole, San Francisco bureau manager

Jerry Sanders is a great believer in momentum. As any of his associates will tell you, when he should be down, he's up. This attitude is especially helpful if you are the president of Advanced Micro Devices Inc. of Sunnyvale, Calif., caught—like almost every other semiconductor company—in the slump.

As Sanders sees it, "Most companies right now are in the situation of having two choices: either slowly bleed to death or take a running leap off a cliff across a chasm. If you've got enough forward momentum, you'll make it to the other side and safety."

The steps Sanders has taken to keep AMD alive are worth examining, because AMD was probably one of the companies hardest hit by the downturn. In the last two quarters of calendar 1974, it reported $1 million and $200,000 losses, respectively. In the nine months ending in December, 1974, the company's loss before taxes was about $800,000. Yet by the end of its fiscal year, in March, it was back at what Sanders considers its break-even point in sales, about $2 million a month.

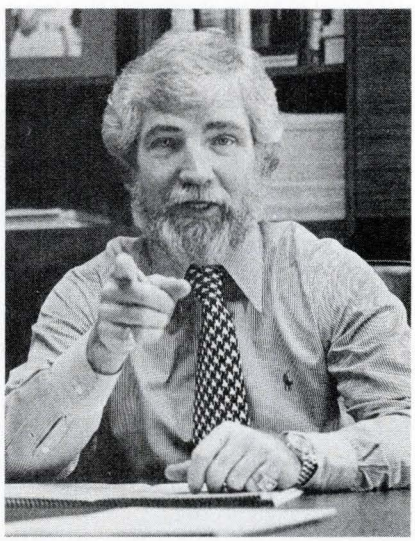
A little history. After a rather rocky start in 1969, the small and, until recently, soaring semiconductor company carved a niche as a second source for popular product lines—primarily in transistor-transistor logic, computer interface and linear circuits, plus some metal oxide-semiconductor devices—and only then began developing its own improved proprietary designs.

In 1973–74 when sales were $26.4 million, TTL accounted for 40% of AMD's output, linear ICs another 20%, computer interface 20%, and LSI (bipolar and MOS memories, primarily) about 20%. In the first part of 1974, says Sanders, AMD began a major push to reverse these percentages.

"But by midsummer it was obvious that we had some fundamental decisions to make, and fast, if we were to survive with our momentum intact," says Sanders. "What this meant was generating as much cash flow as possible internally as fast as possible."

Through a combination of selected layoffs among overhead personnel—technicians, middle-level supervisors, secretarial help, receptionists—and an over-all hiring freeze, the 1,400-employee payroll was reduced by 30%.

"Production-worker layoffs were kept to a minimum," says Sanders. "Instead, production workers were asked to shift to a 32-hour staggered work week on two shifts a day instead of three. "Professional personnel—engineers, supervisors, and corporate staff—went to a 44-hour work week, plus four hours on alternate weekends (in effect a 10% pay cut)."



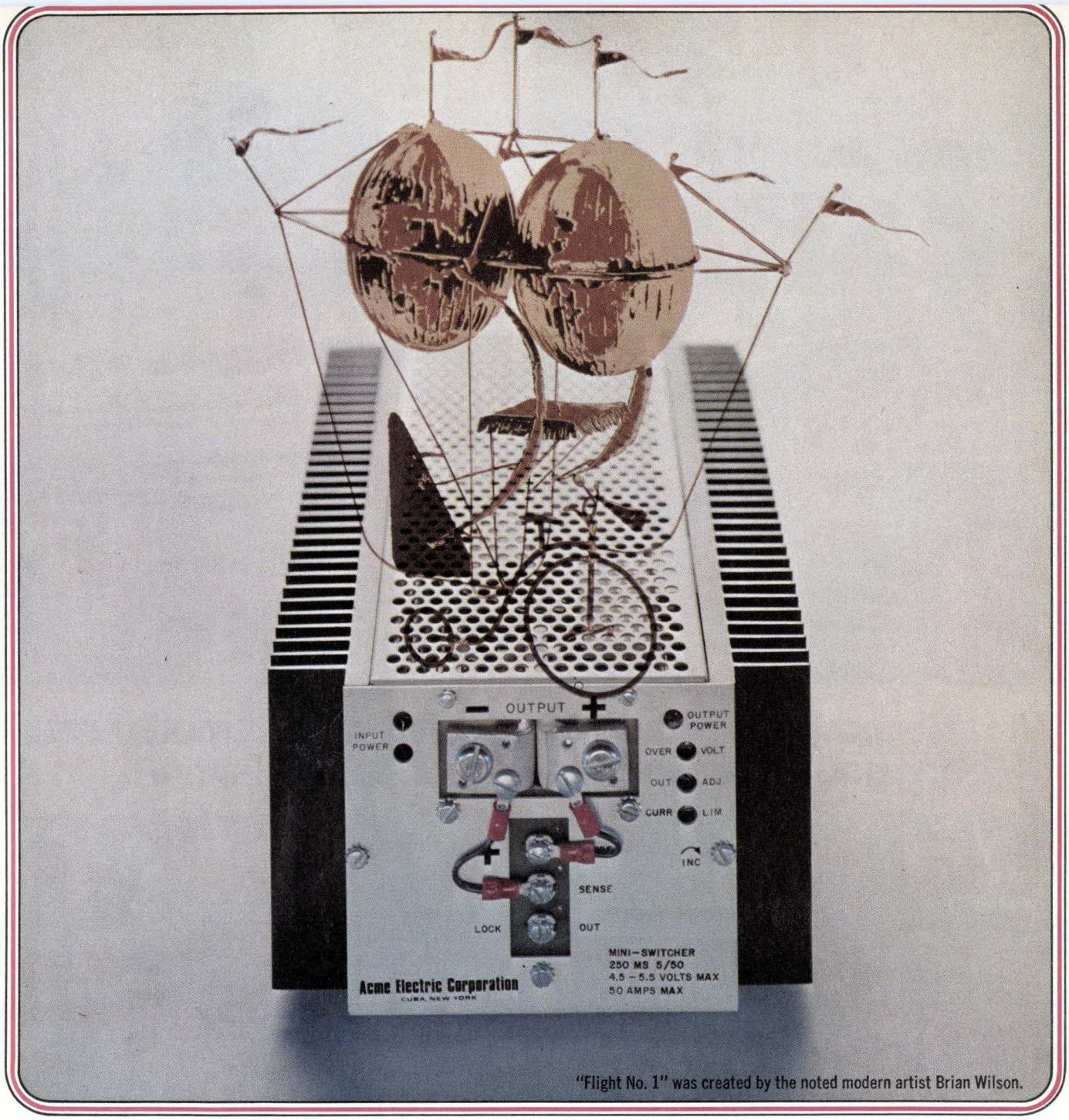
Now hear this. Jerry Sanders, president of AMD, predicts company will grow.

Stepping up sales. Says Sanders, "When the downturn really started getting serious I called all my salesmen in. My message was: sell—if not at a profit, then at just enough to generate an immediate cash flow within the company." And instead of reducing the budget for advertising and promotion, Sanders doubled it. He also took a close look at AMD's heavy dependence on distributor sales and consolidated into three organizations.

As some immediate indications that his strategies are taking effect, Sanders points to a booking-to billing ratio that has come from a low of 0.6:1 to "much better than 1:1," and to the 40% of AMD's sales that are in MOS and bipolar LSI.

Although AMD closed its fiscal year March 31 with roughly the same sales volume as its previous year—$26 million, which can be called an achievement in itself—Sanders confidently predicts that by the end of 1976 AMD will have grown to about $60 million to $70 million in sales.

At least one analyst, James R. Berdell of San Francisco's Robertson, Coleman, Siebel and Weisel, says AMD is on its way to a profitable fiscal year. He says, "Not only has AMD managed to reverse its product mix, but it has dramatically decreased its dependence on distributors. Sanders has got his house well in order now with a positive cash flow, a healthy line of credit, and a good mix of new products coming." □



"Flight No. 1" was created by the noted modern artist Brian Wilson.

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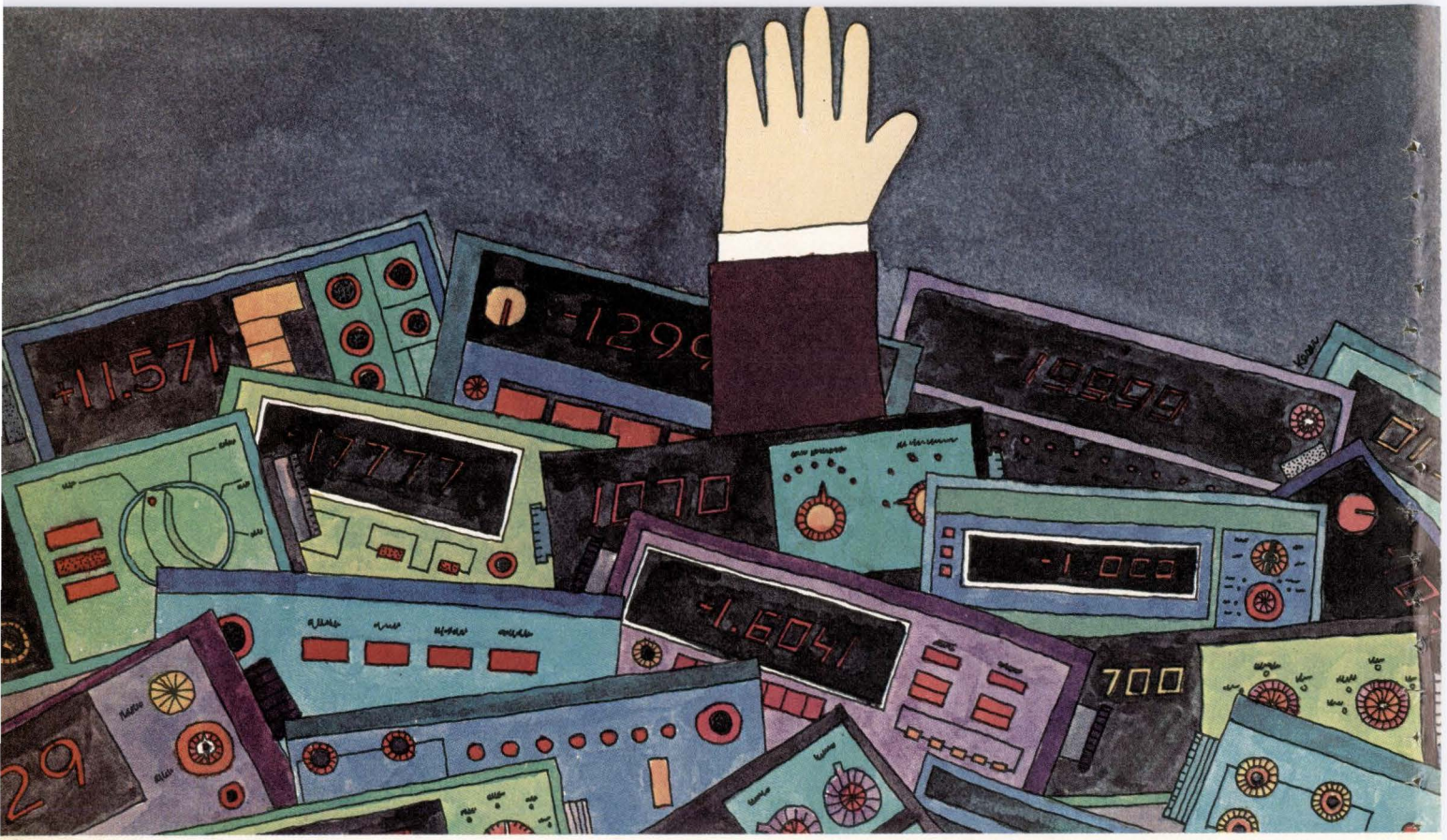
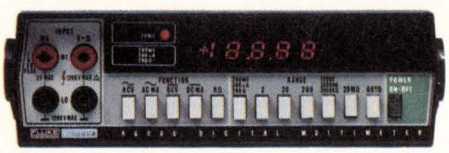


When it comes to picking the right 4½ digit multimeter, are you drowning in a sea of sales claims?

Check the Fluke truth table for all the important facts.

4½ Digit Multimeter Competitors #	1	2	3	4	5	6	7	8	9	10	FLUKE 8600A
Five-range AC/DC volts to 1200V											●
Five-range AC/DC current to 2A			●						●		●
Six-range resistance to 20 megohms					●			●	●		●
Autorange through all ranges plus individual range selection manually									●		●
10,000 Hour demonstrated MTBF											●
Continuous overload specified for all ranges/functions with overload indication								●		●	●
Environmental capability specified and defined											●
Automatic zeroing	●	●				●	●				●
Full line of accessories offering HI volts to 40 KV, RF to 500 MHz, current to 600A											●
Rechargeable battery option, completely built-in and self-contained				●		●	●		●		●
7W or less power consumption for reliability								●			●
Basic DC accuracy of 0.02% for 90 days at 15° C to 35° C	●										●

Ten companies claim to offer a 4½ digit multimeter competitive to the Fluke 8600A. As you can see from the truth table, no one measures up to Fluke. Some have more features than others. None have all the fine features of the Fluke 8600A. For a modest $649 (U.S. price), you can put the 8600A to work right away.



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Communications

Aided by AT&T détente, special carriers grow

Southern Pacific, MCI, Datran expand though new report is bearish about data portions of their service

by Ron Schneiderman, New York bureau manager

As if signaling the end of long court fights, countless tariff filings, and numerous construction delays, a relatively new specialized common carrier is scheduled this week to add 10 more cities to its communications network. With this step, Southern Pacific Communications Inc., which got started over the right-of-way and existing microwave network of its sister company, the Southern Pacific Railroad, becomes a truly nationwide network.

Southern Pacific joins MCI Telecommunications Inc. and a handful of other special carriers of voice, data, and facsimile that provide service to a growing list of customers in competition with American Telephone & Telegraph Co.

The FCC has further improved their prospects by getting AT&T last month to agree to "cooperative approaches" to the new carriers' engineering, installation and maintenance and the reduction of some rates for local distribution. The rate reductions—up to 30%—will be retroactive to last Dec. 1.

Equally significant to the carriers, the agreement includes provisions for the installation and end-to-end testing of circuits by AT&T, as well as for joint trouble-shooting, allowing the special carriers to be much more responsive to their customers' needs. With this agreement, AT&T's implied threat that "these guys [the special carriers] are not permanent is not there anymore," says Norman Brust, MCI's marketing vice president.

MCI has already installed 3,200 circuits. Its list of customers quadrupled in 1974 and now includes over 500 firms. Invoiced revenues currently amount to about $15 million annually, revenue backlog comes to another $7 million, and by March next year, the company expects to begin turning its first profit.

Not everyone is optimistic. Donald L. Dittberner, president of Dittberner Associates Inc., Bethesda, Md., telecommunications management consultants, is pessimistic about special data services. So far, MCI's data service amounts to about 4% of its traffic; president C. Gus Grant estimates Southern Pacific's at 40%. But Data Transmission Co. (Datran) carries nothing but data, and Dittberner sees problems, particularly as Bell expands its Dataphone Digital Service (DDS).

Sees little need. In a paper prepared for delivery at the National Computer Conference in Anaheim, Calif., next month, Dittberner says that his firm finds "little technical, economic, nor political motivation for the typical data-communication user to embrace strongly the service offerings of the special data common carriers." He adds that "data-network components have evolved to such a high degree that most users can cost-effectively implement their data-transmission requirements utilizing standard telephone tariff offerings, leaving little realistic requirements for the new specialized services."

Datran president Glenn E. Penisten couldn't disagree more. "There is no question that we will be able to compete with the Bell services with the proper situation. The approach that Datran has applied, being a total time-division multiplex system, offers 10 times more capacity per microwave path than Bell or any of the other analog carriers can get out of their system."

Optimist. Datran president Glenn E. Penisten is all smiles despite study seeing little need for special carriers' data services.

The FCC, meanwhile, has given "conditional authorization" to Bell's DDS in five cities—Chicago, Washington, Philadelphia, New York, and Boston. AT&T hopes to add 19 cities to the network. But the commission says that while AT&T can charge for DDS at the rates it originally filed for DDS in the first five cities, its rates for the 19 new cities cannot be lower than for any of its analog services—which are higher than present DDS rates. Much of this regulatory tentativeness and confusion, most industry sources agree, stems from a Datran petition filed with the FCC in late January, complaining that AT&T's proposed rate increase did not include DDS.

Datran, which several years ago needed financial help from its equipment suppliers, expects its operating revenue to be at the break-even point by the end of this year, and in the black by the last quarter of 1977.

Yet to be reckoned with by AT&T and the other carriers is International Telephone & Telegraph Corp.'s U. S. Transmission Systems subsidiary, which hopes to begin operating between New York and Washington by early next year. By the end of 1976, says USTS president Francis T. Cassidy, a network running from New York to Atlanta and Houston will be in operation. □

Consumer electronics

Video-disk battle goes public

Philips/MCA and RCA square off with demonstrations in same week, as Teldec starts sales to consumers

by Gerald M. Walker, Consumer Electronics Editor

The battle to gain the dominant position in the forthcoming video-disk marketplace has heated up in the past month. The two major contenders—Philips/MCA on one side and RCA on the other—demonstrated their equipment in New York while the third combatant, Teldec of West Germany, started sales. And just so no one would forget, a fourth possible competitor, Thomson-Brandt in France, reconfirmed that it was still in the fight. They are all after what observers agree are potentially huge sales of what may be the most significant consumer electronics device since color-television broadcasting first began.

RCA, with its capacitive-needle player, and Philips, with its laser optical system, for several months have been maneuvering like a pair of basketball centers vying for a rebound. Philips and MCA, developer of a similar optical system, agreed to work together. Philips then acquired control of U.S. set maker Magnavox.

Philips has the resources to bankroll research and development, as well as provide manufacturing and marketing know-how. MCA has its own R&D effort, but more important, it has access to large libraries of program material, from its Universal Pictures. The acquisition of Magnavox gives Philips a manufacturing and distribution capability in the United States to complement its own strong organization in Europe.

For its part, RCA has well established R&D, manufacturing, and distribution capabilities, plus considerable experience in producing audio disks. In addition, RCA has good ties with the Japanese consumer-electronics companies that date back to the licensing of color-TV patents.

Competition has intensified recently because picture quality has reached market standards after a considerable amount of laboratory effort. What's more, the industry desperately needs a sales boost. Philips and RCA have decided that now's the time to line up allied firms for the big sales push, scheduled to start late next year.

These commercial alliances are critical. Because the optical and capacitive video-disk systems are incompatible, the producer that gains initial momentum in the market is expected to pick up most of the winnings. Consequently, the effort to get such other major television manufacturers as Zenith Radio in the U.S. and Matsushita Electric in Japan into one camp or the other is critical. Each firm needs to convince the industry that its players can be manufactured reliably in large numbers.

Actually, both Philips and RCA engineers concede that it is technically possible to make the two systems compatible, but neither is willing to devote the time or the money to do so. Complicating things, however, are Teldec and Thomson. Teldec, the Telefunken/Decca joint venture, uses a third and equally incompatible mechanical "skid"-needle player. And, although Zenith is a possible licensee for a system, it continues to work with the Thomson-Brandt group on an optical system that is almost compatible with Philips'.

In fact, a Zenith-made floppy disk was run on the Philips/MCA player at the recent New York demonstration, and Philips executives strongly hinted that Zenith is about to join that camp. Both Philips and MCA had previously shown their players and their rigid-type disks at technical conferences around the world.

RCA's entry. Richard W. Sonnenfeldt, RCA staff vice president, introduces his company's video-disk system. Unlike Philips/MCA's, it uses capacitance-needle playback.

Library. In the fall of 1976, the Philips/MCA/Magnavox combine expects to market a $500 (at today's dollars) player, backed by a library of programs from Universal Pictures, owned by MCA, as well as disks from other major motion-picture makers and special educational materials. Disk price will be $2 to $10, depending on the playing time and content.

The disk, rotating at 1,800 revolutions per minute, is scanned by a laser, said to operate 8,000 to 10,000 hours. Kent Broadbent, vice president of MCA Laboratories, says the laser will easily meet Federal radiation-safety requirements. Among the main attractions of the laser-reading system, Philips points out, are frame repetition, slow motion, fast action, and frame-freezing without wear on the disk. In addition, the Philips/MCA disks have coded frame numbers so that, if desired, sequences for replay can be found

by displaying those numbers on the TV screen.

RCA, on the other hand, has kept a lid on details concerning its capacitance system. The company has been demonstrating players here and abroad to invited viewers. But having been burned by over-reaction to the now-dormant Holotape video system and embarrassed by repeated delays in marketing a consumer video-tape system, RCA was reluctant to show off its disks until pressure from the other competitors forced last month's peek.

Rotating at 450 rpm, RCA's vinyl disk has a metal coating protected by a styrene film and a lubricating surface to make the capacitive needle glide easily. Luminance, chrominance, and audio signals are encoded in a relief pattern pressed into the disk. The stylus, made of sapphire shaped to fit the groove and a thin metal electrode perpendicular to the groove, detects the relief pattern in the record by changes in capacitance between the tip of the electrode and the metallic coating on the record surface. The stylus, which retails for $10, is expected to play 300 to 500 hours.

Players priced at $400 (in today's dollars) will be ready to go in the fourth quarter of 1976, says Richard W. Sonnenfeldt, staff vice president for video-disk operations, if the company gives the go-ahead. Disks will be priced at $10 for an hour-long recording; a two-hour movie probably will retail for $12 to $15. Emphasizing RCA's experience in mass-producing audio disks and players, James Hillier, executive vice president for research and engineering, insists that, although the capacitance system does not offer the flexibility of the optical type, it is less complex.

Meanwhile, Teldec's TED video-disk players have been selling for a couple of weeks at a list price of about $600. "Customer response has been positive," reports a marketing official at Telefunken GmbH. "We are confident our expectations for 1975 will be fulfilled."

TED's market entry was delayed for a year because the paper jacket that protects the paper-thin plastic disks when they are not in the playback unit had to be redesigned. □

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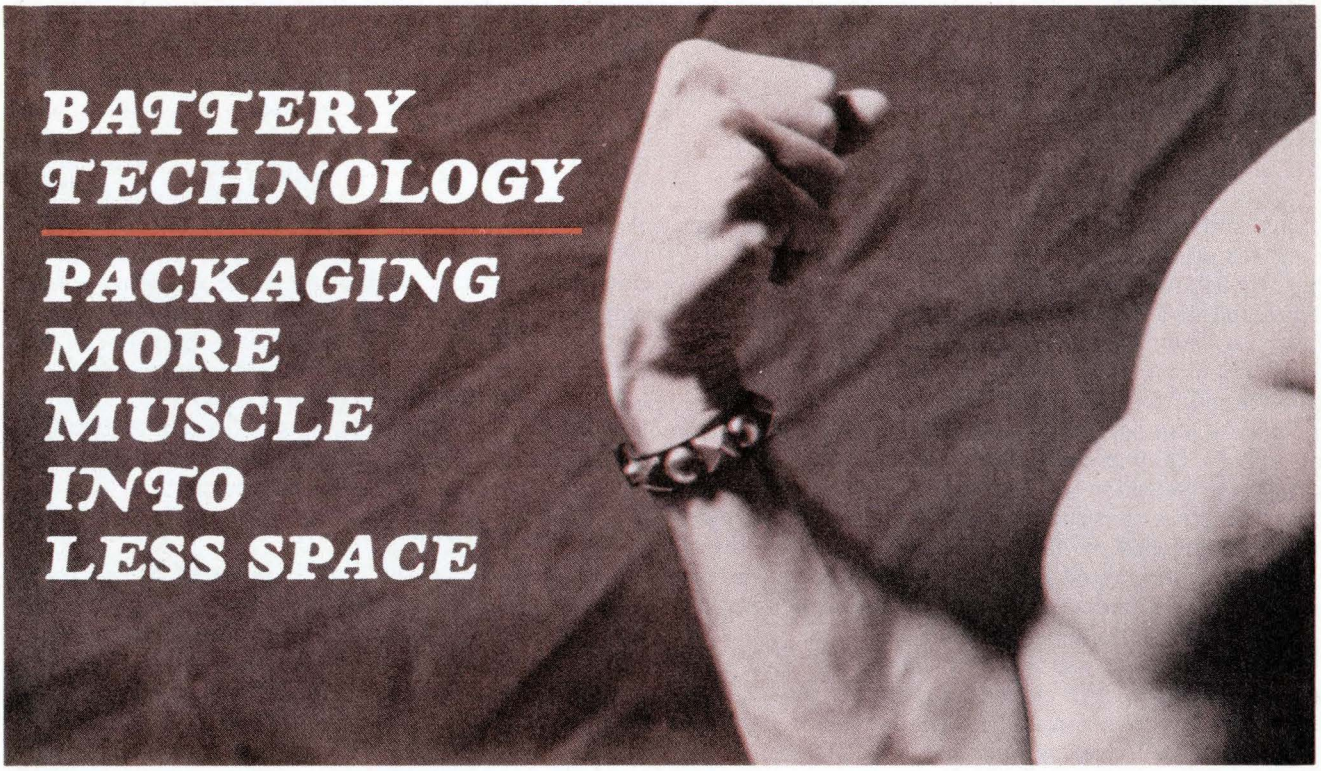


BATTERY TECHNOLOGY

PACKAGING MORE MUSCLE INTO LESS SPACE

Older power sources are threatened by new primary and secondary cells made of lithium, zinc-chloride, divalent silver-oxide, silver-cadmium, and silver-zinc, as well as gelled and 'starved' lead-acid electrochemicals

by Jerry Lyman, *Packaging & Production Editor*

SPECIAL REPORT ☐ As the increasing application of semiconductor technology reduces the power requirements of electronic equipment, ever more sophisticated batteries are being developed to replace larger power sources. At decreasing prices, these batteries have several advantages over their predecessors—more power per pound, longer shelf life, higher performance over a longer temperature range, and better packaging.

Inexpensive primary batteries suffice for many small electronic products, such as portable radios, calculators, and watches. However, at higher prices, rechargeable batteries eliminate the inconvenience of battery changing or provide reliable standby power for equipment, such as volatile computer memories, which would otherwise lose their effectiveness if the line power failed.

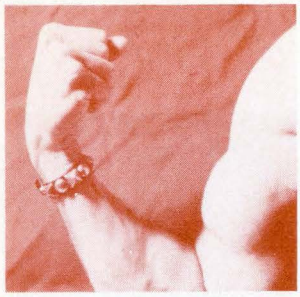
Three new primary batteries are now appearing: zinc-chloride batteries, which are improved Leclanche cells; divalent silver-oxide cells, which generate a large amount of energy in a small package; and lithium cells, which provide high energy density, long shelf life, and excellent performance even in environmental extremes.

To simplify installation and replacement, battery designers are implementing some novel packaging ideas, including a cassette-type alkaline power pack, a thin, flat, zinc-carbon battery, and hybrid packages containing more than one battery type.

Among secondary batteries, the low cost, high capacity, and long storage capability are making the gelled-electrolyte lead-acid cell a serious competitor to the more expensive nickel-cadmium battery. And such expensive space-proved power supplies as silver-zinc and nickel-cadmium batteries are finding applications in down-to-earth equipment. New versions of the sealed nickel-cadmium cell can be charged in periods as short as 15 minutes to three hours.

Cutting the cord

As the power requirements of electronic equipment are reduced by use of MOS, complementary-MOS, and integrated injection logic, designers are moving to eliminate the expense of rechargeable batteries and built-in chargers. As a result, battery manufacturers are devel-



oping and starting to supply some fairly high-energy long-life primary systems, including divalent silver-oxide and lithium batteries. However, most of the market, estimated at $500 million a year, is filled by zinc-carbon, zinc-chloride, and alkaline batteries, used for such applications as toys, cameras, hand-held calculators, cassette recorders, and portable radios.

Table 1 summarizes the electrical characteristics of all of today's commercially available batteries. As indicated, the selection is tremendously wide. Although characteristics, construction, and pricing of zinc-carbon and alkaline cells are fairly well known, capabilities of the recently developed zinc-chloride heavy-duty battery are not so well known. This can be an inexpensive alternative to either of the other systems.

Because of their capability to operate at high electrode efficiencies, the current output of zinc-chloride cells is usually higher, and they will operate at high current drains for longer periods than will Leclanche cells of the same size. The construction of the zinc-chloride cell (Fig. 1) is similar to that of the conventional carbon-zinc Leclanche cell, but the electrolyte system is different. In a zinc-chloride cell, the electrolyte contains only the soluble salt, but a Leclanche cell also contains a saturated solution of ammonium chloride, along with the zinc chloride. Although omission of ammonium chloride improves the electrochemistry, the seals had to be improved to confine the vigorous action.

When all chemicals but zinc chloride are eliminated, electrode blocking by reaction products is avoided, and electrode polarization at high current densities is minimized. Because of the electrochemical reactions in the zinc-chloride cell, water is consumed along with the electrochemically active materials so that the cell is nearly dry at the end of its useful life. And unlike the zinc-carbon battery, which can cause extensive circuit damage by leakage, the zinc-chloride battery has excellent resistance to leaks. What's more, the zinc-chloride battery operates much better at low temperatures.

In a typical application for AA cells, a 75-cent alkaline cell lasts four times as long as a 30-cent zinc-carbon cell, and a 40-cent heavy-duty zinc-chloride cell will last twice as long as its zinc-carbon counterpart.

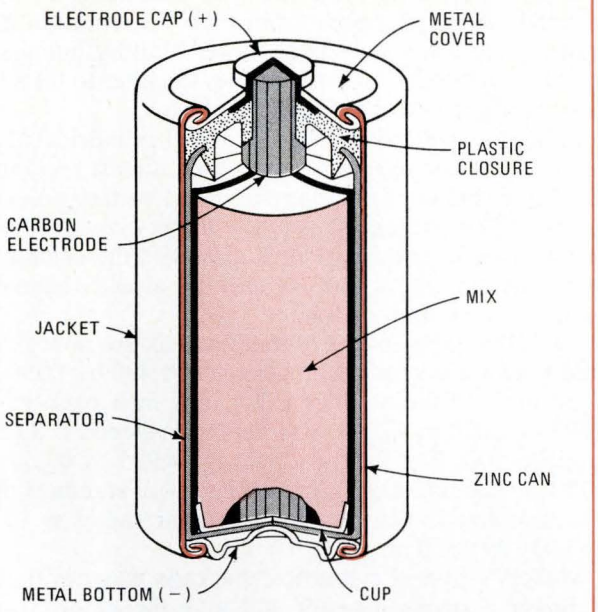
Packaging the 'buttons'

The present sizes of such equipment as electronic watches, exposure meters, cameras, hearing aids, and pacemakers would be impossible if they had to use zinc-carbon, zinc-chloride, or alkaline batteries. These tiny products are powered by button-size mercuric-oxide cells, which are typically 0.125 inch high and 0.220 inch in diameter. These cells come in cylindrical, flat-pellet, and button configurations.

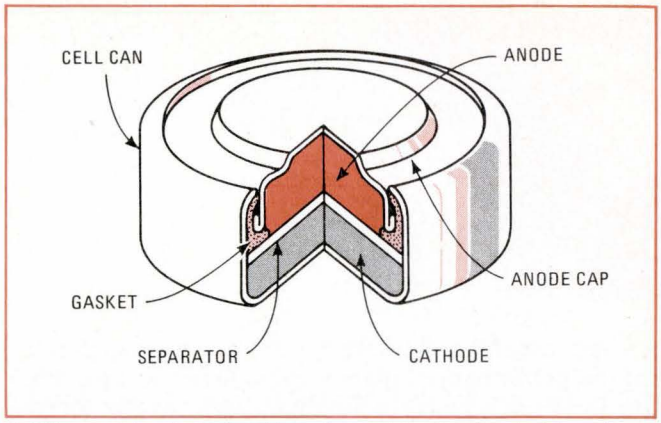
Mercury cells are divided into two basic types—one with a nominal voltage of 1.35 V, and the other with a

TABLE 1: ELECTRICAL CHARACTERISTICS OF PRIMARY BATTERIES

	Leclanche	Zinc-Chloride	Alkaline	Magnesium	Mercury-Oxide	Silver-Oxide	Divalent Silver-Oxide	Lithium
1. Energy output Watt-hours per lb Watt-hours per in.^{3}	 20 2	 44 3	 20 to 35 2 to 3.5	 40 4	 46 6	 50 8	 70 14	 100 to 150 8 to 15
2. Nominal cell voltage	1.5	1.5	1.5	2.0	1.35 or 1.4	1.50	1.5	2.8
3. Practical drain rates Pulse High (>50 mA) Low (<50 mA)	 Yes 100 mA/in.^{2} Yes	 Yes 150 mA/in.^{2} Yes	 Yes 200 mA/in.^{2} Yes	 No 200 to 300 mA/in.^{2} Yes	 Yes No Yes	 Yes No Yes	 Yes No Yes	 Yes Yes Yes
4. Impedance Z_i	Low	Low	Very low	Low (Delay on start up)	Low	Low	Low	Less than 1 Ω
5. Temperature range Storage Operating	 −40 to 120°F 20 to 130°F	 −40 to 160°F 0 to 160°F	 −40 to 120°F −20 to 130°F	 −40 to 160°F 0 to 160°F	 −40 to 140°F 32 to 130°F	 −40 to 140°F 32 to 130°F	 −40 to 140°F 32 to 130°F	 −65 to 160°F −40 to 130°F
6. Temperature vs capacity	Poor at low temperature	Good at low temperature compared to Leclanche	Fair to good at low temperature	Fair at low temperature	Good at high temperature poor at low temperature	Poor at low temperature	Poor at low temperature	Excellent
7. Shelf life at 68°F to 80% initial capacity (in years)	2 to 3	2 to 3	3 to 5	2 to 3	2 to 3	2 to 3	2 to 3	3 to 5 (estimated)
8. Shape of discharge curve	sloping	sloping	sloping	fairly flat	flat	flat	flat	flat



1. Heavy duty. Zinc-chloride cells can last as much as 2.5 times longer than zinc-carbon cells. This performance results from an electrolyte containing only zinc chloride, improved sealing techniques, and better construction.



2. Silver oxide. A silver-oxide cell consists of a depolarizing silver-oxide cathode, a zinc anode having a large surface area, and a highly alkaline electrolyte. These small cells are extensively used in electronic digital watches.

1.4-v rating. In general, the 1.35-v cells and batteries are recommended as voltage-reference sources for scientific and medical applications, and the 1.4-v cells are used mainly in consumer applications where a flat voltage characteristic is not needed. Mercury cells offer a flat-voltage discharge characteristic, good performance at high temperatures, good resistance to shock and vibration, and shelf life as long as two and a half years.

In all these cells, an ion-permeable barrier separates an anode, formed from high-purity amalgamated zinc, from the cathode of mercuric oxide and graphite. The ions of the electrolyte, which is a solution of alkaline hydroxide, act as carriers for the chemical action in the cell. To minimize corrosion, the cell containers are made of nickel-plated steel.

Upgrading silver-oxide cells

Although a battery system using monovalent silver oxide (Fig. 2) has about the same energy density as a mercury cell, its 1.5-v output is higher. This makes it desirable for light-emitting-diode readouts in digital watches, as well as cameras and hearing aids. However, chiefly because of material costs, the silver-oxide cell is more expensive than the mercuric-oxide cell. Unlike the packaging of the mercury cell, silver-oxide cells are supplied chiefly in the button configuration.

During the past year, Ray-O-Vac, Madison, Wis., a division of ESB Inc., began manufacturing a line of batteries that supply as much as 40% more energy than earlier silver-oxide cells, and other companies have been developing similar products. The power output has been increased by use of a highly active divalent silver oxide to replace the monovalent type as a depolarizing cathode. The depolarizer converts hydrogen formed at the cathode to water. Service life of the two kinds of 1.5-v silver cells is compared in Fig. 3. The older RW-12 monovalent cell, 0.455 by 0.220 inch, has a rated capacity of 175 milliampere-hours. The RW-32 Silver II of the same size has a rated capacity of 245 mAh.

Of all the primary batteries, the volatile lithium cell has the greatest energy density by far—about 150 watt-hours per pound—and the highest cell voltage—about 3 v. Many researchers consider the nonaqueous lithium cell the battery of the future because of its superior characteristics, although it still has a few drawbacks.

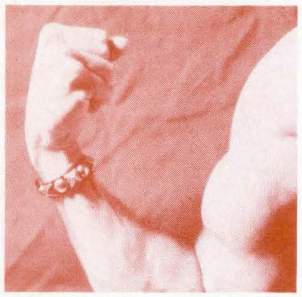
Evaluating the lithium cell

In addition to yielding more power and energy per unit of weight and volume, the lithium cell can operate from −65°F to +165°F, has longer shelf life than any other battery type, and has a flat voltage-time curve. But its high price has thus far restricted the lithium battery mostly to military-aerospace applications.

Two major obstacles have hindered development of a commercial cell—the tendency of lithium to react violently to even trace quantities of water and the need for an active cathode material that is compatible with both the lithium and the organic electrolyte. Both of the two lithium-battery manufacturers decline to reveal what cathode material they are using. And despite the need for a tight seal, the cell must have an emergency venting system to release excessive gas pressure if and when the circuit is shorted. A special elastomeric seal has been developed for that purpose.

But despite their drawbacks, lithium cells are being used for emergency crash-locator beacons, sonar pingers, sonobuoys, missiles, expandable jammers, and even animal telemetry—applications in which high energy at small size and weight is crucial. Power Conversion Inc., Mount Vernon, N.Y., has delivered several thousand batteries for balloon-borne radiosondes where low-temperature performance is vital. The cells are also being used in standby power systems for volatile memories and in smoke-detection systems. In time, lithium cells are expected to become price-competitive with other premium primary batteries.

The lithium battery, its spirally wound core packaged



in a steel case (Fig. 4), looks like any commercial D cell, but the performance differs greatly. One standard lithium D cell can power a flashlight continuously for 18 hours, whereas two comparable zinc/carbon cells would last only 15 minutes, points out Stewart Chodosh, marketing manager for Power Conversion.

Power Conversion, which has been producing lithium batteries for several years, offers eight standard cell types rated from 0.5 to 10 Ah. Mallory Battery Co., Tarrytown, N.Y., is sampling its version of the nonaqueous lithium cell.

Lithium cells operate efficiently at high discharge rates, a mandatory characteristic for applications having high current drain. The bar chart in Fig. 5 shows that a lithium D cell's energy, with a 1-A current drain at 70°F, is equivalent to four mercury-zinc D cells, five alkaline-manganese D cells, seven magnesium D cells, or 30 carbon-zinc D cells. A comparison of lithium cell's flat voltage/time profile with other types of cells (Fig. 6) shows that it is clearly superior to the others.

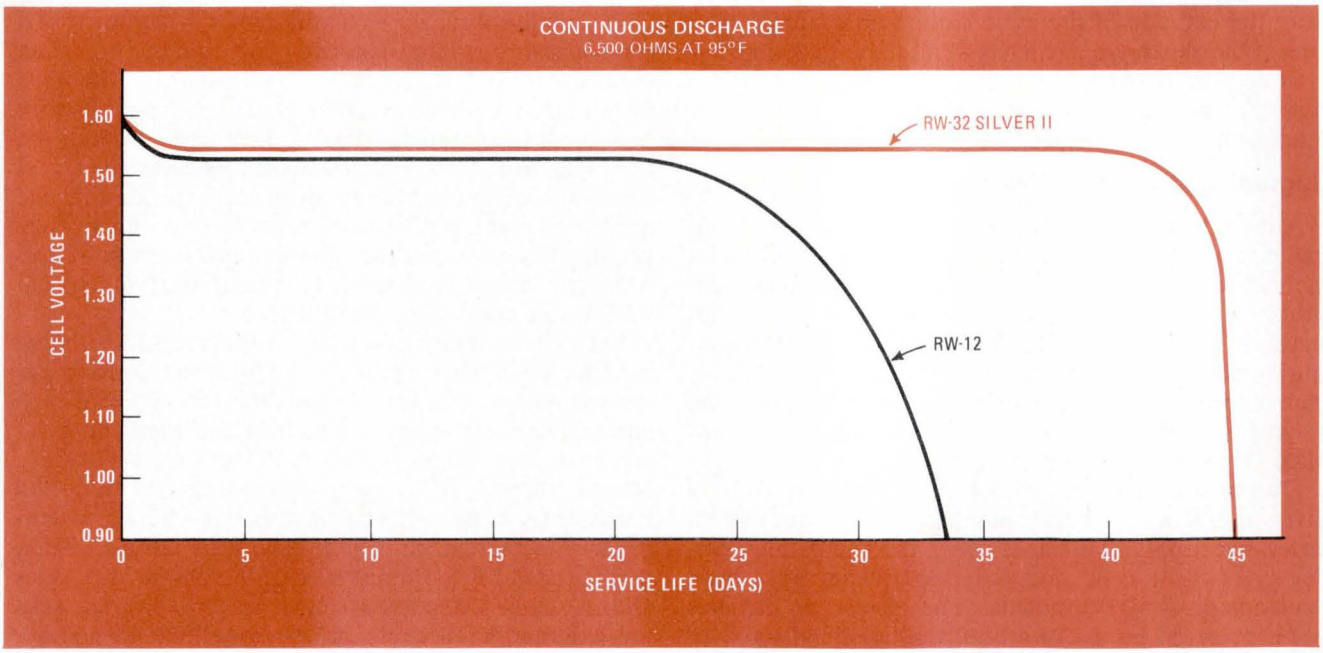
Packaging battery systems

Anyone who has struggled to replace individual cells in the small battery compartment of a calculator, cassette recorder, or camera has hoped for a better way of doing it. Now Mallory and Ray-O-Vac have overcome this time-consuming annoyance by packaging cells in cassettes, which also prevent incorrect installation and bent battery contacts. What's more, Mallory has packaged two different types of batteries together to take advantage of the best characteristics of each.

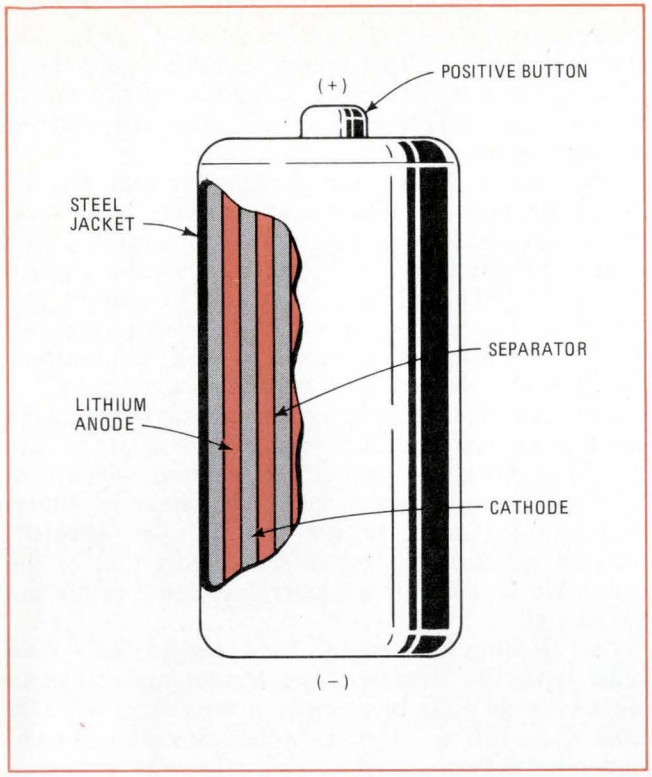
In Mallory's Flat-Pak (Fig. 7) several cylindrical alkaline cells are connected in series in an almost rectangular plastic container that has two metal battery posts on one end. This package slips into a battery compartment like a cassette. The Flat-Pak is aimed at the calculator and camera markets; one 6-V unit has already been designed for a Summit calculator.

Two 500-mAh versions of the Flat-Pak are now available. One is a 6-V unit in a package of 1.890 by 1.390 by 0.350 in., and the other is a 9-V unit in a package of 1.890 by 2.000 by 0.350. Also being developed is a long thin 500-mAh Flat-Pak in a package 4.925 by 0.750 by 0.270 in. Comparative dimensions of a standard 9-V 500-mAh alkaline battery for transistor radios is 1.766 by 1.031 by 0.656 in.

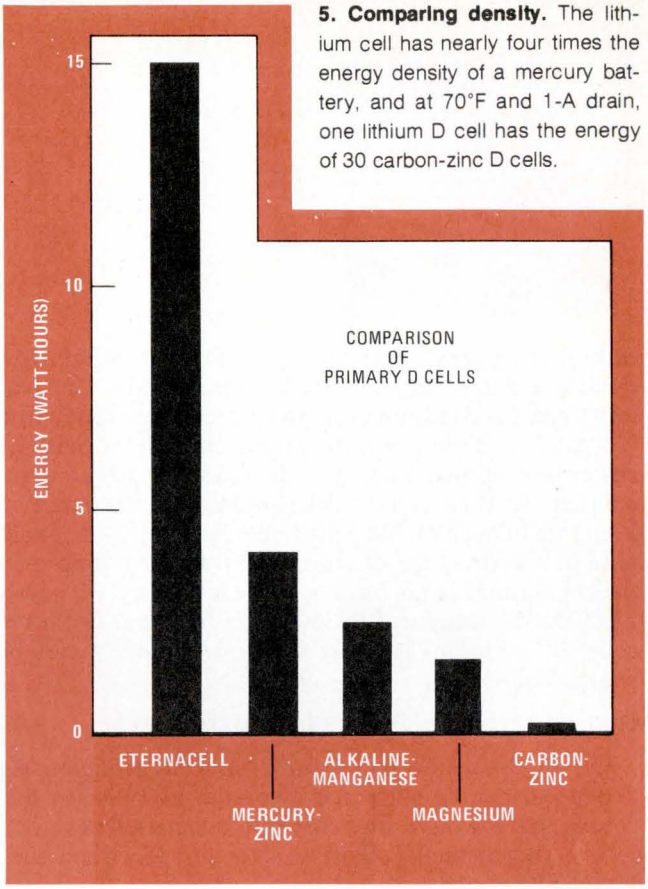
Mallory's hybrid cylindrical package was developed to power a smoke detector and give the required audible alarm when the batteries are nearing the end of their lives. Since a long-life mercury battery is the alarm's power source, triggering the required low-battery alarm is difficult because of the flat voltage/time characteristic (Fig. 8a). And because its discharge characteristic is flat, internal voltage regulation is not needed. However, if a cadmium-oxide battery were used, an appropriate low-voltage point could be designated on its stepped voltage/time curve (Fig. 8b) to trigger the signal. Unfortunately, the expensive cadmium-oxide batteries don't have adequate capacity. To power the smoke detector, Mallory has connected seven mercury and two cadmium cells in series in one cylindrical battery case. When the stepped curve of the cadmium cells is added to the flat characteristic of the



3. Silver cells. Replacing the monovalent silver-oxide depolarizer with divalent silver oxide improves energy density by 40%. Identically packaged monovalent (RW-12) and divalent (RW-32) silver-oxide primary batteries, measuring 0.455 by 0.220 in., are compared above.



4. Lithium. A nonaqueous lithium cell contains a high-energy lithium anode that reacts to even a trace of water. This cell must have both a nearly hermetic seal and a venting system to relieve gas pressure caused by excessive current discharge.



5. Comparing density. The lithium cell has nearly four times the energy density of a mercury battery, and at 70°F and 1-A drain, one lithium D cell has the energy of 30 carbon-zinc D cells.

seven mercury cells, the result is the composite curve of Fig. 8(c), which drops from 11.8 V to 10.3 V at 630 mAh. A circuit senses this 1.5-V drop and activates the alarm while about 300 mAh are left to operate the alarm until the battery can be replaced.

Customizing a zinc-carbon cell

Usually a designer must fit his equipment to one of the several standard cylindrical and flat configurations of commercial primary batteries of various sizes. An exception is the Polaroid SX-70 camera, for which Ray-O-Vac originally manufactured its P-70 flat-zinc-carbon battery pack. This company is now using the P-70 technology to develop a family of flat zinc-carbon power packs, called Strata-Pacs, for the calculator industry.

The Strata-Pacs are intended to be manufactured in several forms and voltages. The first one to be available is a 6-V 500-mAh unit measuring 3.5 by 2.9 by 0.25 in. Prices will be competitive with comparable alkaline batteries, Mallory says. Their low profile makes the Strata-Pacs suitable for cassette loading, and the large surface area of the equivalent battery plates enable this source to supply a high current drain. In calculator applications (Fig. 9), a Strata-Pac I has outperformed equivalent alkaline and heavy-duty zinc-chloride cells. Shelf life is equivalent to that of zinc-carbon batteries, Ray-O-Vac claims.

Considering rechargeable batteries

Designers frequently decide that their equipment justifies the higher price of secondary batteries, or rechargeable batteries are necessary to provide a reliable emergency power source. Four types dominate electronic applications—sealed nickel-cadmium, gelled-electrolyte lead-acid, silver-cadmium, and silver-zinc batteries (Table 2).

Electronics engineers most often use the sealed nickel-cadmium battery in applications ranging from consumer goods and portable test equipment to powering industrial, aviation, and aerospace equipment. In general, sealed nickel-cadmium cells are more economical when purchased in large quantities than other rechargeable types in the small sizes (AAA, AA, and C).

However, a silver-zinc cell, with the equivalent energy density of 45 Wh per pound, provides four times the energy of a nickel-cadmium cell and five times the gelled-electrolyte lead-acid cell's energy density. At 22 to 34 Wh per pound, a silver-cadmium cell has slightly less energy density than a silver-zinc unit, but its maximum life is three times as long as the typical 100 cycles for the silver-zinc cell. The typical discharge characteristics of these secondary battery systems is compared in Fig. 10.

At ratings of 1 Ah and higher, the lead-acid cells cost only one third to one fourth as much as comparable nickel-cadmium cells. But a silver-zinc cell is somewhat more expensive than its nickel-cadmium counterpart—4 Ah of nickel-cadmium power costs more than $20, compared to less than $12 for the same amount of power from a lead-acid battery.

Neither the silver-zinc nor the lead-acid cell has the "memory effect," which can be a drawback for nickel-

cadmium batteries that are operated at a certain low discharge levels for short, repetitive periods. The battery becomes conditioned to that level of operation and "forgets" its design capacity so that it delivers only the customary output when the demand for power is increased. To their credit, nickel-cadmium cells supply a high rate of current, have high energy density, are available in a wide range of sizes, operate over a long temperature range, and have a life expectancy of nearly 1,000 cycles, compared to 300 cycles for silver-cadmium cells. In addition, recently developed models can be charged quickly.

Quick-charging nickel-cadmium cells

On the debit side, nickel-cadmium cells are relatively expensive, can be permanently damaged by heavy discharge, have a high discharge rate during idleness, and register no distinct voltage rise to indicate when they reach full charge.

The 10-hour or C/10 rate has been accepted as the rate at which sealed nickel-cadmium cells can be safely charged. C is the ampere-hour capacity of the cell, and 10 is the number of hours required at maximum charge efficiency to fully charge a completely discharged cell. This formula requires 11 to 16 hours.

However, faster recharging is often demanded for batteries used in such equipment as oscilloscopes, digital multimeters, and electronic photoflash guns. Most of the quick-charging systems depend on varying one or more of the functions of nickel-cadmium cell—voltage, pressure, or temperature.

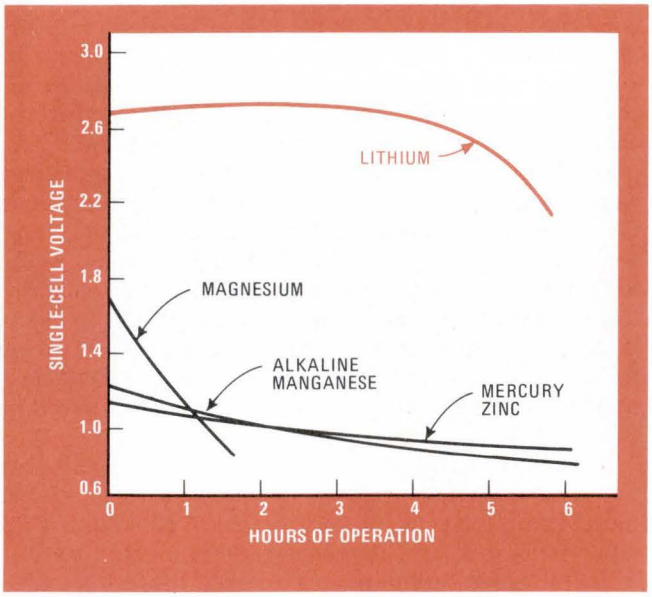
The General Electric Co. Battery Products section, Gainsville, Fla., and Union Carbide Corp., New York, have developed fast-charging nickel-cadmium cells. The fastest of the three is GE's Power-Up-15 battery, which can be charged to 90% of its capacity in 15 minutes. The accompanying charger senses both temperature and voltage, and when either reaches its limit, an electronic switch reduces the rate to the C/10 rate—a trickle.

Eveready's Hustler, which can be recharged in one to three hours, can withstand overcharge at a rate of C to 3 C long enough for the cell temperature, which rises when full charge is approached, to be sensed by a thermal-control element of the charger. The Hustler's charger, which is less sophisticated than that of the Power-Up-15, has only a temperature cutoff to prevent overcharge.

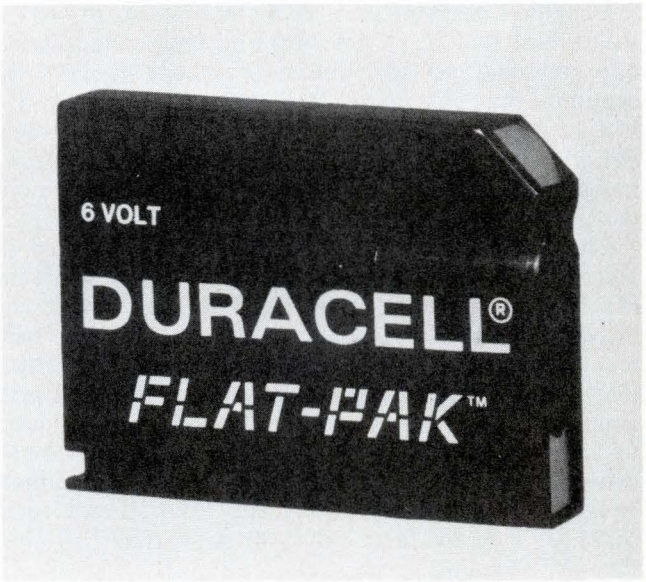
GE's Goldtop line can also be recharged faster than older types. By increasing the temperature range in these cells, they can be charged at the rate of 0.3C for three and a half to four hours with a conventional rectifier and without the need for thermal-sensing elements. Temperature tolerance was raised from the usual 50°C to 65°C by improving the plate design, the separator, and the seals.

Increasing energy density

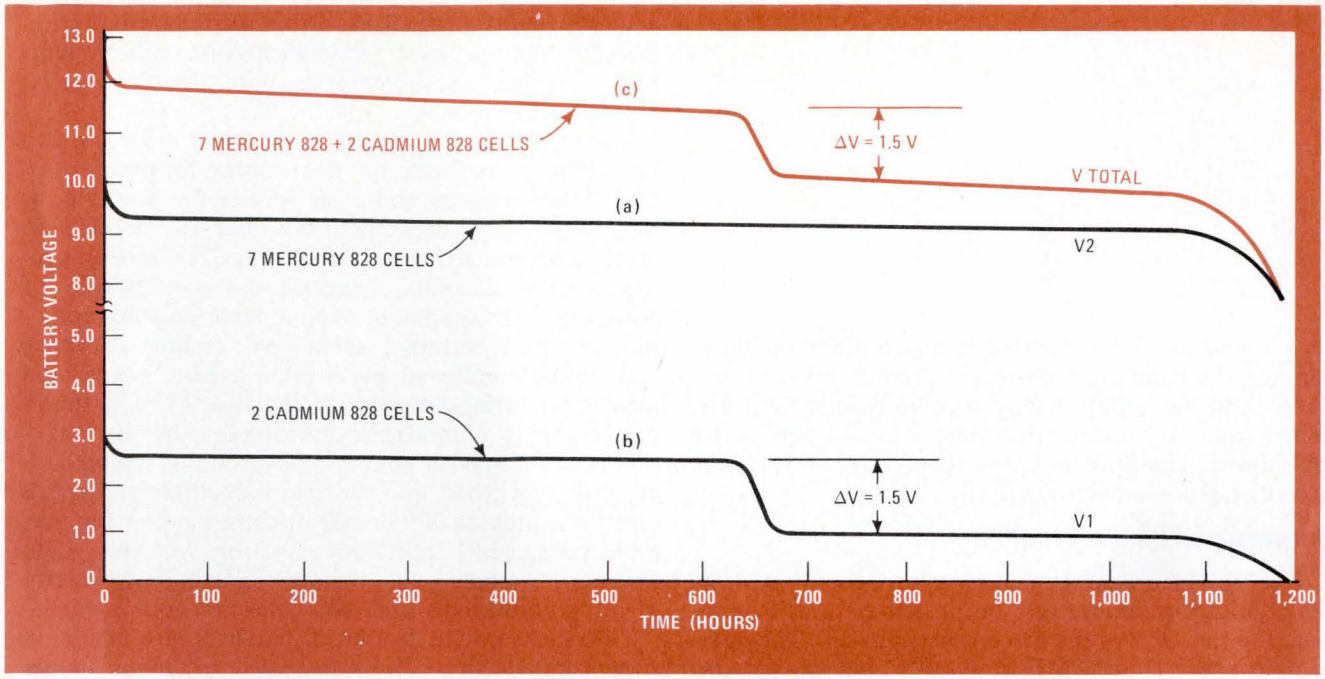
Many applications require a lighter, more powerful power source than the nickel-cadmium battery. These include powering portable television cameras, videotape recorders, airborne telemetering equipment, missiles, and electronic pipeline trouble-finders. Such tasks are usually performed by silver-zinc and silver-cad-



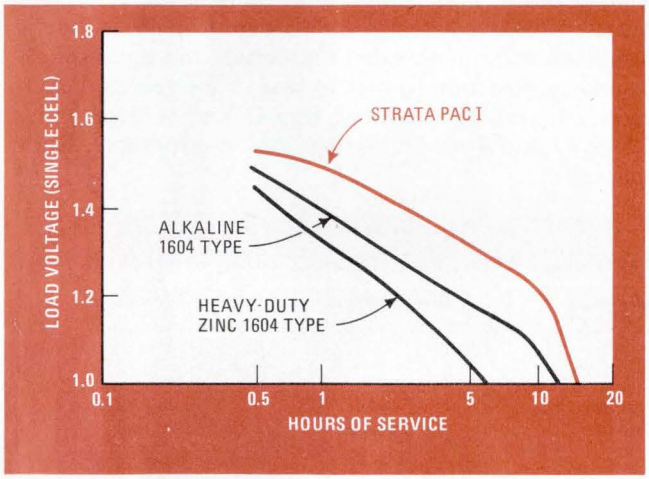
6. Dependable. At 1-A drain, the lithium D cell's voltage-time curve is flat for most of its useful life. Only the mercury-zinc cell, with a lower energy density and cell voltage, approaches the flat voltage characteristic of the lithium cell.



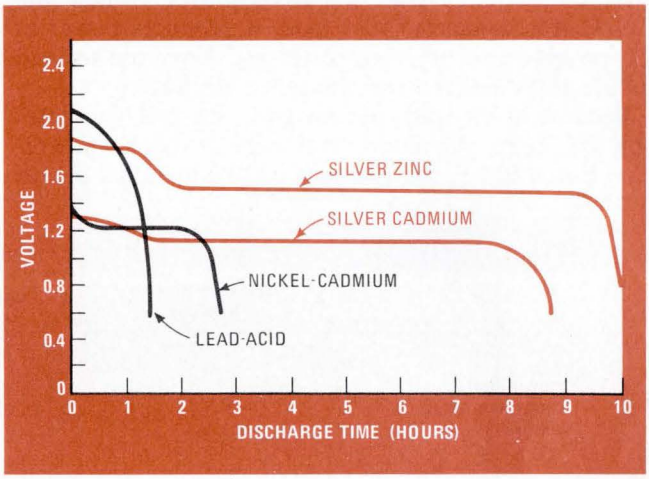
7. Flat-Pak. One of the newer battery packages is Mallory's 6-V, 500-mAh Flat-Pak, suitable for calculators and cameras. This unit measures 1.89 by 1.39 by 0.35 in. and has special cylindrical alkaline cells. A 9-V 500-mAh Flat-Pak version is also available.



8. Exploiting characteristics. Because of their flat voltage characteristic, there is meager warning when mercury cells near their full-discharge point. However, by adding two cadmium cells in series with seven mercury cells, an alarm can be activated to signal a low-battery condition because the hybrid registers a distinct 1.5-V drop at 630 mAh. At this point, about 300 mAh are left to operate the system.



9. Calculator service. With a typical calculator load (6 V at 30 mA), the Strata-Pac, an improved version of the SX-70 camera's flat zinc-carbon battery outperforms competitive primary batteries.



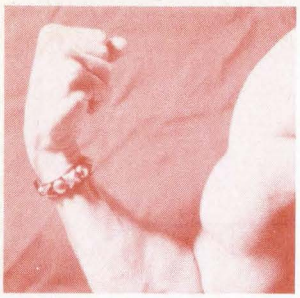
10. Discharging characteristics. Typical discharge characteristics are compared for silver-zinc, silver-cadmium, nickel-cadmium, and lead-acid batteries of equal weight and current drain.

mium battery packs. The capacity of these power systems ranges from 0.1 Ah to 750 Ah.

In contrast to nickel-cadmium cells, silver-zinc and silver-cadmium cells are unhampered by the "memory" problem and will deliver full voltage on call. Both indicate when they reach full charge by a jump in voltage, a characteristic that eliminates the need for monitoring the temperature and pressure when charging. The silver-cadmium battery is the most expensive secondary battery, followed by silver-zinc, which is slightly higher than a nickel-cadmium system. The least expensive secondary battery for powering electronic equipment is the gelled-electrolyte lead-acid cell, largely because of the relative abundance of its materials.

Despite its well-known advantages, the wet lead-acid battery has been restricted mostly to automotive and industrial applications because the liquid electrolyte requires special shipping, handling, storage, and maintenance. Most of these batteries also contain lead-antimony components, which causes high gassing rates during charging and high self-discharge during storage. Yet the lead-acid battery yields the highest voltage per cell of any secondary system, costs little per watt-hour of capacity, and can withstand high rates of charge and discharge. The cells can be connected both in series and in parallel to build up high-capacity power systems.

To exploit these advantages, Globe Union Inc., Milwaukee, in 1965 introduced the gelled-electrolyte lead-acid battery, the Gel/Cell, to this country. Since no water or electrolyte needs to be added, the battery is



sealed, and it can be installed in any position. Without spillage, the handling problems of the wet cell are eliminated, and the battery has an unusually long shelf life. When internal pressure rises past 1 pound per square inch during charging, one-way relief valves release the excess pressure and automatically reclose.

Surpassing liquid electrolyte

The Gel/Gell's energy density approaches that of the sealed nickel-cadmium cell, but it delivers 2.12 V, compared to the 1.2 V of the nickel-cadmium cell. The operating range is from −76°F to +140°F, but capacity increases above 68°F and decreases below that level. The basic components of a fully charged Gel/Cell are lead-dioxide positive plates, a gelled sulphuric-acid electrolyte, and sponge-lead negative plates. When the Gel/Cell is connected to a load, it produces power as the positive and negative plates are converted to lead sulfate and water replaces the gelled electrolyte.

Because of the lead-calcium grids, the Gel/Cell loses only 2% to 3% per month in storage at room temperature, but at 95° F, the loss goes to 10% to 12% a month and at 0°F, it drops to 0.5%. Other secondary batteries, including competitive gelled-electrolyte cell systems that have lead-antimony grids, lose their charge at higher rates (Table 2).

The gelled-electrolyte lead-acid battery is used in two basic types of applications—float service for uninterruptible power supplies and cycle service for portable instruments. Many manufacturers offer two models to meet these requirements. Globe's Type A Gel/Cell provides four to six years of service in a standby role for powering such equipment as solid-state volatile memories, computer-terminal memories, security systems,

A simple standby supply is often used to power MOS memories during momentary outages. The system's power supply normally trickle-charges the secondary cell. When the power goes off unexpectedly, the secondary cell is switched into the line immediately. Type B Gel/Cells provide 300 to 500 discharge cycles for portable instruments, portable television receivers, defibrillators, transceivers, remote telemetering instruments, portable tools, and data-collection equipment.

Gelled-electrolyte lead-acid batteries are made in sizes from 0.9 Ah to 20 Ah in sealed rectangular cases that are dissimilar to the configurations of consumer batteries. However, Gates Energy Products, Denver, is producing both 2.5-Ah D and 5-Ah X sizes of sealed lead-acid cells. These units are not gelled lead-acid cells, but use a "starved-electrolyte" system (the electrolyte is combined with an absorbent material) and have spiral-wound construction similar to that of the sealed nickel-cadmium cell. In addition, Ray-O-Vac is developing 2.5-Ah D and 4-Ah F rechargeable, nonspillable, lead-acid cells. □

TABLE 2: ELECTRICAL CHARACTERISTICS OF SECONDARY BATTERIES

	Gelled-electrolyte lead-acid	Nickel-Cadmium	Silver-Cadmium	Silver-Zinc
1. Energy output Watt-hours per lb Watt-hours per in.^{3}	 9 1.1	 12 to 16 1.2 to 1.5	 22 to 34 1.5 to 2.7	 40 to 50 2.5 to 3.2
2. Nominal cell voltage	2.12	1.2	1.1	1.5
3. Cycle life	200 to 500	500 to 2,000	150 to 300	80 to 100
4. Temperature range Store Operate	 −76 to 140° F −76 to 140° F	 −40 to 110° F −20 to 140° F	 −85 to 165° F −10 to 165° F	 −85 to 165° F −10 to 165° F
5. Shelf life at 68°F to 80% of capacity	8 months (with lead-calcium grids)	2 weeks to 1 month	3 months	3 months
6. Internal resistance	low	low	very low	very low
7. Discharge curve	sloping	flat	flat	flat
8. Relative cost, rated on a scale of 4 for maximum	1	2	4	3

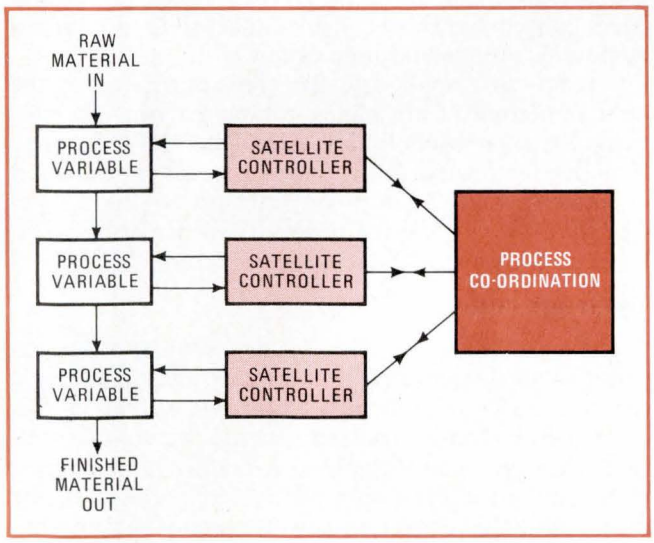
Prospects brighten for data acquisition

Integration of transducer and converter functions at sensor sites promises to make systems practical in areas now out of reach; top priority is currently focused on low-cost monolithic converters

by Stan Harris, *Analog Devices Inc., Norwood, Mass.*

☐ New semiconductor circuits are propelling the data acquisition and process control industry toward new markets and a fundamental shift in design concepts. The major factor in this is the proliferation of monolithic linear integrated circuits as they replace discrete and hybrid components, in effect reducing the size and cost of multi-channel analog-to-digital data acquisition and control systems. The still unrealized but almost certain development of an inexpensive, monolithic, and complete analog-to-digital converter will go a long way toward producing a basic change in system design.

At the heart of the industry's prospects are increasingly complex and precise ICs; they are altering and compressing traditional system building blocks and will culminate soon in decentralized systems. Essentially this means that small multi-function packages will replace simple sensors at the point of data acquisition or control. These packages will send and receive purely digital information to and from the central processing unit. The CPU is thus relieved of many traditional functions. Problems and costs associated with analog signal transmissions are eliminated, and the combination of low cost and compactness considerably extends the horizon for new applications.



1. Acquisition. Three general elements will be contained in a data acquisition and control system of the future. Raw analog data is gathered at the transducer source and converted directly into digital form. And microprocessor-based "satellite" controllers convey the data under the direction of a coordinating computer.

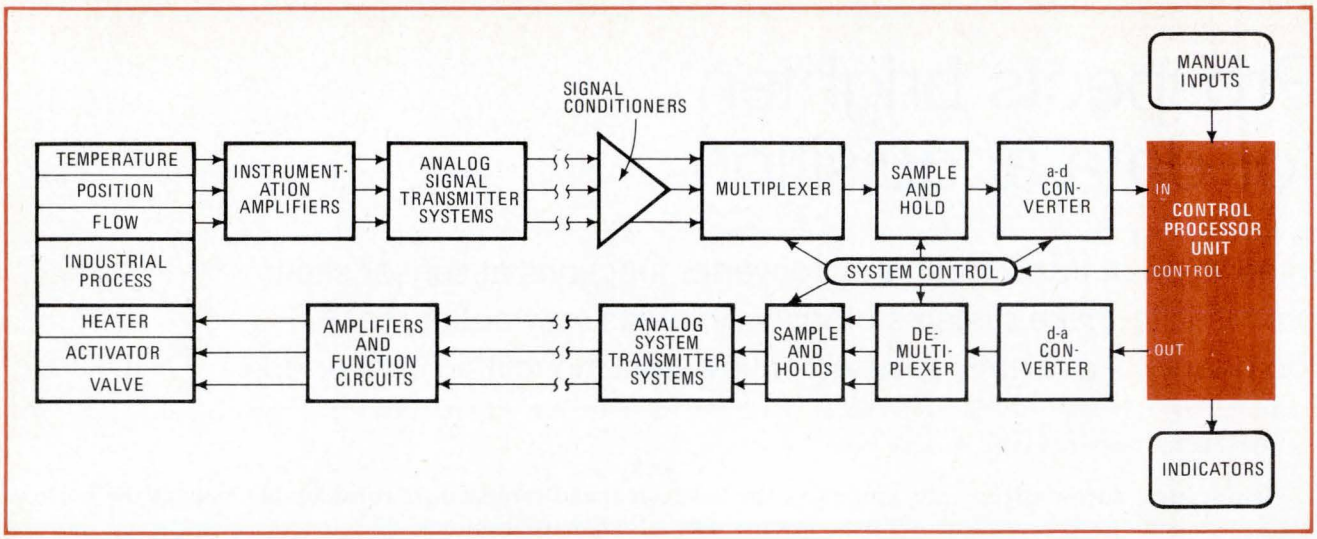
Figure 1 illustrates the generalized concept of a "satellite" controller system, the satellite being a subsystem consisting of a transducer-converter-digital-processor circuitry that handles some key functions that were formerly centralized. Clearly the success or failure of this concept depends on the availability of inexpensive digital processing and on converter circuits accurate enough to provide reliable control. Low-cost analog-to-digital converters will be used in large quantities to convert each analog input in real time. Then, instead of analog-signal multiplexing—a chore requiring expensive componentry—the digital outputs can be directly time-division multiplexed and transmitted.

The use of digital multiplexing at the subsystem site will make possible a reduction in the amount of transmission line required for a given number of transducer inputs. The only remaining analog components in the system are the converters. Gone are the op-amps, sample-and-holds, comparators, and the rest.

Full development of these systems will hinge on their substantially lower costs. Existing data acquisition and control systems are marked by high costs in two respects: the cost of the system circuit-functions and the cost of the installation of the signal transmission network. (The installed cost of wire can run as high as $35 per foot.) These costs have inhibited more widespread use of automatic monitoring and control of physical processes—processes that pervade our industrial and consumer world.

The way things are

Figure 2 represents the typical arrangement of a present-day data acquisition and control system subdivided on a functional basis. It does all of the following: collects and conditions analog data, transmits and buffers it, time-division multiplexes the analog channels, holds and converts the data sequentially, provides parallel digital output to a digital processor, processes the digital data according to control algorithms, drives a converter, time-division-multiplexes the analog-output sequence, holds and transmits the individual channel signals, conditions the analog signals, and, finally, drives the output transducers that control the process or other real-world variables. Ten years ago the various



2. Today. Data acquisition systems currently in use require a large amount of expensive analog circuitry including instrumentation amplifiers, signal conditioners, sample and holds, converters, multiplexers, etc. Most are built with relatively expensive discrete or hybrid components.

functions were implemented with discrete component assemblies manufactured at some expense by systems houses.

While the performance of the functions typically far exceeded the requirements of most of the channels, it was needed to handle the dynamic range and diversity of signals. And, as high as the cost of the analog function was, it was often small when compared to the cost of the digital computer that processed the data. Lower-cost standard modules were soon developed by component manufacturers to equal or exceed the performance of the discrete custom design. At the same time, lower-performance versions of the same modular functions were made at an even lower cost for less demanding applications.

Enter the linear IC

Linear ICs, when used within the modules as discrete replacements, lowered the cost of analog functions still more. But linear ICs have gone further and are displacing some of the modules themselves. Indeed, operational amplifiers are now almost exclusively monolithic. Even IC instrumentation amplifiers are being used now for signal conditioning. Two new monolithic instrumentation amplifiers, Analog Devices' AD521 and Burr-Brown's 3660, are among the latest examples of linear ICs that can outperform many modules and at lower cost. Linear ICs are also making inroads into multiplexing.

Several technologies—the most promising of which is C-MOS—are being used to produce complete analog multiplexers in one IC package. These circuits comprise logic inputs and decoders, level translators, switch drivers, and the switches themselves. Some offer floating switches which handle the full input voltage range of the sample-and-hold circuit. Others are more limited, but can be efficiently combined with an inverting sample-and-hold.

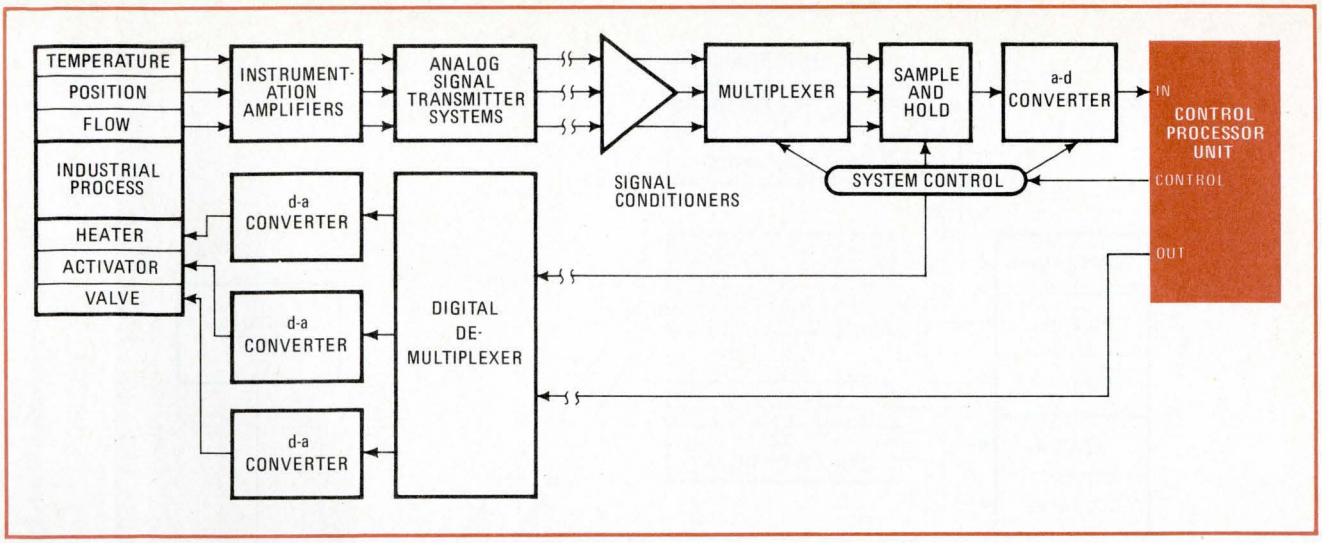
While the costs of complete IC multiplexers are relatively high, they are dropping quickly. Less expensive IC subcircuits, meanwhile, are being incorporated into multiplexer assemblies that were once all discrete. Similar developments are occurring in sample-and-hold circuits. These have been available in IC packages for some time, usually in the form of multi-chip hybrids consisting of general -purpose op amps, and of discrete components wire bonded together on a substrate.

More interesting is a new sample-and-hold circuit built with a concept called Compound Monolithic Integration (CMI). Using this approach, an overall circuit function is partitioned among several monolithic LSI chips and then wire bonded together to form the complete function. The partitioning is done without regard for the stand-alone function of each chip, so as to minimize the total number of chips. The result is in an optimum cost/performance tradeoff not possible with discrete, hybrid, or an everything-on-one-chip monolithic approach. (A complex technology that combines dielectric isolation with linear compatible MOS has recently been utilized by Harris Semiconductor to produce a monolithic sample-and-hold circuit.)

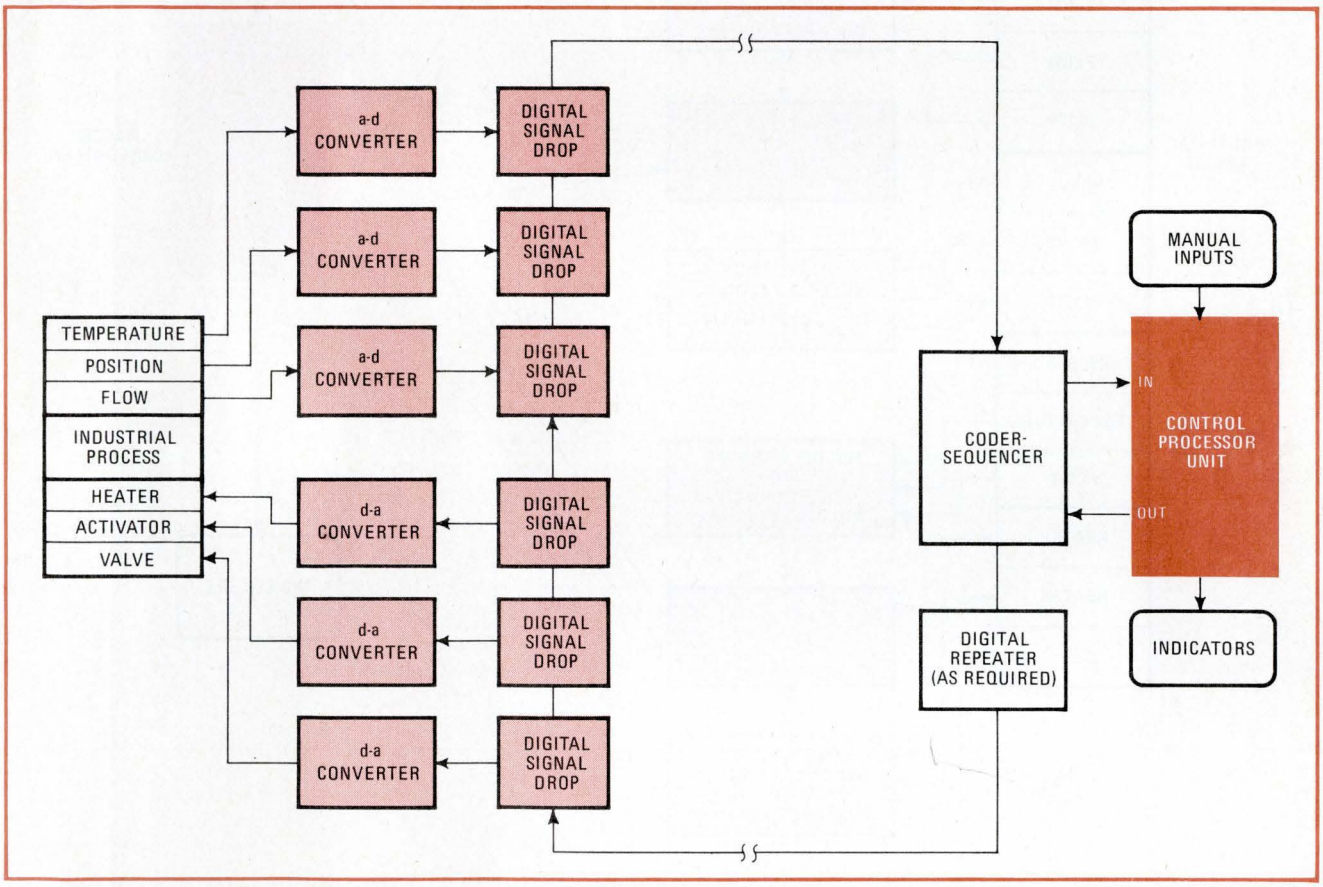
CMI was first applied to the converter, perhaps the most important of all analog components in new systems. Precision Monolithics' AIM-DAC-100 has been available for several years, and the recent introduction of Analog's AD562 12-bit converter proves the conjecture that ICs will offer better standard performance at lower costs than modular techniques permit.

The tough one

The most difficult problem for the designer of IC converter circuits is combining both linear and digital logic technologies in one function. In the d-a converters this combination is easily realized because the digital interface circuitry is quite simple. It is readily implemented with standard linear-circuit-process technology. In the analog-to-digital converter, however, complex combinatorial and sequential logic must be added to the comparatively simple steering logic of the d-a converter. The trouble is that these logic circuits, when built with today's linear bipolar processes, are impractical. Linear processing demands great space for isolation of higher



3. Getting down. The availability of low-cost digital-to-analog converters allows designers to put a d-a converter at each return channel and then multiplex the analog components from the input channel. This eliminates most of the expensive analog components in the return path.



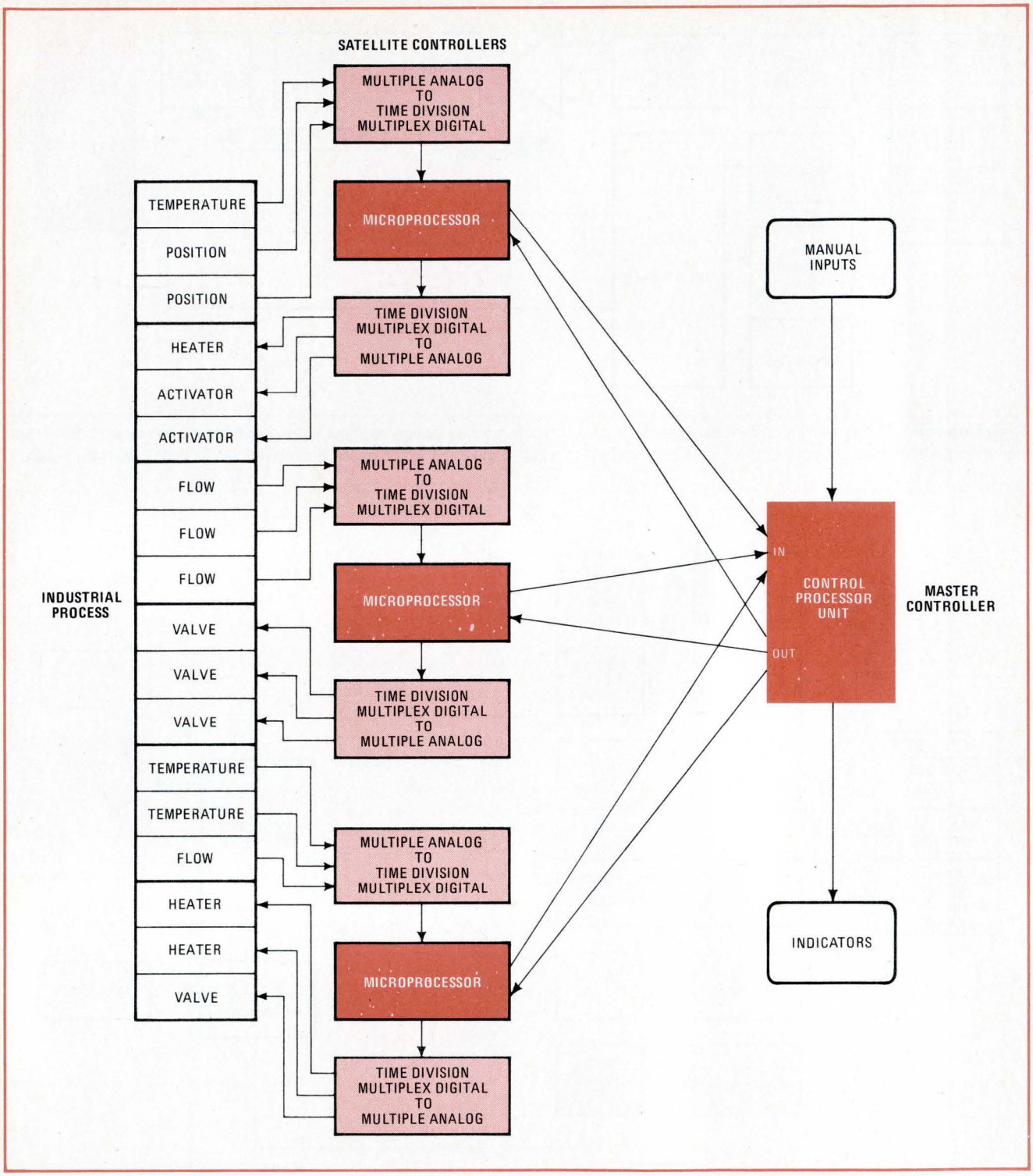
4. Still better. Low-priced monolithic analog to digital converters will enable designers of data acquisition and control systems to put both d-a and a-d converters on each channel, so with one stroke, most of the expensive analog componentry will be eliminated.

performance transistors. When the d-a circuit, voltage reference, and output op amp are integrated with the a-d logic, the chip becomes very large and unprofitable to build.

As a transitional solution, designers are building a-d converters with separate analog and digital chips in IC-size packages. Better yet, new a-d converters will shortly appear that use the CMI concept—matched chips specially partitioned to work together to implement the a-d function.

Of course, achievement of a completely monolithic a-d converter, while extremely difficult, will be a significant step toward cost effectiveness. And because the incentives are so great, new designs built with new linear process technologies are already emerging.

Analog Devices has recently introduced the AD7570,



5. The ultimate? Small microprocessors in conjunction with monolithic converters in data acquisition subsystems mean that most control functions can be accomplished at the input source; a master controller manages subsystems.

a 10-bit C-MOS a-d converter which combines thin-film and C-MOS technology on one chip. With this process a C-MOS successive-approximation register along with a d-a converter are combined on one chip. Another example of a promising technology is demonstrated by an RCA op amp made with C-MOS and bipolar transistors on a single chip. While a far cry from a monolithic a-d converter, the technology offers the possibility of putting the bipolar comparator and voltage reference together with a C-MOS d-a converter and successive-approximation register. Still another monolithic possibility is building the linear and logic functions of an a-d converter with integrated injection logic (I^2L) processing.

In summary, while difficulties remain in adding the necessary logic for monolithic a-d converter design, this is not true of the d-a converter where 6-, 8-, 10-, and

soon 12-bit monolithic d-a converters will be available.

The discussion, to this point, has essentially concerned itself with components based upon the partitioning shown in Fig. 2. However, the industry stands at the threshold of a new concept in data acquisition that is based upon the improved performance of monolithic converter components and the availability of inexpensive CPUs and microprocessors.

Consider the impact of the availability of low-cost d-a ICs. IC d-a converters with 10- and 12-bit resolutions make it possible to considerably reduce the complexity of the conventional system, as shown in Fig. 3, where each return channel has its own d-a converter and digital signal buffer sequenced directly from a CPU. Note that a great deal of the analog control circuitry is eliminated from the control side of the system.

A similar reduction of analog processing would be made by assigning one low-cost IC a-d at each analog input, as shown in Fig. 4. These a-d converters would completely eliminate the need for analog multiplexing. And, by using high-speed converters, the need for analog sample-and-hold would also be eliminated. The a-d converters would be controlled digitally and their outputs polled by a digital multiplexer.

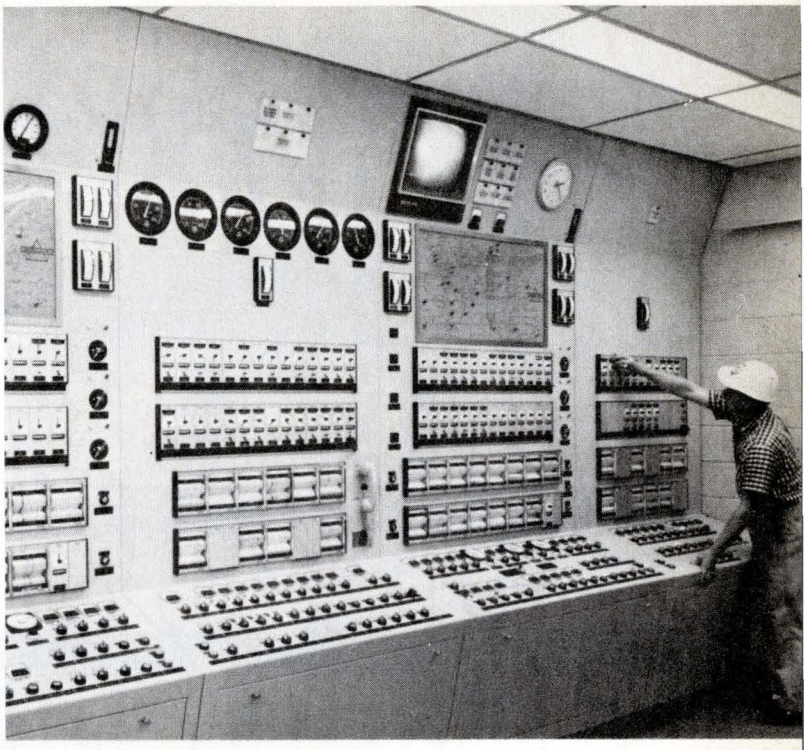
Rearranging things

Furthermore, since time-division-multiplexing of digital signals is easily accomplished, the communication would be reduced to a sequence of digital words, address, and synchronization information—much in the manner of standard digital data processing systems. Each subsystem of the a-d converter would encode its particular analog signal and insert the digital word at a prearranged address in the sequence. The sequencer could then pick off the information for the central processing unit and replace the incoming information with a command at the same address that would be interpreted by one of the subsystems of the d-a converter. The address in the sequence would then made available for the next a-d word from the assigned subsystem. Each subsystem would circulate—unchanged and unrecognized—each signal and command that did not carry its identifying address. Addresses might be as simple as a position in a sequence of time slots following a code word, or they might take the form of separate address bits associated with each data word.

It is clear, then, that the advent of really low-cost monolithic converter chips, together with low-cost microprocessors, will have a profound effect on both data acquisition and control architecture.

Another system which offers more process flexibility is shown in Fig. 5. Here a master controller communicates on a strictly digital level with satellite controllers that monitor and control local process operations. The satellites are programed with the local control algorithms and maintain segments of the process under the coordination of the master controller.

These "off-the-shelf" satellite systems could be used as stand-alone controllers for many industrial processes which cannot yet be economically automated. Indeed, once these stand-alone control systems become available, their increased use should force component prices down, making systems practical for applications where they are now marginal.



6. Example. Typical of process-control applications is this one, a multichannel system at an International Paper Co. plant. The system was built by the Foxboro Co., Foxboro, Mass.

A number of alternative data acquisition and control systems have been described in which a-d converters, microprocessors, and d-a converters, are combined with separate converters, one assigned to each variable being measured and controlled. Although these alternatives differ in detail at the digital level, they share in one notable dissimilarity to present-day systems: the absence of analog signal multiplexing and transmission.

Back at the ranch

The ability to incorporate stand-alone, low-cost data-acquisition components into a wide range of systems will doubtlessly proliferate throughout production facilities and factories. Yet the process control area may be only the first of many new applications.

Take, for example, the potential for IC-structured data-acquisition and control systems in the home. Led by the successors of today's IC microprocessors and monolithic converters, a domestic data-acquisition and control system would permit monitoring and control of any number of functions. Homes could be equipped with a microprocessor-based CPU which, through a network of sensors, would monitor and control temperatures, humidity, property surveillance, power, fuel, communications, food processing, even the status of the garage door.

At present, of course, the complexity of a-d converters prohibits widespread use. But once the monolithic a-d barrier is broken the system would become no more than a standard low-cost component, making data acquisition and control feasible wherever desirable. □

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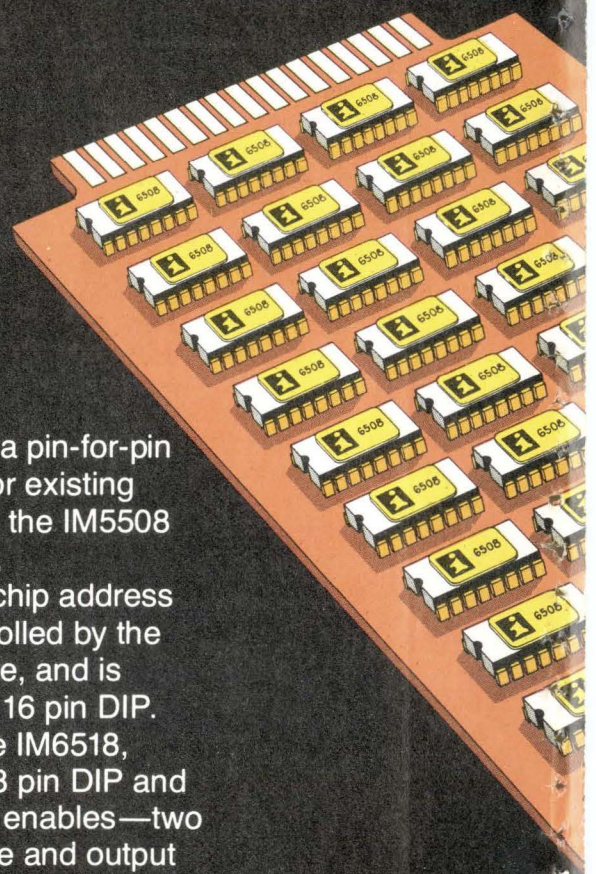

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Power is only 5μW total in standby, 10mW at 1MHz. Typical access speed at 5 volts V_{cc} is 200nS. And the price is right. At 100+ quantities the industrial version is $28, the military is $70.

It has TTL-compatible inputs and outputs, works directly with bus-oriented microprocessors without additional power supplies or interfaces. It's a pin-for-pin replacement for existing RAMs such as the IM5508 and the 93415.

It has on-chip address registers controlled by the chip-enable line, and is packaged in a 16 pin DIP. A variation, the IM6518, comes in an 18 pin DIP and has three chip enables—two for write-enable and output buffering and one for address registers.

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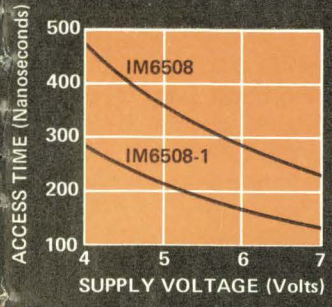
The IM6508-1: Supply current 10µA.

Now it really gets interesting. While the IM6508 has an I_{cc} of 100μA, we deliver a "dash-one" version that requires one-tenth that much —that is, 10μA I_{cc}. It also has significantly faster access, as shown in this speed/voltage graph comparing the IM6508 and IM6508-1 across their 4- to 7-volt supply voltage range.



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There's more. In addition to the above, we also are delivering the IM6508A, which operates at supply voltages up to 11 volts. At that voltage, its access time is speeded up to 150nS.

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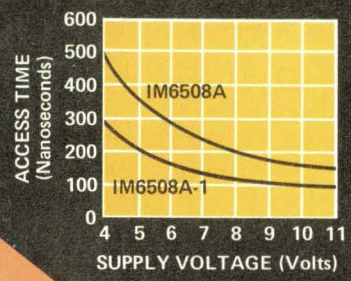

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Updating circuit symbols, the graphic language of electronics

Electronics technology has come a long way since *Electronics* last published its abridged guide to circuit symbols back in 1962. In the interval, many new semiconductor devices have emerged, large-scale integrated circuits have become an everyday reality, and even complete optoelectronic networks are now monolithic.

All these developments are reflected in this updated guide, which shows those symbols most often needed in a modern schematic and currently in worldwide use. As yet, there are no standard graphic symbols for complex integrated devices like microprocessors, memories, high-order logic functions, and linear circuits. Such devices are usually represented by block diagrams with appropriately labeled pins.

For easy reference, the guide is divided into seven sections, and similar items within a section are also grouped together. The seven sections are: semiconductors; optoelectronic devices; two-state logic devices; fundamental circuit components; contacts, switches, and relays; transmission paths; and microwave circuits.

Except in the case of two-state logic devices, all the symbols shown here as recommended by IEEE/ANSI come from "Graphic Symbols for Electrical and Electronics Diagrams" [IEEE No. 315, 1971]/[ANSI Y32.2, 1970]. This document has been approved by the Institute of Electrical and Electronics Engineers, the American National Standards Institute, the American Society of Mechanical Engineers, the Canadian Standards Association, and the U.S. Department of Defense. The symbols denoted by (*) are proposed revisions for the upcoming 1976 publication of this IEEE No. 315 standard, which is updated at least every five years.

All the two-state logic device symbols shown here as recommended by IEEE/ANSI are from "Graphic Symbols for Logic Diagrams (Two-State Devices)" [IEEE Std. 91, 1973]/[ANSI Y32.14, 1973]. This document, which is also updated at least every five years, has been approved by the Institute of Electrical and Electronics Engineers, the American National Standards Institute, the American Society of Mechanical Engineers, and the U.S. Department of Defense.

The symbols given as approved by IEC (O) are from "Recommended Graphical Symbols," IEC Publication 117, which is prepared by the International Electrotechnical Commission, a voluntary independent organization that represents approximately 50 member countries from all over the world. The delegates to the Commission, which meets every one or two years in a different host country, are professional technical people. The IEC publication consists of 16 sections, in addition to an index. Revisions have been issued periodically from 1960 through 1974.

Those symbols that are widely used by segments of the U.S. electronics industries are indicated here by (□). The relay contact arrangements noted in the guide as approved by NARM (✓) are from "Definitions of Relay Terms," July, 1970, a booklet prepared by the National Association of Relay Manufacturers.

The basic work for both the ANSI Y32.2 and the ANSI Y32.14 documents is done by the IEEE Standards Coordinating Committee No. 11, in conjunction with the American National Standards Committees No. Y32.2 and No. Y32.14, respectively. These three groups also work along with the U.S. National Committee, Advisory Group for IEC Technical Committee No. 3. The various working groups under these main committees meet about once a month.

The American National Standards Committee No. Y32.14 is planning to meet in May to review symbology for high-level logic devices.

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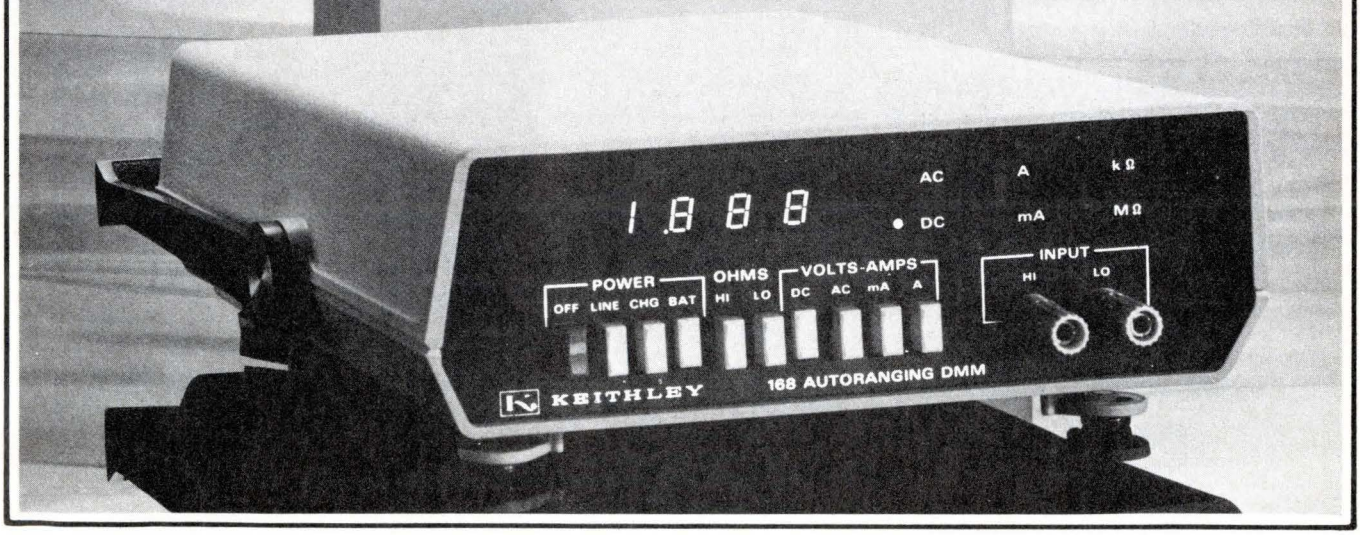

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Circle 99 on reader service card 99

Designer's casebook

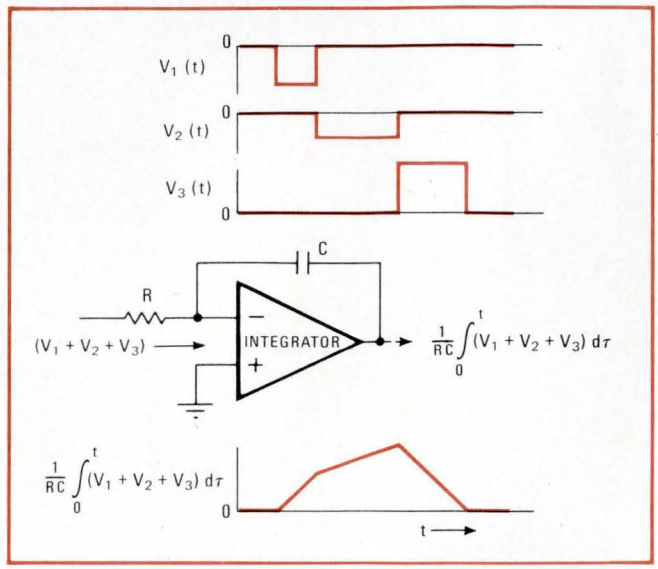
Waveform is synthesized from linear segments

by E. D. Urbanek
Bell Telephone Laboratories, Murray Hill, N.J.

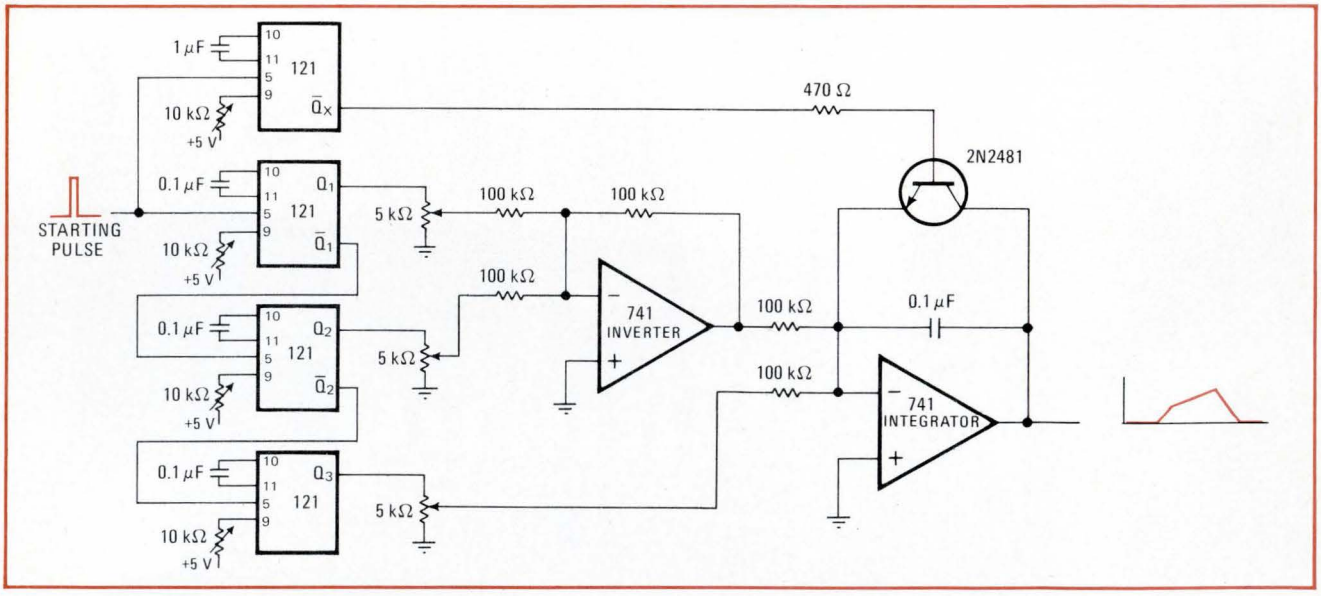
Just as a curve can be approximated by a series of straight lines, so can a waveform be approximated by a succession of voltage ramps. The voltage ramps may be the output of an integrator driven by a succession of rectangular pulses of various amplitudes and durations. Figure 1 shows how the integration of three such pulses produces three sequential ramps to yield a novel wave shape. The amplitude and polarity of each pulse determine the slope and direction of the corresponding ramp, and the width of the pulse determines the length of the ramp. The output voltage function can be made to resemble a curve if enough pulses and ramp segments are used.

A function generator that synthesizes waveforms in this manner is used as a control for automatic-gain-control circuits and for sweep generation. As shown in Fig. 2, it contains type 121 one-shot multivibrators to generate the pulses that are to be integrated, a 741 operational amplifier connected as an inverter to change the polarity of pulses when necessary, and another 741 op amp connected as an integrator. The 2N2481 transistor prevents drift.

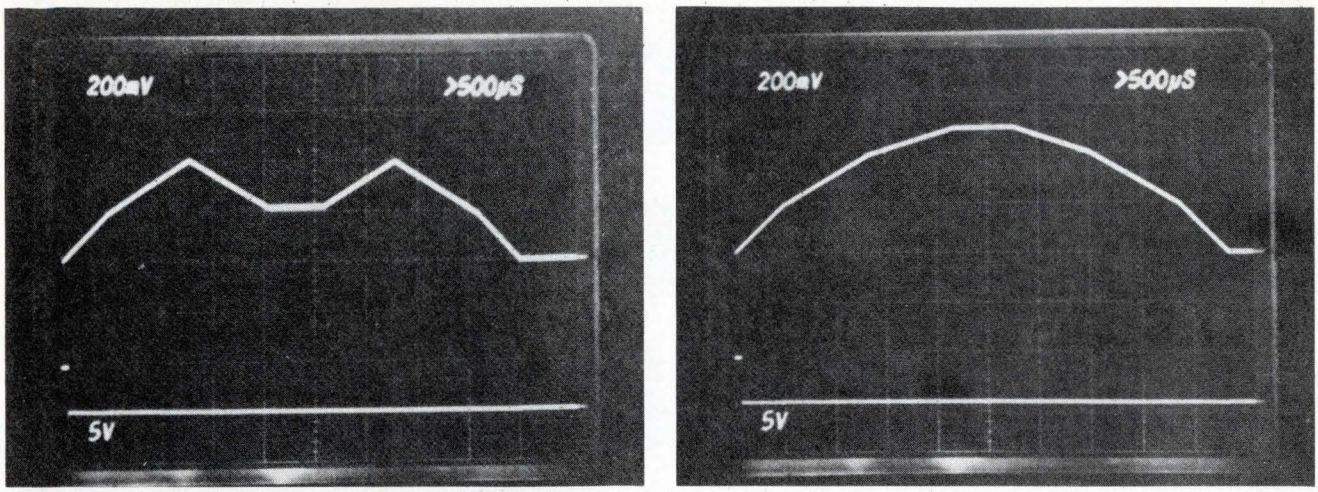
The one-shot units are arranged in a series so that the complementary output ($\bar{Q}$) of the first unit serves as the trigger for the second unit, and so forth. This arrangement produces a sequence of positive pulses. The duration of each pulse is determined by the timing resistor and capacitor of its one-shot, and the amplitude of each pulse is set by the potentiometer at the output of the one-shot. Each positive pulse can be connected directly to the integrator to produce a ramp with negative slope, or it can be connected through the inverter and thence to the integrator to produce a ramp with positive slope.



1. Waveform generation. Integration of sequential rectangular pulses produces sequential voltage ramps that make up output waveform. Amplitude, polarity, and duration of pulses determine the slope, direction, and length of the ramps.



2. Circuit. Function generator uses one-shot multivibrators to supply series of pulses to op amp connected as integrator. Pulse polarity can be reversed by op amp connected as inverter. Complementary output from each pulse generator triggers next pulse in sequence, producing continuity in wave shape. Pulse widths are set by RC time constant for each one-shot, and pulse amplitudes are set by potentiometers.



3. Waveforms. Scope traces generated by seven-segment function generator. Maximum voltage on these traces is about 0.5 volt, and duration of traces is about 4 milliseconds. Traces could be brought down to zero-voltage level smoothly, by sloping segments, or abruptly, by use of transistor to short-circuit integrating capacitor. Trace on right here shows that just a few segments suffice to approximate a curve.

An additional one-shot unit and the transistor are used to form an anti-drift control. The complementary output ($\overline{Q}_x$) of this one-shot is used to drive the transistor, which discharges the 0.1-microfarad integrating capacitor. With no input pulse applied, the transistor keeps the capacitor discharged. Holding the integrator output at zero in this way prevents integration of any offset voltages. When an input pulse is applied to start the function generator, ($\overline{Q}_x$) is driven off and the transistor releases the capacitor. The off time of ($\overline{Q}_x$) may be adjusted to coincide with the total on time of the function generator, or it may be adjusted to terminate the waveform at any point during the on time.

Scope traces of seven-segment waveforms are shown in Fig. 3. The voltage level remains constant (because there is no input pulse to the integrator) between the end of the seventh segment and the retriggering of the start pulse. The maximum voltage on each trace is about 0.5 volt, and the total duration of a trace is about 4 milliseconds.

In applications where a wide range of ramp slope is required, the potentiometer attenuators can be eliminated, and the input resistors on the inverter and integrator can be made variable. This increases inverter gain and allows control of both voltage and time constant of the integrator for adjusting the slopes. □

Direct-reading converter yields temperature

by James Williams and Thomas Durgavich
Massachusetts Institute of Technology, Cambridge, Mass.

It's possible to convert temperature accurately to a numerically equivalent frequency for direct display or for instrumentation. The circuit described here uses an 1N914 temperature-sensing diode to provide 0.1°C resolution from 0°C to 100°C, with accuracy of ±0.3°C over the entire range.

The 301A operational amplifier is set up as an integrator. The 150-picofarad capacitor from the inverting input to pin 1 provides feed-forward compensation for high slew rate. The 2N2646 unijunction transistor resets the integrator when the 4300-pF capacitor charges to about −10 volts. The 1N821 temperature-compensated diode provides a voltage reference that determines the firing point of the unijunction transistor, provides stable zero and full-scale references, and sends a 1-milliampere current through the 1N914 temperature-sensing diode. The 2N2222 transistor and its associated components provide an output pulse that is compatible with transistor-transistor logic.

In operation, the circuit functions as a voltage-to-frequency converter. The voltage at the wiper arm of the 1-kilohm potentiometer is integrated until the transistor's firing point is reached. When the transistor fires, it resets the capacitor. The frequency of oscillation is related to temperature because the diode voltage biases the integrator via the noninverting input. The only variable voltage available to the amplifier is the temperature-dependent (−2.2 millivolts per °C) potential from the 1N914 diode. To adjust the circuit, put the diode in a 100°C environment and turn the 10-kilohm potentiometer till the output frequency is 1,000 hertz. Then put the diode in a 0°C environment, and turn the 1-kilohm potentiometer for 0 Hz out. This procedure must be repeated two or three times, until the adjustments cease to interact. Once the circuit is adjusted, its output frequency is 10 times the sensed temperature within 0.3°C from 0° to 100°C. For example, if the temperature is 37.5°C, the meter will read 375 Hz.

The output frequency can be counted by TTL count-

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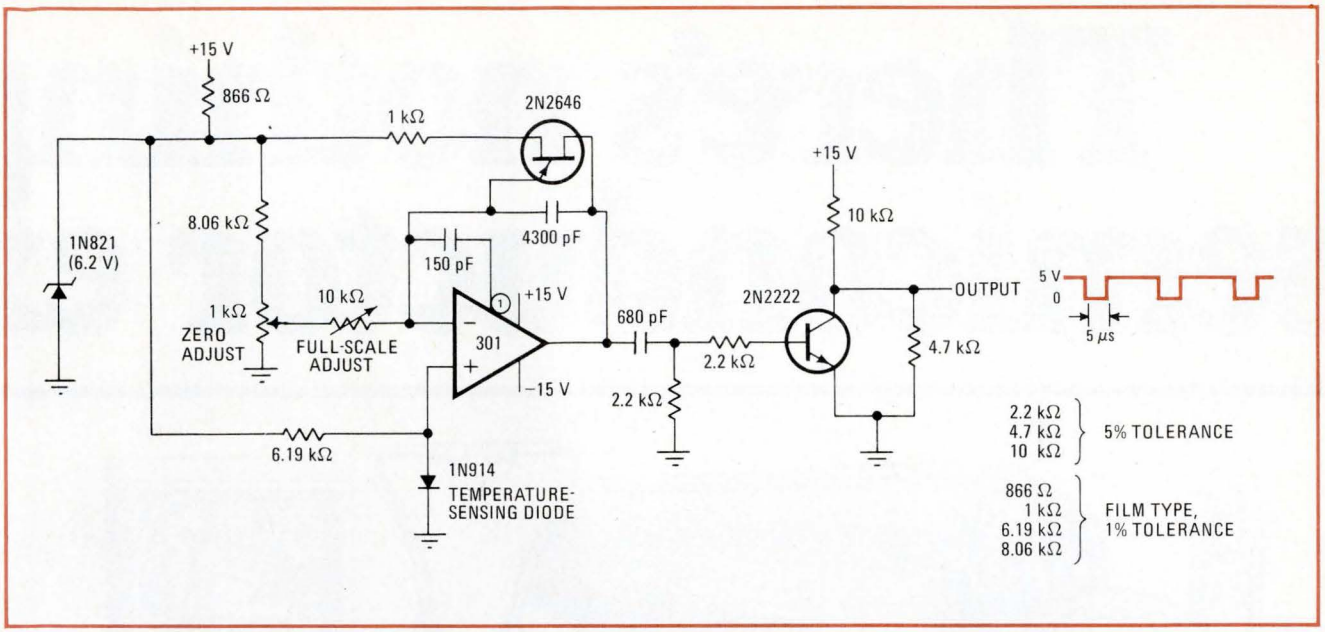

Temperature-to-frequency converter. Frequency of relaxation oscillator varies with temperature-dependent voltage across 1N914 diode. Over 0°C-to-100°C temperature range, frequency changes linearly from 0 to 1,000 Hz. Therefore frequency meter at output can show temperature directly. Accuracy is ±0.3°C. Excellent performance and low cost (less than $5 for parts) make this circuit outstanding.

ers and a 1-Hz square wave. The 1-Hz square wave can be fed to the base of the 2N2222 through a 2.2-kilohm resistor, and the resultant gated pulses at the output can then be fed to TTL counters. □

One NOR gate starts shift-register loop

by Jean-Pierre Dujardin
Ohio State University, Columbus, Ohio

A circulating shift register with a single logic 1 in the loop is required in cyclic-triggering operations such as sampling transducers in time-sharing telemetry. Systems for starting this type of circuit are often complex, but the arrangement shown here simply uses a NOR gate with the four-stage shift register.

As the waveforms show, the output terminals of the 4015A shift register go high in a continuing sequence from stage one through stage four and then back to stage one again. The 4002A three-input NOR gate starts this operation and keeps it going.

The input terminals of the NOR gate are connected to the first three output terminals of the shift register. When these terminals are at logic 0, the output terminal of the gate is at logic 1, which is brought to the data input terminal (D) of the register. The next clock pulse transfers the logic 1 at D into the first stage of the register. When at least one of the inputs to the gate is a logic 1, the output from the gate is a 0, which is presented to the register input. Thus, after a maximum of three clock pulses, a single 1 is circulating.

This circuit requires no external timing to introduce the single 1 into the loop and no resetting. If external noise introduces errors, they are automatically corrected. Extension of the system to more than four shift-register stages is straightforward: outputs from all but the last stage are fed into a NOR gate that, in turn, feeds the D input of the first stage in the register. □

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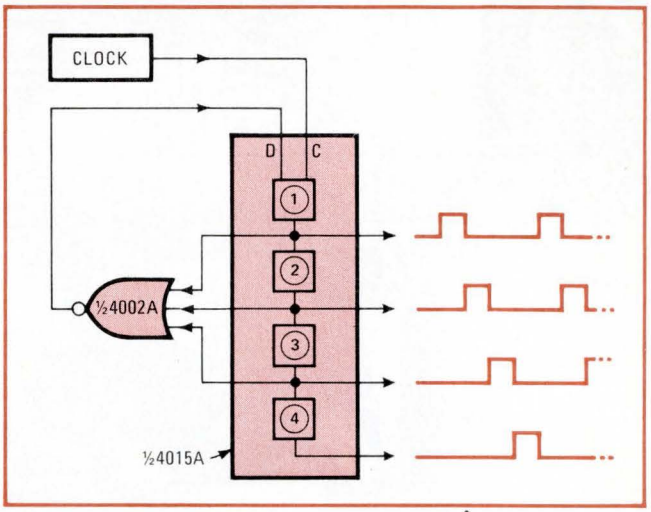
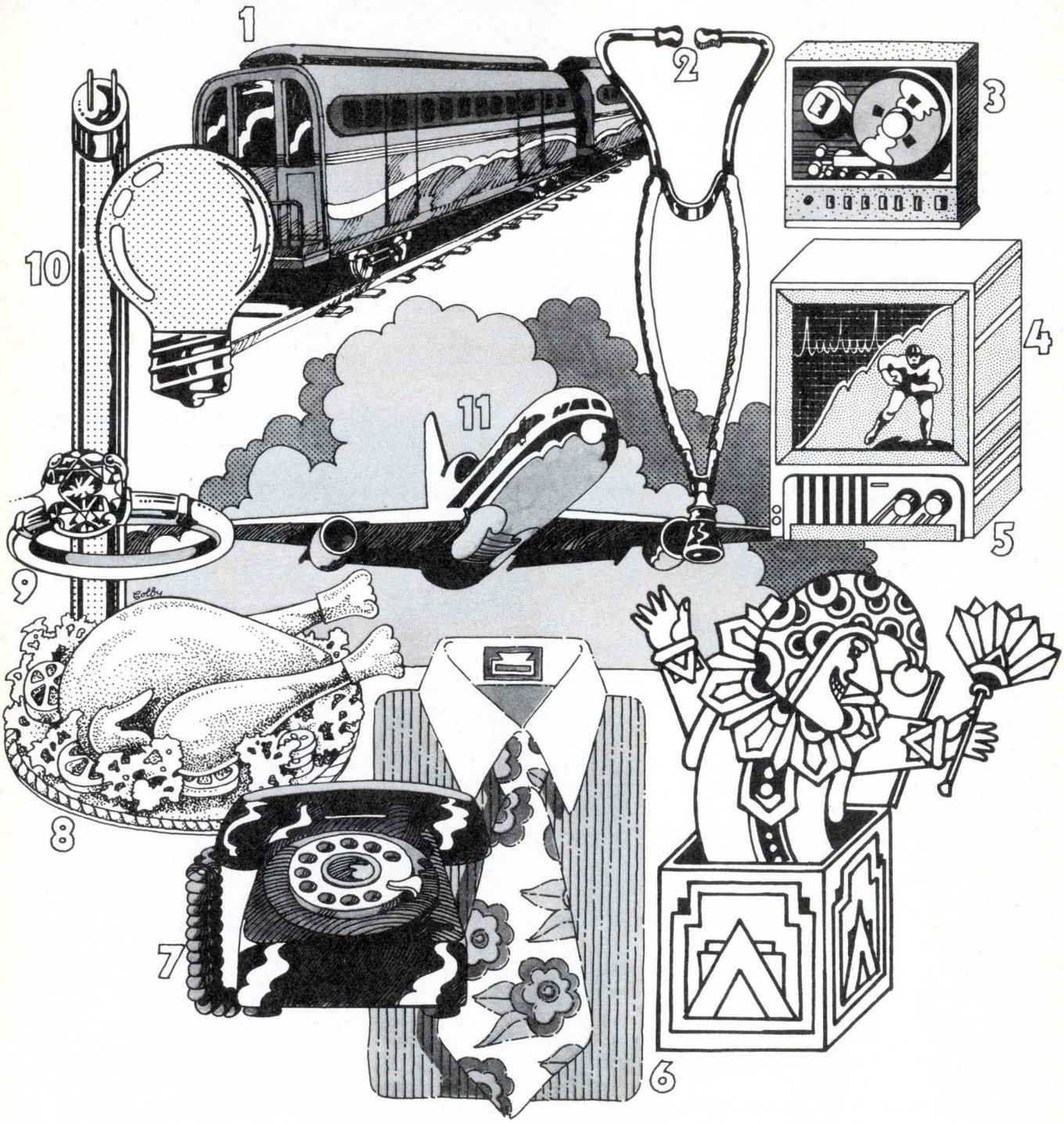


C-MOS ring circuit. Arrangement of NOR gate and four-stage shift register provides a pulse output that circulates to each of the output terminals in sequence, moving from one stage to the next as the clock cycles. The two C-MOS ICs determine performance level.

There's nothing semiconductor ex



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Engineer's notebook

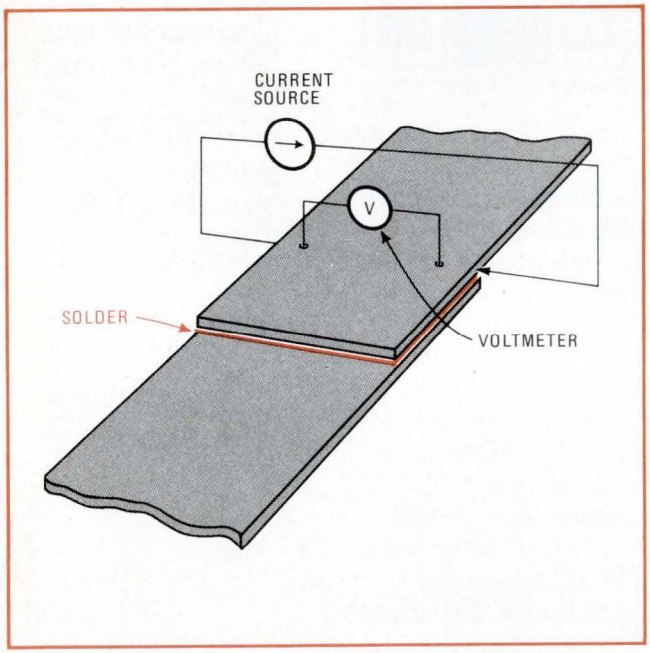
Four-point method tests solder joints

by J. R. Pivnichny and J. R. Skobern
IBM Corp., Endicott, N.Y.

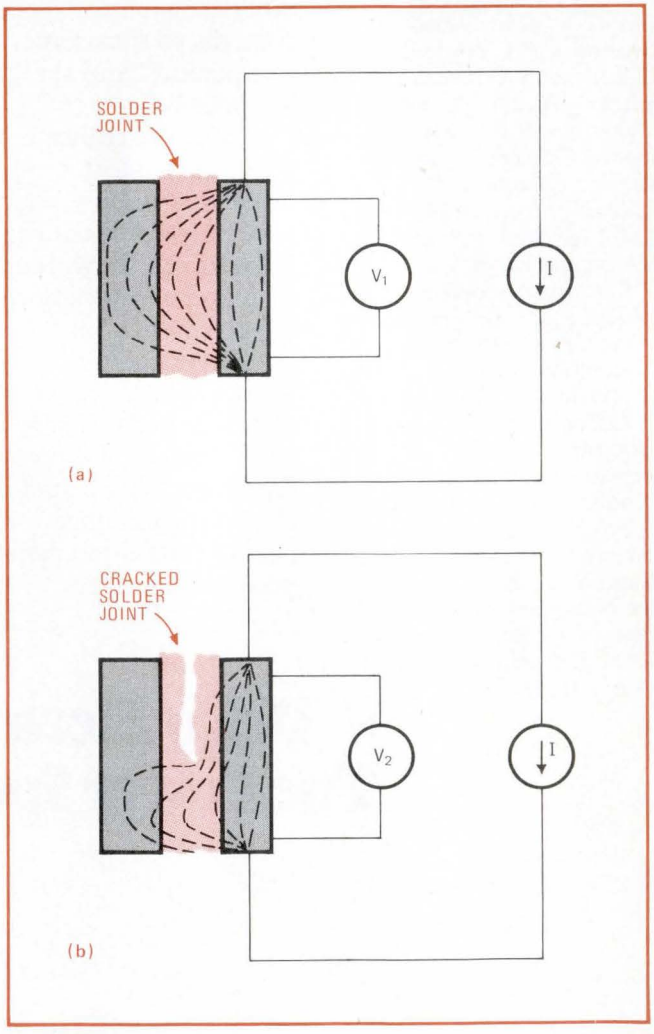
If a solder joint cracks it may cause expensive system failure. And it often will crack when mechanical forces exceed the design limits or when the soldering process is poorly controlled. In either case, electrical testing can detect a defective joint before it reaches the stage of system assembly. Figure 1 illustrates the use of such a test to check the overlap joint between a flat-wire bus and a connector strip.

The quality of the solder joint between overlapping metal strips can be monitored with a four-point (or four-probe) resistance-measurement technique (Fig. 2). The output and return leads of a constant-current

1. Test arrangement. Measurement tests joint between bus and connector. Soldered assembly, in jig, is shown close up in Fig. 4.



2. Solder joint. Four-point measurement monitors quality of connection between overlapped metal strips. Constant-current source drives current into and out of one strip; voltmeter measures drop between two points adjacent to current probes. Voltage indicates resistance to current spreading through solder to second strip.



3. Current flow. Section views through metal strips and solder joint show how quality of joint affects current spreading. (Scale of drawings is distorted, magnifying thickness of solder layer for clarity.) Good connection allows conduction through both metal strips, presenting low resistance to current flow and producing low voltage drop. Cracked joint restricts current flow and produces voltage drop that is typically three times as great as for good joint.

source are attached to one strip near the solder joint. The path for current flow includes the conductors on both sides of the joint and the solder interface between them. Voltage drop is measured between two points close to the current probes. This, divided by the known constant current, indicates the resistance between the two points.

A good solder joint allows current to flow through the solder and into the second metal strip (Fig. 3a). This spreading of the current produces a low resistance between the voltage-monitoring points. A cracked joint, however, interrupts the current path to the adjacent conductor (Fig. 3b). The constricted current path increases current density and hence the apparent resistance at the monitoring points.

A typical test arrangement uses a current of 100 milliamperes. The resistance values for good joints lie within 10% or 15% of an experimental average value, but a defective solder joint has a resistance that stands out as a 300% increase over the average level. Therefore, limits for go/no-go testing are readily established. Photographs of a working test arrangement are shown in Figs. 1 and 4. □

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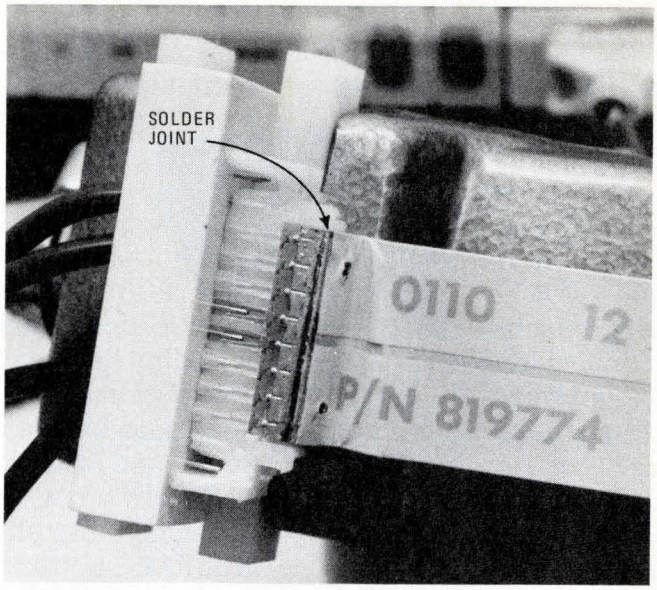


4. Application. This flat-wire bus has been soldered to a beryllium-copper connector strip that has eight terminal points. The connector strip will be used to join the bus to a pc board, but first the quality of the solder joint is checked by using four of the terminal points as measurement probes. Current source is connected to the two outermost points; digital voltmeter is attached to the next two in.

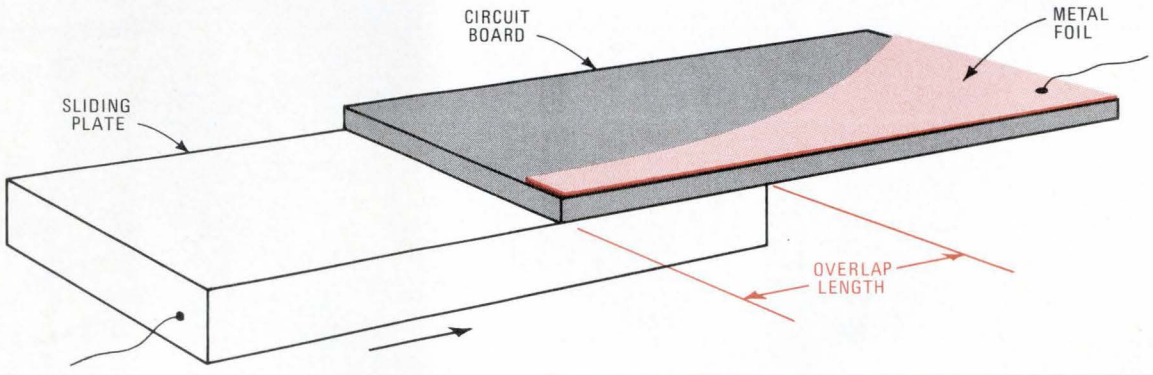
Pc board forms custom variable capacitor

by Robert L. Taylor
I & F Electronics, Nashville, Tenn.

A variable-frequency circuit can exhibit linear mechanical tuning if a specially shaped capacitor is used. Such a capacitor can be used for rf transmitters and rf receivers that have linear slide dials, for position transducers that have direct read-out on a frequency counter, and for many other applications.

One of the simplest capacitor configurations is a metal plate sliding under a printed-circuit board that has been etched to give the desired variation of capacitance (C) with overlap distance (x), as shown in Fig. 1. The capacitance depends upon the dielectric constant and thickness of the board and upon the area of unetched foil that overlaps the plate:

$$C = k\varepsilon_o A/d$$



1. Variable capacitor. Circuit-board foil and metal plate constitute capacitor that can be varied by changing overlap length. Shape of foil determines relationship of capacitance to overlap. For 1/16-inch paper-base phenolic board, C is about 20 pF/in.² of overlap.

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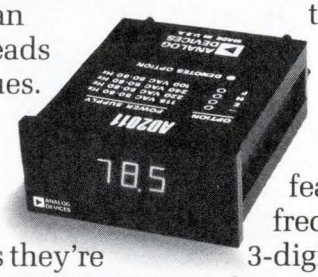

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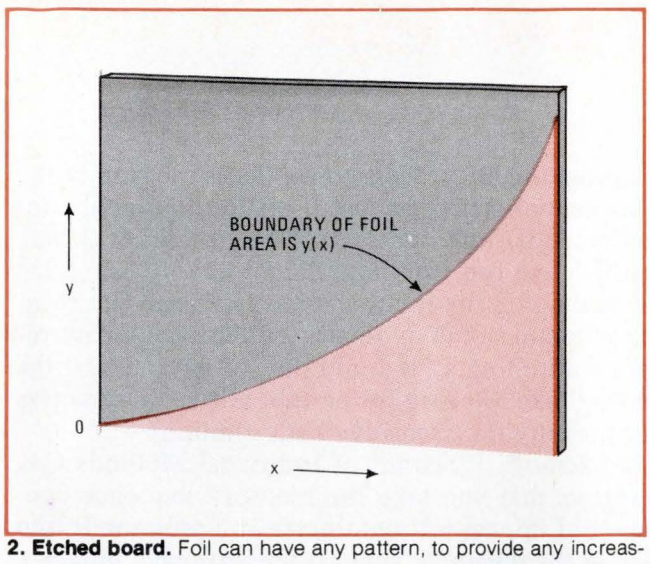


2. Etched board. Foil can have any pattern, to provide any increasing function of capacitance with overlap distance (x). For convenience in analysis, foil shown here covers area from y = 0 to y = y(x). Therefore overlap area is integral of y(x).

where k is the dielectric constant, ϵ_0 is 8.85×10^{-12}, A is the overlap area, and d is the board thickness (all quantities expressed in MKS units). For a typical 1/16-inch paper-base phenolic board, C is about 20 picofarads per square inch.

The overlap area, A, is a function of the shape of the foil pattern on the board (Fig. 2)

$$A = \int y(x)\, dx$$

and therefore the capacitance is related to the pattern by

$$C(x) = (k\epsilon_0/d) \int_0^x y(\xi)\, d\xi$$

If the foil area is to be shaped so that the resonant frequency of an LC tank circuit changes linearly with the overlap length, as represented graphically in Fig. 3, then

$$f = \tfrac{1}{2}\pi(LC)^{1/2} = -mx + b = -(f_{max} - f_{min})x/s + f_{max}$$

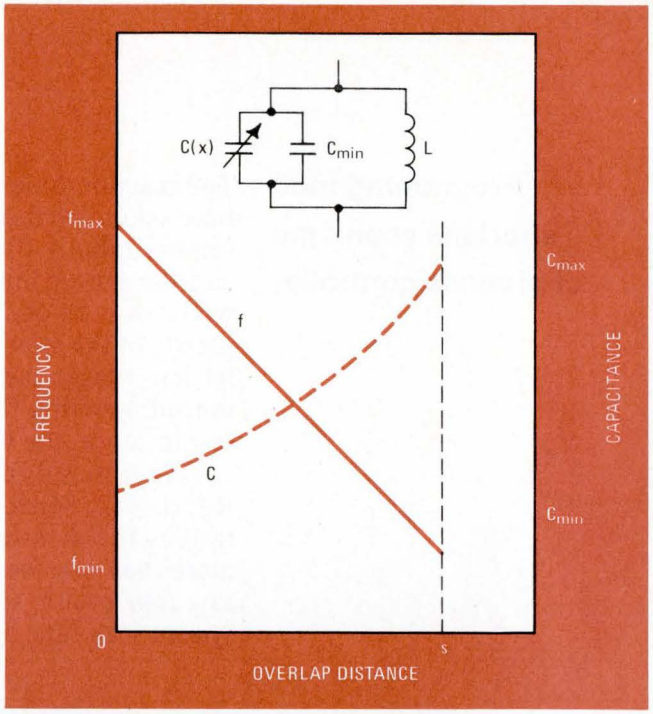
or

$$C = M/(H - x/s)^2$$

where

s = the maximum overlap length, corresponding to resonant frequency f_{min} in Fig. 3
L = the inductance in the tank circuit,
$H = 1/(1 - f_{min}/f_{max})$
$M = 1/[4\pi^2 L(f_{max} - f_{min})^2]$

To obtain the oscillation frequency f_{max} when the overlap is zero, a fixed capacitor must be placed in parallel with the variable one. The value of this capacitance is M/H^2, and therefore the variable capacitance must be reduced by this amount. That is,



3. Linear tuning. To make resonant frequency of LC tank circuit change linearly with overlap, foil needs shape defined in text.

$$C(x) = M/(H - x/s)^2 - M/H^2$$

The foil shape that produces this capacitance relation is found from

$$C(x) = (k\epsilon_0/d) \int_0^x y(\xi)\, d\xi$$

or

$$y(x) = (d/k\epsilon_0)\, C'(x)$$

where C'(x) is the derivative of C with respect to x. Thus the desired foil pattern is

$$y(x) = 2Md/k\epsilon_0 s(H - x/s)^3$$

As an example, suppose the resonant frequency of a 1-microhenry tank circuit is to vary linearly from 40 to 20 MHz when the overlap changes from zero to 5 inches. In this case

f_{max} = 40 MHz
f_{min} = 20 MHz
L = 10^{-6} H
s = 5 in.

These values yield

M = 63 pF
H = 2
$C(x) = 63/(2 - x/5)^2 - 15.8$ pF
$y(x) = 1.3/(2 - x/5)^3$ in.

where x is expressed in inches, and 1/16-in. paper-base phenolic circuit board is used.

Other foil shapes can be devised to provide other capacitance-variation relationships. The function y(x) is found from the derivative of C(x). Properly constructed, these capacitors have excellent mechanical stability and fair temperature stability. □

Engineer's newsletter

Programing trick shortens scan time of process controller

The reaction time of a programable process controller is the sum of the time taken by three sequential steps: the input analog-to-digital conversion (about 10 milliseconds), the output conversion (about 3 ms), and the sensor time, which can run from about 2.5 to 25 ms per 1,024 words of memory, depending on the number of sensors and the complexity of the scanning program stored in memory. Clearly, if a controller has a large memory controlling a large number of parameters, **the over-all reaction time may take too long for certain critical parameters** (for instance, the valve pressure for a sensitive bath solution).

To get round this problem, E. J. Schnur of Industrial Methods Co., Royal Oak, Mich., suggests that you take the memory sequence controlling the measurement of this critical parameter and **program it into more than one location in the memory.** Then, if the sequence inhabits, say, four evenly spaced locations, it will be executed at four times the system scan rate. The only penalty is that you use up some memory.

ASTM wants help with measurements

The ASTM Committee F-1 on Electronics is looking for experts to help in making measurements in three technologies: characterization of silicon-on-sapphire; adhesion of thick and thin films; and characterization of semiconductor processing chemicals. The committee, which meets three times a year, was established by the American Society for Testing and Materials to **unite producers and users in setting standards** on test methods, specifications, classifications, and nomenclature for semiconductor and other electronic devices. Next meeting is set for June 10 and 11 at the National Bureau of Standards in Gaithersburg, Md. Those interested should contact Harry A. Schafft of the NBS, Washington, D.C. 20234; his number is (301) 921-3625.

Circular slide rule solves trig problems

If you're not quite ready to part with $100 for a scientific calculator but still need something to help with vector calculations, conversions between polar and Cartesian coordinates, complex-number manipulations and other trigonometric problems, you can always invest $8.95 in a handy little circular slide rule from Hunter Associates. Specially designed for trig problems, the model F 27 **makes a snap out of such things as sin(arc tan x).** Write to Hunter Associates, 792 Partridge Dr., Somerville, N.J. 08876.

Suppliers to attend microprocessor congress

Want to give some of your key personnel a single-shot but intensive exposure to microprocessors? Then consider the week-long microprocessor congress being held in Washington, May 5–10, by Integrated Computer Systems Inc., 4445 Overland Ave., Culver City, Calif. (213) 559-9265. What makes the project different from the others is that just about **all suppliers of processor chip sets will be around in the early evening** to give separate seminars on their equipment and hold in-booth hardware demonstrations.

The syllabus lists a series of overlapping two-day courses on device architecture, applications, systems, and software development, plus a single-day manager-level overview course. The congress will be repeated in Brussels, Belgium, June 2-7. **—Laurence Altman**

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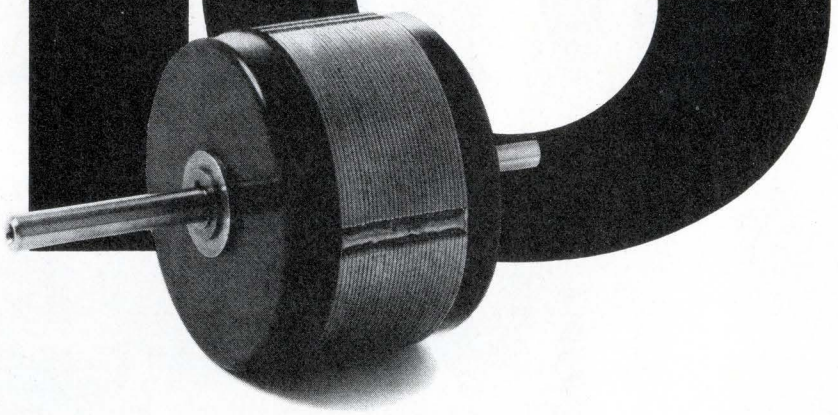

Yet our new Econo-Line Stepper Motor is big enough for tough EDP jobs, and versatile enough to use wherever you might need it.

This is one time when 13 has to be considered a *lucky* number. Our new stepper motor costs only $13 each in 10,000 quantities. (We've equally remarkable prices for lesser quantities.)

And not only is the price tag on Kearfott's Econo-Line outstanding, but so is what's inside the motor.

This stepper motor takes the tough jobs in stride—for example, in printers, card punches, tape readers, paper drives. Plus any other application calling for a size 19 motor producing stepping torque up to 6 inch ounces at stepping rates of 200 pulses per second.

Its many attractive features include:

- ☐ Number of phases ____ 4
- ☐ Stepping angle ____ 15°
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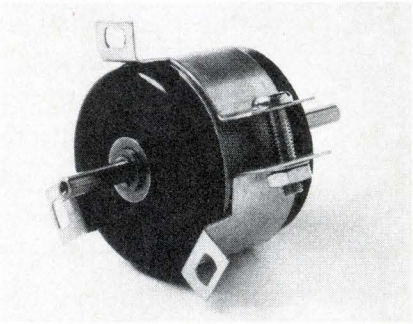
- ☐ Winding resistance ____ 5.8 ohms/phase

The Econo-Line also fits in a smaller space than that variable motor drive you may be paying more for right now. And, in keeping with its thrifty price, it is easily mounted in your product with a standard 27¢ capacitor clamp.

In these inflationary times, it takes more than good luck to get a good product from a good source at a good price. So, why not get all the details?

Write The Singer Company, Kearfott Division, 1150 McBride Avenue, Little Falls, New Jersey 07424.



SINGER
AEROSPACE & MARINE SYSTEMS

Microprocessor runs signal generator

Local or remote programing of frequency and output level in Fluke synthesized signal source are controlled by Intel 4004

by Bernard Cole, San Francisco bureau manager

One of the most tedious jobs—and therefore most subject to error—in connection with the use of signal generators is that of programing the precise frequencies for testing and then controlling their sequence. John Fluke Manufacturing Co. of Seattle, Wash., has combined a general-purpose signal generator with the small but powerful Intel 4004 microprocessor to do these crucial programing and controlling functions automatically [*Electronics*, March 20, pp. 104-105].

Designated the model 6010A synthesized signal generator, the unit has a keyboard control that allows free-form entry of frequencies in hertz, kilohertz, and megahertz. The instrument covers the range from 10 hertz to 11 MHz. Programed frequencies are read on a seven-digit light-emitting-diode display.

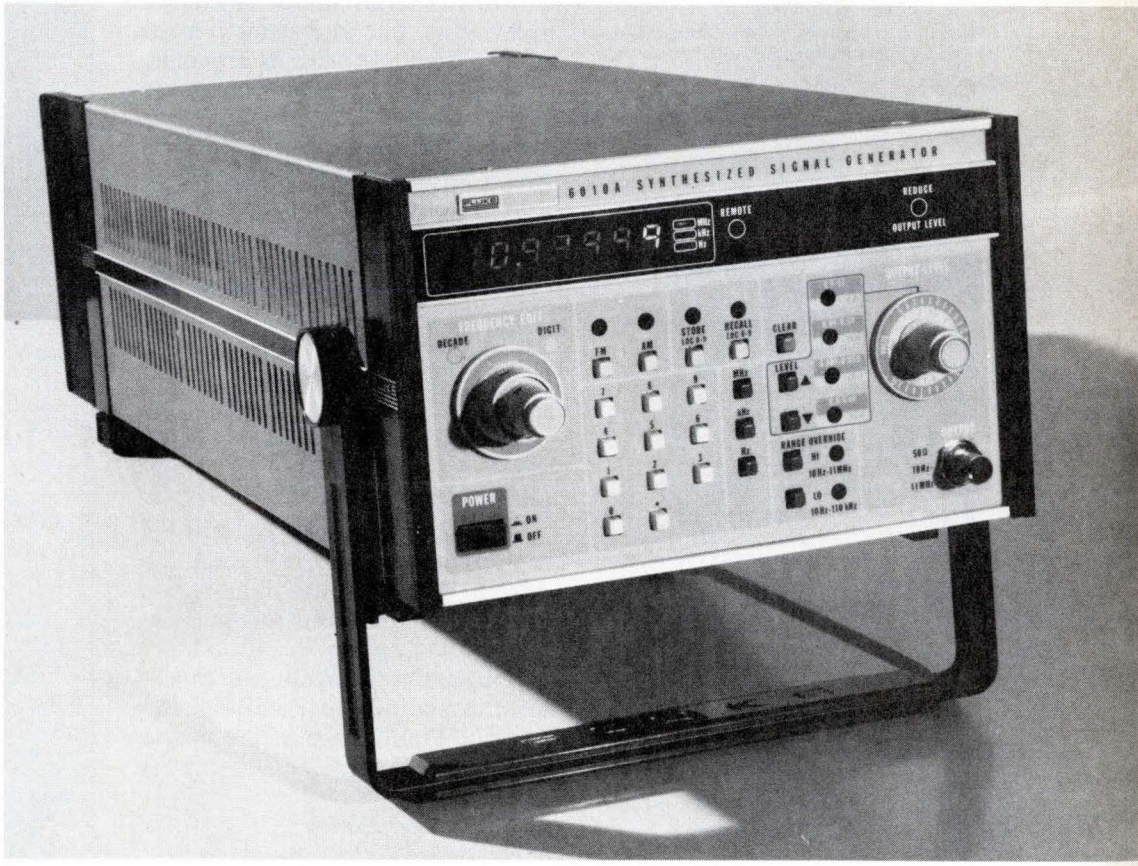
A key feature of the 6010A, reports John Kistner, product manager, is that the entire output of the instrument is programable, both locally and remotely. As many as 10 preset frequencies, modulation settings, and amplitude levels can be stored and recalled through the keyboard. And since the microprocessor handles the interfacing problems, the 6010A can fit easily into any automated testing system. The unit will "handshake" directly with most ASCII and IEC bus systems.

The 6010A, says Kistner, offers two remote programing formats—fixed form and free form. In the fixed-form mode, the decimal point is determined by the range selected. The free-form mode provides freedom of data-entry equal to that of the front-panel keyboard and edit controls.

"Whenever an entry is made," says Kistner, "the microprocessor automatically justifies the number in the LED readout and selects the range to give the greatest possible resolution." As a sophisticated bench oscillator, he says, the 6010A is very easy to use.

"For example, frequency selection or tuning is enhanced by a large dual-concentric rotary knob," says Kistner. "The outer ring is used to select a decade, and the inner knob selects the digit. The decade being tuned is clearly indicated by a

Under control. Synthesized signal generator from Fluke is controlled by a microprocessor, which also handles the task of interfacing the instrument to an automatic test system.



New products

brighter digit in the LED display. In addition, the bright decade can be incremented or decremented by the 'digit' knob with complete wrap-around or carry-over."

Automatic. The instrument also provides additional protection to the device under test. Although the 6010A has three ranges of added attenuation—20, 40, and 60 dB—the instrument always starts out automatically with the maximum value. "As a production-line instrument, the 6010A—because of microprocessor control—has a real advantage," says Kistner. "Repetitive measurements can be made with less chance for error, since the seven-digit frequency ranges can be recalled by just the press of a button."

Frequency range of the 6010A is from 10 Hz to 109.9999 kHz in the low mode and 10 Hz to 10.9999 MHz in the high mode, with resolution of 0.1 Hz and 10 Hz, respectively. Amplitude range is from 0.25 millivolts rms to 5 V rms (0.5 W) into 50 ohms. Frequency response is ±0.5 dB from 10 Hz to 11 MHz. Output impedance is 50 ohms. The attenuator consists of 20- and 40-dB sections providing 0 to 60 dB of attenuation in 20-dB steps. Control is provided by a rotary knob that adjusts amplitude over a 26-dB range or a keyboard selects one of four attenuator settings.

Remote level-control is provided by two lines (TTL positive true) by which it is possible to select 20- and 40-dB attenuator sections. An external analog voltage (BNC connector or rear apron) will program output from 0.25 to 5 volt rms. Analog remote control, says Kistner, can be used to provide a measure of amplitude modulation.

Measuring only 5.25 by 17 by 8.5 inches and weighing only 20 pounds, the 6010A has an fm option in addition to its standard a-m capability. Other options include a high-performance temperature-compensated crystal oscillator and a phase-lockable input. Price of the microprocessor-controlled 6010A is $2,495.

John Fluke Manufacturing Co. Inc., P.O. Box 7428, Seattle, Wash. 98133 [338]

Power modules for the thrifty

Dc-dc converters provide high efficiency at no-frills price; power supplies for medical applications have UL approval

by Lucinda Mattera, Components Editor

In today's markets, no one is willing to buy more performance and features than he needs. Semiconductor Circuits Inc. of Haverhill, Mass., is responding to this cost-conscious attitude with two new families of modular power-supply products. One family is a line of single-output dc-dc converters that provide efficiencies as high as 90%, can tolerate input variations as great as 2:1, and cost as little as $30.95 in single-unit quantities. The other family is a series of line-operated dc supplies for medical instrumentation that meet the Underwriters Laboratories' "Standard for Safety: Medical and Dental Equipment," No. 544, yet are priced as low as $26.95 in small quantities.

Three series make up the dc-dc converter family. All the modules, because of their high efficiency and effective thermal management, generate only a 12°C rise in case temperature. They do not require any power derating over their full operating temperature range of -25°C to +71°C. Additionally, the output of each unit is protected against short circuits, without any time limit.

The SW series includes models that accept an input of 9 to 16 volts and produce an output of 5 V at 1, 1.5, 2, or 3 amperes. Other series SW models convert an input of 18 to 32 V to a 12-V output, or an input of 19 to 32 V to a 15-V output at 1 or 2 A. Line and load regulation can range from 0.2% to 0.5%, and efficiency is between 65% and 80%. For quantities of one to nine, price is $30.95 to $64.95, depending on the model selected.

Some units in the DR series work from an input of 9 to 18 V and are available with an output of 12 V at 1 A, 15 V at 800 milliamperes, 24 V at 500 mA, or 200 or 250 V at 30 mA. Other models in this series handle inputs of 18 to 36 V, producing outputs of 24 V at 500 mA, or 200 or 250 V at 30 mA. The line and load regulation of the DR series is 2%, and efficiency ranges from 70% to 90%. In single-unit quantities, the units cost from $44.95 to $59.95.

The series DC devices provide an input-to-output isolation of 300 V dc and operate from an input of 35 to 70 V. Outputs can be 5 V at 1, 1.5, 2, or 3 A; 12 V at 1 A; 15 V at 800 mA; 24 V at 500 mA; or 200 or 250 V at 30 mA. For one to nine units, price ranges from $45.95 to $74.95.

All three series of dc-dc converters are available from stock to within three weeks.

There are two UL series of dc power supplies—one (suffix W versions) complies with UL requirements for patient-contact applications and the other (suffix R versions) is for hazardous-location applications. Because of their UL acceptance, these devices are particularly attractive for use in clinical and medical instrumentation requiring Class A or B approval by UL.

To meet the patient-contact stan-

For medical equipment. Modular power supplies for medical electronics meet requirements of Underwriters Laboratories for patient contact and use in hazardous locations.

dard, power-line leakage must not exceed 10 microamperes. For the hazardous-location rating, maximum leakage current must be less than 100 μA.

Another patient-contact requirement is thermal overload protection—the component's temperature, under overload conditions, cannot exceed the limit set by UL. In the suffix W models, the temperature of the power transformer is continuously monitored by active internal circuitry. If the UL temperature limit is surpassed, the transformer is shut down. These models also include a grounded copper shield between the primary and secondary windings of the power transformer. This shield, which is necessary for UL approval, prevents a short between the windings, reduces primary-to-secondary capacitance, and increases transformer impedance to leakage current.

All the UL series units can operate from an input of 105 to 125 V ac at 50 to 440 hertz. Minimum input-to-output isolation is 2,500 V ac, and output ripple and noise is held to 1 millivolt root-mean-square. Typical output voltage temperature coefficient is 0.02%/°C, while operating temperature range is −25°C to +71°C, with no power derating. Output voltage can be ±12 or ±15 V dc at current levels of ±25, ±50, ±60, ±100, or ±200 mA. Line regulation ranges from 0.01% to 0.2%, while load regulation can be from 0.05% to 0.2%.

Price depends on the model selected. For example, a suffix R unit having an output of ±15 V dc at 25 mA with line and load regulation of 0.2% costs $26.95 in quantities of one to nine. At the other extreme, a top-of-the-line supply—like a suffix W unit with a ±12-V ±200-mA output, line regulation of 0.01%, and load regulation of 0.05%—is priced at $73.95 each for one to nine. Delivery time for small quantities of the UL series is two to four weeks.

Semiconductor Circuits, Inc., 306 River St., Haverhill, Mass. 01830 (For further information about the dc-to-dc converters, circle 339 on the reader service card; about the supplies for medical instrumentation, 340.)

Densest erasable ROM has 8-k bits

Intel 'EPROM' is organized in byte-sized widths for widest application in microprocessor-based systems; 4-k version is also introduced

by Bernard Cole, San Francisco bureau manager

Many program controls for today's microprocessor-based systems require 8-bit-wide read-only memories to handle the microprograming chores. That's why Intel's 8,192-bit programable ROM, the densest electrically alterable PROM available today, is organized as 1,024 words by 8 bits.

Using the floating-gate avalanche MOS technology that Intel calls Famos, the new model 2708 can store twice as much data as previously available PROMs and can operate at about twice the speed. It dissipates one third as much power per bit and can be reprogramed five times faster. Joining National Semiconductor Corp., Intel is also introducing a 4-kilobit unit. Designated the 2704, it is organized as 512 words by 8 bits.

According to Don Bryson, PROM marketing manager, the two new devices make Intel the first supplier of a complete family of 2,048-, 4,096-, and 8,192-bit PROMs and interchangeable metal-mask ROMs. Both new devices are guaranteed to operate at worst-case access times of 500 nanoseconds from 0 to -10°C. In contrast, says Bryson, the standard 1702A 2-k PROM has a worst-case access time of 1 microsecond. Both new units also feature very low power dissipation, typically 97 microwatts per bit.

Reprograming is done with a single high-voltage pulse per bit while the erasable PROM operates at its standard supply levels of +5, -5 and +12 volts. This advance, says Bryson, is made possible by a new write-control circuit design and makes the 2708/2704 design extremely fast and easy to program. The typical programing time, he says, is about 12 milliseconds per bit and allows the 8-k PROM to be programed in 90–100 seconds and the 4-k in under 40–50 s. By contrast, the 1702A requires about 120 seconds for 2,048 bits. Moreover, says Bryson, both the 4-k and 8-k PROMs remain TTL-compatible during programing. Inputs and data outputs require normal logic levels while 25-V programing pulses are applied to a single program-pulse input pin. The programing pulses cause the erasable PROMs to store data bits as charges in storage cells.

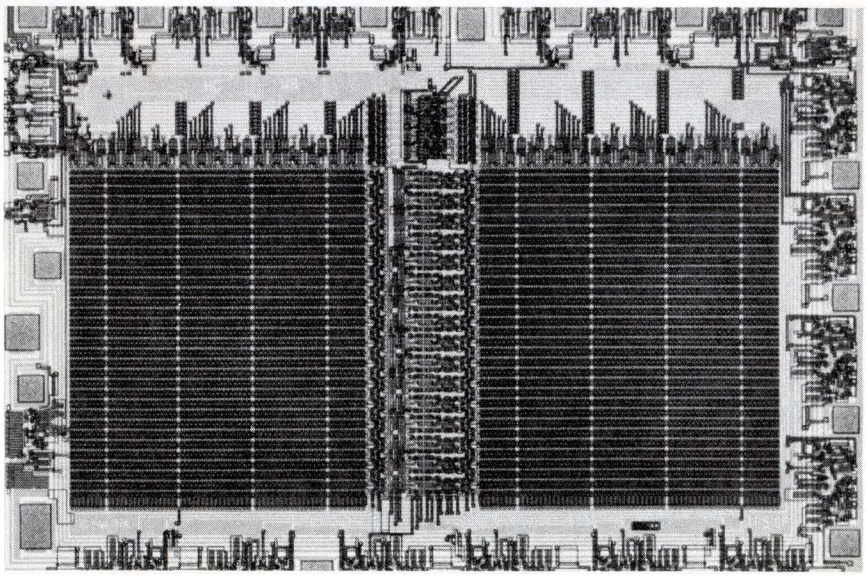
To make the PROM erasable, the package has a transparent lid. This allows the user to expose the chip to a high-density shortwave ultraviolet lamp, which will erase the data in 10 to 20 minutes.

The 2708 and 2704 are supplied in the same pin package as the 1702A. Like the 1702A, they are fully decoded, static designs that operate without clocks. They are DTL/TTL compatible, have chip-select control, operate on standard +5-, -5-, and +12-V supplies and have three-state, OR-tied data outputs to facilitate expansion.

The company's interchangeable metal-mask ROMs are the 1302 and 2308. Also available, says Bryson, is the 2316, a 16-k (2,048 words by 8 bits) metal mask-programable ROM for systems where the highest density replacement is needed, the company says.

Price of the 8-k model 2708 is $65.50 each for 100 to 999; and of the 4-k 2704, $39.40. Delivery is from stock.

Intel Corp., 3065 Bowers Ave., Santa Clara, Calif. 95051 [342]



MOS memories

TI's new 3rd generation 4K RAMs.

200ns speeds in 18-pin packages. And availability is now!

Texas Instruments brings you third generation 4K MOS RAMs: TMS4050-2 (200ns), TMS4050-1 (250ns) and TMS4050 (300ns). These compact 18-pin 4K RAMs offer even better board packing density than their 22-pin counterparts, as much as 70 to 100%.

Volume availability is now. The TMS4050s are in full production. They utilize the same single-transistor cell design and reliable N-channel silicon gate process as TI's popular TMS4030 4K RAM. This helps insure on-time delivery.

The TMS4050s have been made easy to use. All inputs, except clock, are compatible with Series 74 TTL, while power dissipation is kept low (420 mW operating, 0.1 mW standby, typically). A full 12-line address and single hi-level clock minimize system timing headaches. Plus, data input and output are multiplexed to provide a simple memory bus interface.

	ACCESS TIME MAX	100-999 PRICE
TMS4050NL	300ns	$19.64
TMS4050-1NL	250ns	$21.64
TMS4050-2NL	200ns	$24.62
TMS4050JL	300ns	$22.78
TMS4050-1JL	250ns	$25.07
TMS4050-2JL	200ns	$28.56

Compare prices (see insert). You can see that TI's TMS4050s offer the best performance at the lowest price. And why shouldn't they? TI has more experience in building 4K RAMs. Plus, volume production experience means lower cost-to-you – and higher PC board density.

The TMS4050-2, TMS4050-1, and TMS4050 are available through TI's authorized distributors in 18-pin plastic (NL) or ceramic (JL) packages. For data sheet, write Texas Instruments at P.O. Box 5012, M/S 308, Dallas, Texas 75222.

TEXAS INSTRUMENTS
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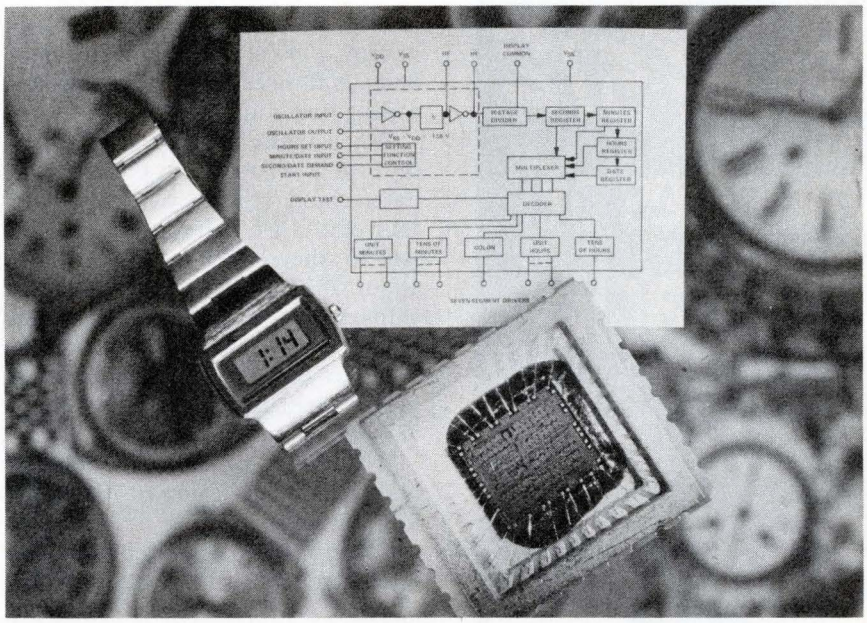
Semiconductors

C-MOS chip drives display

Liquid-crystal readout for clocks, watches needs no interface circuitry



No interface circuitry is needed with a complementary-MOS watch/clock chip from Motorola Semiconductor that directly drives a liquid-crystal display. The chip includes an oscillator for an external crystal, which also generates the 3.8 volts required by part of the chip and the display. The chip itself requires only one 1.58-V battery and draws under 10 microamperes.

The chip is available in three forms, a conventional 40-pin dual in-line package for industrial clocks, a bare chip for hybrids, and a new, 36-terminal leadless package measuring only 0.37 by 0.41 inch. This ceramic package is ideal for watch applications, where it can be reflow-soldered into place, but Motorola expects considerable interest in the chips for instrumentation applications as well.

The type MC14440 provides hours and minutes constantly, with seconds and date of the month displayed on call. The colon separating the hour and minute flashes at a 0.5-hertz rate. Switch inputs are provided for setting the time at a 1-Hz rate.

The oscillator section of the circuit uses a 32-kilohertz crystal: a trimmer capacitor, another small capacitor and resistor are also needed. This circuit operates from 1.5 V and generates both the time base and ac drive for the voltage-multiplier used for the rest of the circuit and for the liquid-crystal display.

On the chip, in addition to the oscillator and setting-function control, are 15 dividers, registers for the displays, a multiplexer and decoder, plus latches for the digits. Output high-voltage to the display segments with a 1.58-V battery is 3.6 V minimum. The oscillator operates with a minimum voltage of 1.5 V.

The MC14440L (in DIP) and the MC14440Z (leadless package) are priced at $18 each in 100-lots. Motorola will shortly announce liquid-crystal displays, MLC500 and MLC501, compatible with the chip.

The company is also announcing a C-MOS circuit for driving analog, stepping-motor watch displays. The MC1445O, which uses a similar 1.58-V battery, consists of a crystal oscillator usable to 1 megahertz, plus a 16-stage divider that has an output of 0.5 Hz with a 32-kilohertz crystal. Current drain is only 2.6 μA typically at 1.5 V, and output is a 1.6% duty-cycle pulse of 1.5 V at 200 μA minimum. The part is available in chip form, and in small ceramic and plastic six-lead flat packs. The plastic version, MC1445OP, is priced at less than $5 each in quantities of 100.

Motorola Semiconductor Products Inc., P.O. Box 20912, Phoenix, Ariz. 85036 [411]

Microprocessor peripheral chips reduce board count

Applying the LSI technology it has used to develop its PACE and IMP microprocessors, National Semiconductor Corp. has developed a family of peripheral chips that will reduce board counts in various configurations by 60 to 75%.

Specifically, 10 chips are being introduced to handle four kinds of functions in the PACE or IMP configurations and in 8- or 16-bit systems. These are address latch elements, bus transceiver elements, system timing elements, interface latch elements, and the flag latch and jump condition multiplexer.

In an 8-bit IMP or PACE system, says Bernard Kute, National's microprocessor applications manager, one address latch element replaces two quad tri-state latches. In a 16-bit system, it replaces four. One bus transceiver element replaces two quad tri-state transceivers and a decode gate for the CROM-2. In a 16-bit system this element replaces four quad tri-state transceivers and the decode gate.

One system timing element, which generates the four-phase MOS clocks and all system timing strobes, replaces nine chips—one oscillator, one shift register, five decoding gates and two clock drivers—as well as assorted line terminators.

An interface latch element of 8 bits replaces two quad bidirectional tri-state latches. The new multiplexer chip, which is used only in the IMP, replaces two address

latches, a 16-bit tri-state multiplexer, a 4-bit latch, one flip-flop latch, and three gates for various decoding functions.

When these elements are used in the PACE system, says Kute, the parts count is reduced from 13 to four chips, a 60% reduction. In the IMP-16, the reduction is 19 to five, about 75%. In the IMP-8, only six chips do the job of 20. An additional benefit, says Kute, is that, when applied to the IMP-4, the chip count drops, from eight to two chips, a 75% reduction.

In 100-lots, prices of the peripheral chips range from $10.70 each to $21.40 each.

Some of the chips can be used interchangeably in the PACE and IMP systems; others are designed for one of the microprocessors.

National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, Calif. 95051 [412]

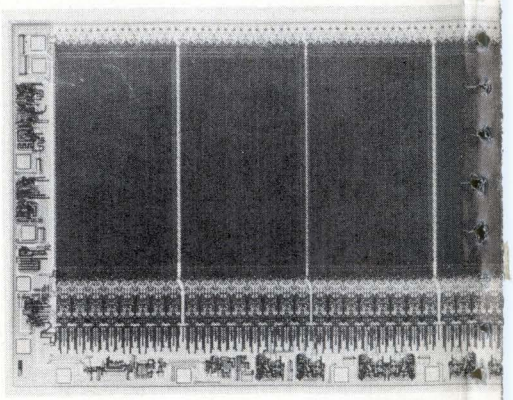
Reference diodes are temperature-compensated

A family of ultra-low-current temperature-compensated reference diodes has temperature coefficients as low as 5 ppm/°C over the operating temperature range from −55 to +100°C. The low-noise multi-current units, which can operate at currents as low as 100 microamperes, suffer only very small changes in temperature coefficient with operating-current shifts as large as 50%. The diodes are hermetically sealed in DO7 glass packages, and have maximum power dissipation ratings of 400 milliwatts. Units with maximum long-term drifts as low as 10 ppm/year can be supplied.

CODI Corp., Pollitt Dr., Fair Lawn, N. J. 07410 [414]

Intel offers 16-kilobit CCD memory

The day of the semiconductor bulk memory has dawned. Now that Intel has introduced the first 16-kilobit



charge-coupled-device memory, manufacturers of digital equipment can begin the changeover from magnetic-drum and fixed-head-disk memories to semiconductor peripherals.

The model 2416 CCD serial memory is a monolithic device housed in a standard 18-pin dual in-line package. The chip is an array of 64 shift registers, each of which is 256 bits long; input/output control logic similar to that of a random-access memory completes the circuit. This configuration gives the device its high storage capacity while maintaining the speed associated with smaller serial memories—maximum access time is less than 200 microseconds. Both read and write data rates are in excess of 64 megabits per second.

The n-channel silicon-gate device is available from stock at distributors in two package versions: an 18-pin plastic DIP and a 22-pin ceramic DIP. The 18-pin unit sells for $55.50 in hundreds, while the 22-pin device is priced at $58 in the same quantities.

Intel Corp., 3065 Bowers Ave., Santa Clara, Calif. 95051 [413]

TV sound system fits on one chip

A single, monolithic integrated circuit—the Sprague ULN-2211P—performs the entire sound function, including power-output stage, of television receivers. Capable of delivering 2 watts into an 8- or 16-ohm speaker, the IC operates from a

Gates introduces the future in energy cells.

There's now a new energy source that's a superb alternative: Rechargeable, sealed lead-acid batteries from Gates.

We call these batteries the future in energy cells. And for good reason.

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Gates Energy Cells offer great packaging flexibility. In fact, our individual cell availability allows you to choose your own specific voltage (in 2-volt increments) and current, as well as configuration.

Just as important as what Gates Energy Cells have to offer is what they don't have to offer. Like outgassing problems. Or cell reversal. Or "memory" problems.

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To find out more about the future in energy cells, circle our reader service number or write us. We'll send you *free* literature containing features, application information, ratings and specifications. George Sahl, Gates Energy Products, Inc., 1050 S. Broadway, Denver, CO 80217.

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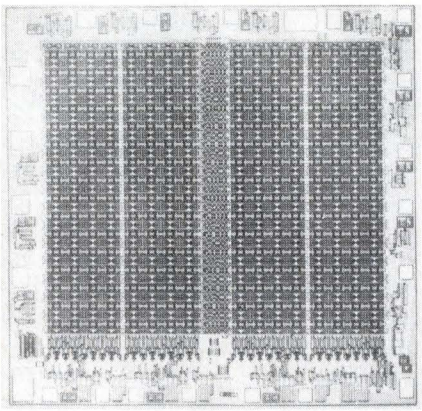
CHERRY ELECTRICAL PRODUCTS CORP. 3608 Sunset Avenue • Waukegan, Illinois 60085

single 18- to 30-volt supply. Automatic thermal shutdown and overcurrent limiting are included in the device, as are a limiter gain of 70 decibels, a dc volume-control range of 70 dB, and a typical limiting threshold of 200 microvolts. Complete technical details are given in Sprague Engineering Bulletin No. 27110.30A.

Technical Literature Service, Sprague Electric Co., 35 Marshall St., North Adams, Mass. 02147 [416]

1-k C-MOS RAM consumes only 75 μW in standby mode

Believed to be the first 1,024-bit C-MOS static random-access memory in commercial production, Intel's 5101 is organized as 256 words of 4 bits each. It can be used with either input and output data buses or with a common I/O bus. The silicon-gate device has a maximum standby power consumption of 75 nanowatts per bit for a total at 76.8 microwatts



and a worst-case access time (and minimum cycle time) of 650 nanoseconds. These specifications hold over the temperature range from 0 to 70°C. A military version, good up to 125°C, will be introduced shortly. Various versions, with various power dissipations and temperature ranges, are priced, in hundreds, from $29.40 to $70.40 each. Most are now available from distributor's stock.

Intel Corp., 3065 Bowers Ave., Santa Clara, Calif. 95051 [417]

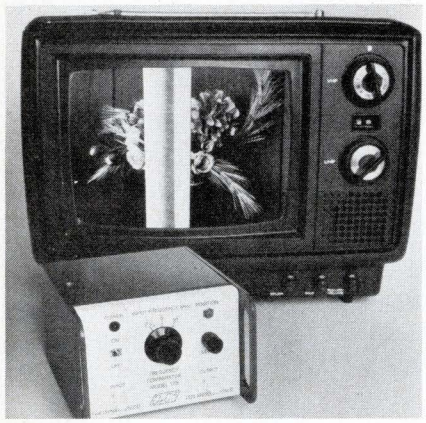
Instruments

Calibrator works from TV signal

$99.95 instrument offers precise oscillator tests, traceable to NBS standards

It usually takes days to calibrate an oscillator accurately, especially if the measurements must be traceable to the National Bureau of Standards' oscillators.

The DyCo model 175 frequency



comparator, priced at $99.95, cuts the time needed for high-resolution frequency-source calibration to minutes, yet maintains NBS traceability. Its circuitry uses techniques developed at NBS, in which the phase of the signal from an oscillator under test is compared with the phase of a color-television reference signal broadcast by one of the four major television networks [*Electronics*, March 20, p. 107].

The oscillator must provide a signal of 0.5 volt or more at a frequency of 2.5, 5, or 10 megahertz. This signal is processed by the frequency comparator and injected into the chroma amplifier circuit of a modified TV receiver. (The modification does not impair the receiver's normal operation.)

The frequency-comparator signal generates a vertical color bar on the TV screen. Because of the frequency difference between the oscillator signal and the network color subcarrier signal as received by the TV set, the color of this bar changes continually. If the period of one complete cycle of this color change is measured, the frequency difference between the signal from the oscillator and the color reference can be calculated. And since the differences, or offsets, between the network oscillators and the NBS cesium standard are published monthly by NBS, calibrations using the model 175 are traceable to NBS.

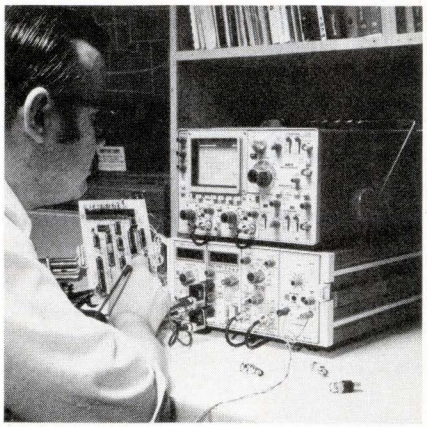
Because the network oscillators are offset from NBS standards, and because the model 175 relies on phase comparisons rather than direct frequency comparisons, very high frequency-measurement resolutions are possible with only moderately accurate time-period measurements. For example, if the cycle-time measurement is off by ±0.01 second, the frequency-measurement error is $\pm 3 \times 10^{-11}$.

Power for the model 175 frequency comparator is derived from a 120-V ac line. The unit has a delivery time of three weeks.

The Dynatron Company, P.O. Box 48822, Los Angeles, Calif. 90048 [351]

Trigger-level output improves counter precision

By adding a trigger-level output to its 225-megahertz universal counter, Tektronix Inc. has greatly increased the value of the instrument to any user who is interested in making pulse-width or time-delay measurements of intervals about 100 nanoseconds long. At these speeds, pulses tend to be trapezoidal, rather than square, and measurements of the same time interval can vary considerably unless each measurement is made with the counter set to precisely the same trigger level. By providing a trigger-level output, the DC 505A enables the user to set the trigger level by means of a good digital voltmeter, thus ensuring accurate measurements regardless of wave shape.

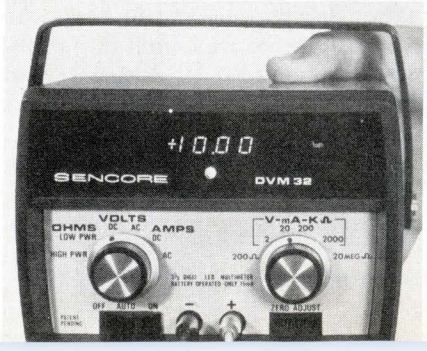


Selling for $1,395—the same price as the earlier DC 505—the DC 505A is a plug-in member of Tektronix's TM500 modular instrument family. It has a 7-digit readout and a worst-case sensitivity of 300 millivolts peak to peak.

Tektronix Inc., P. O. Box 500, Beaverton, Ore. 97005 [354]

3½-digit multimeter consumes little power

Designed to meet the needs of field-service, industrial, and educational users, the DVM32 is a portable, battery-powered digital multimeter that weighs only 2.25 pounds (with batteries) and consumes a maximum of 600 milliwatts. In its automatic mode, the meter shuts off its 0.3-inch light-emitting-diode display between measurements, thus reducing power consumption to about 90 mW. Housed in a high-impact Cycolac case for both ruggedness and user protection, the instrument is protected up to 2,000 V on all dc ranges and up to 1,000 V on all other functions. Basic dc accuracy is within 0.5% of reading ± 1 count from 10% of full scale (200 counts) to full scale (2,000 counts). In addition to automatic polarity,

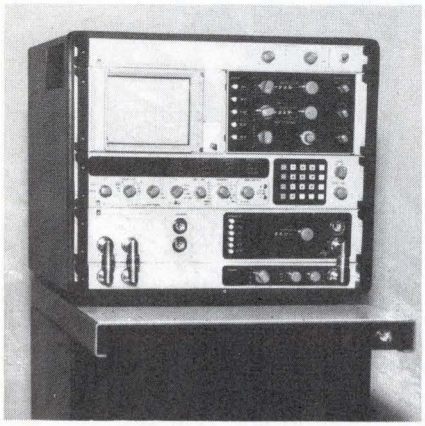


decimal, and overrange indication, the DVM32 offers two ohms functions: low-power and high-power. The low-power ohms function applies no more than 80 millivolts to the circuit under test so that it can make measurements without turning any semiconductors on. The high-power mode applies 800 mV. Priced at $198, the DVM32 portable multimeter measures ac and dc voltage, ac and dc current, and resistance.

Sencore Inc., 3200 Sencore Dr., Sioux Falls, S. D. 57107 [355]

Synthesizer increases network-analyzer precision

By substituting a programable frequency synthesizer for the sweeper in its model 1710 rf-network analyzer, General Radio has produced a high-resolution instrument that is



ideal for making narrow-band measurements on such high-Q devices as crystal or surface-wave filters. Called the GR 2261 synthesizer network analyzer, the instrument spans the range from 200 kilohertz to 500 megahertz with programed increments as small as 0.1 Hz. As many as 1 million frequency steps per sweep are possible. Since high-Q devices are, by definition, prone to ringing, the 2261 in a "snap shot" mode of operation waits until the device under test has recovered from the latest frequency change before displaying its response. For users who already own a 1710, a retrofit kit—the model 1710 OP5R—is also offered. The kit contains a model 1062 synthesizer, a 1062-Pl tracking synthesizer, and an 1167 frequency programer.

General Radio, 300 Baker Ave., Concord, Mass. 01742 [356]

100-MHz counter/timer is priced at $295

Priced at $295 for unit orders, the model 5740 100-megahertz universal counter/timer is a 7-digit machine that measures frequency, period, period average, elapsed time, and total events. The unit has a sensitivity of 10 millivolts from 5 Hz to 20 megahertz, degrading linearly to 50 mV rms (150 mV peak to peak) at 100 MHz. Features include a 0.43-inch light-emitting-diode display, an attenuator that allows input levels as high as ±250 V, and the ability to count random pulses. The instrument's crystal-controlled time base has a maximum short-term drift (jitter) of 1 part in 10^8 per second, and it has a maximum long-term drift of 6 parts in 10^7 per month, the company says.

Data Precision Corp., Audubon Rd., Wakefield, Mass. 01880 [357]

Small ac-powered meter has 0.43-inch LED display

Built into the same-size small case as its 4½-digit model powered by 5 volts DM-4000 [*Electronics,* March 20, p.187], Datel's latest digital panel meter is a 3½-digit, line-operated unit. The same large 0.43-inch LED digits as the earlier logic-powered meter, the DM-2115 is Datel's first ac-powered DPM. It has a true differential input with a common-mode rejection ratio of 70 decibels, a maximum error of ±((0.05% of reading +1 count) at 25°C, and an operating temperature range of 0 to 50°C. The instrument has a small-quantity price of $159.

Datel Systems Inc., 1020 Turnpike St., Canton, Mass. 02021 [358]

GlasGuard.™ It gets inside faster.

Because it's designed for automatic insertion. Designed to cut your assembly time and your assembly cost.

GlasGuard is AVX's new axial monolithic capacitor in a glass package. It's like other glass axials because it costs less to buy. Less to assemble. But it's unlike other glass axials because it has AVX quality built in. Quality guaranteed by advanced design. Painstaking manufacturing. Thorough testing.

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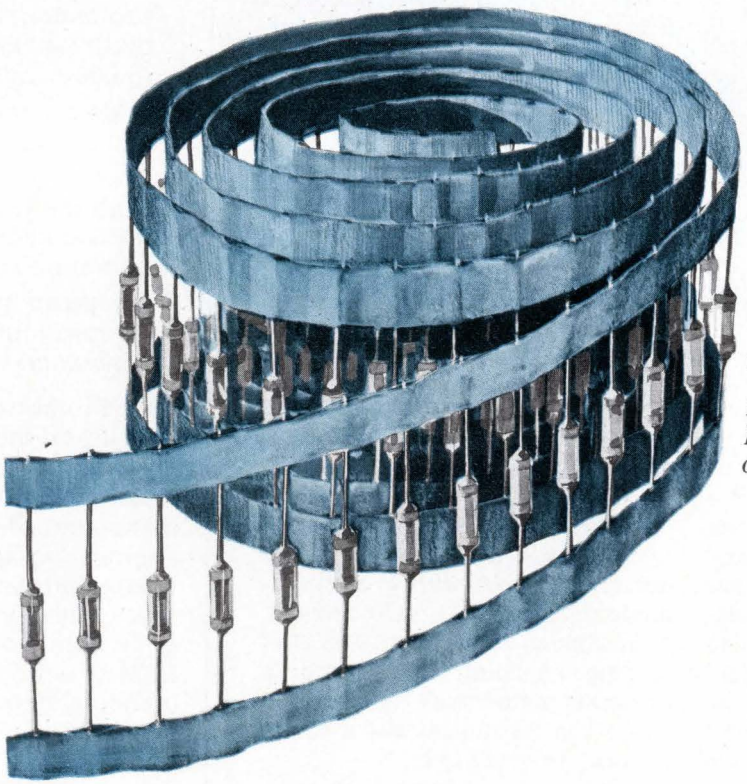
AVX Ceramics Division, P.O. Box 867, Myrtle Beach, S.C. 29577 803-448-3191. TWX 810-661-2252



Dimensions:
Length .170 to .260 inches
Diameter .065 to .100 inches
Lead diameter standard size .020 inches
Capacitance: 1pf to 120,000pf
Voltage: 25, 50, 100, 200VDC
Four temperature characteristics.

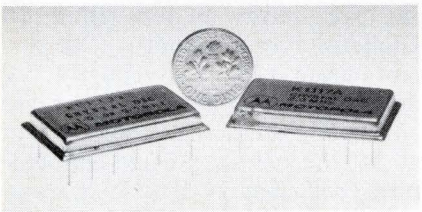
AVX Distributors: Cramer Electronics Inc./Jaco Electronics Inc.
Newark Electronics/Texas Instrument Supply/Weatherford Co.

Subassemblies

Clocks built for microprocessors

First in Motorola family of crystal-controlled units drives Intel 8080 CPU

Microprocessor manufacturers have put stringent specifications on the complicated multiphase clock generators required for timing their products. As a result, clock design has become a major stumbling



block for designers of microprocessor-based systems—it's the only part of the system not available in building-block form.

But now Motorola's Component Products department is developing a family of self-contained crystal-controlled clocks for today's microprocessors. The first, to be introduced at Intercon/75 this month, is designed specifically to drive the Intel 8080 microprocessor without further interfacing. Designated the K1117A, the plug-in package is priced at $68.13 for one, down to $10 to $15 in quantities greater than 1,000. In June, Motorola will start shipping prototypes of two other versions that will directly drive the Motorola MC6800 microprocessor and the firm is readying other clocks for 8-bit bipolar microprocessor families, says Cal Chopp, marketing manager for the department.

Built on a 0.34-by-0.84-inch ceramic substrate, the Intel-compatible clock sits only 0.2 inch off the board, and contains the quartz crystal, the oscillator circuit, n-channel MOS and TTL drivers, and all timing, wave shaping, and interface circuitry needed to provide the critical, non-overlapping two-phase waveforms used by the 8080. By combining all crystal and logic components on a single substrate, Motorola can laser-trim resistors anywhere on the substrate, to maintain critical output requirements.

"It allows us to provide 10-nanosecond guardbands on critical waveform parameters to accommodate large voltage and temperature changes," notes John Morton, Motorola's engineering manager, "and we also adjust to get a workable tolerance for overshoot and undershoot." The K1117A provides two-phase n-MOS outputs at 2 megahertz, as well as two TTL outputs that can be used with the 8080 to generate ready and status strobes.

Motorola guarantees a frequency stability within 0.01% over an operating range of 0 to 70°C: supply voltages of +12 and +5 volts are the same as those required by the Intel part.

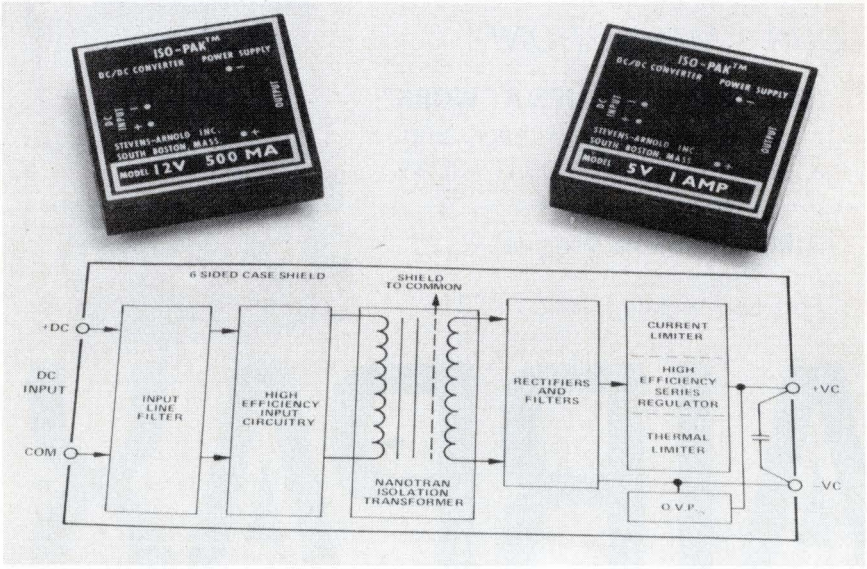
One of the clocks that will be ready in June, the MC6870A, will generate a two-phase n-MOS output and a two-phase TTL output at 1 MHz, the minimum system requirement of the Motorola MC6800. Another version, the MC6871A, will provide two-phase n-MOS and two two-phase TTL outputs, as well as a 4-MHz clock output for the Motorola part. It will have two separate disable inputs that can be programed for pulse-stretching when used with lower-speed memories, the company says.

Motorola Inc., Component Products Dept. 2553 N. Edgington, Franklin Park, Ill. 60131 [381]

Dc-dc converter sources have high power density

Its new F series of single-output dc-to-dc converter power supplies (shown below) is about half the size and double the power density of other modules, claims Stevens-Arnold Inc. The 5-watt, 1-ampere output supply is housed in a copper module measuring 2 by 2 by 0.37 inch and has a power density of 3.3 watts per cubic inch. The company says the flat package should be attractive to customers who have tight board spacing in their systems.

Efficiency of the F series is 70%, which Stevens-Arnold claims is about 15% to 20% higher than average. This efficiency, achieved by using high-efficiency converters and regulator circuitry, lets heat out of the package quickly, allowing the high power density while holding the surface-temperature rise to less than 10°C per package watt dissipated. The copper package reduces thermal resistance by as much as 50%, which increases the rate of thermal and power dissipation. No



derating or external heat sink is required over the full operating range of −25 to +71°C.

When the output is shorted, a nonlatch-down constant circuit limits the output current to 140% of the rated output. If the semiconductor-junction temperature reaches a preset point, a second current-protection circuit will cut down the output current to 90% of the initial output. This helps ensure long-term thermal safety.

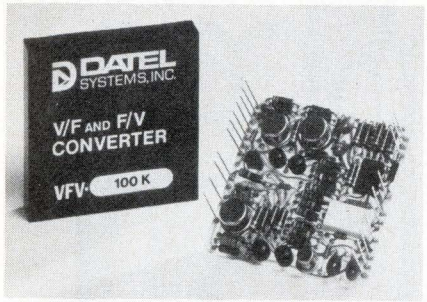
The F series is available with standard inputs of 5, 6, 12, 15, 24, 28, and 48 volts dc. Standard outputs are 3 V at 1 A, 5 V at 1 A, and 6 V at 350 mA. The voltage range is 12 V dc −1.2 V, +2 V. Input current is 0.595 A, and the converter-switching frequency is less than 20 kilohertz. Power output is 5 W, current output is 1 A, and voltage at 5 V dc is accurate within ±0.5%. Load and line regulation are both within ±0.2%, the average voltage-temperature coefficient is ±0.015%°C, and stability is within ±0.05% per hour. Load recovery time is 12 microseconds, and the output-noise bandwidth is 20 megahertz. A π-type input filter, multiple transformer shields, and six-sided package shielding eliminate open-board noise and shielding problems.

Besides standard powering applications, Stevens-Arnold intends the F series as noise and power isolaters and for solving many-level conversion problems from a single dc input. Price is $89, except for the 48-V-input devices, which sell for $99. Delivery time is from stock to four weeks.

Stevens-Arnold, Inc., 7 Elkins St., South Boston, Mass. 02127 [382]

V-f and f-V converter is linear within 0.05%

The VFV-100K is a universal voltage-to-frequency and frequency-to-voltage converter with a frequency range of 0 to 100 kilohertz and a maximum nonlinearity of 0.05%. The manufacturer points out that the nonlinearity specification re-

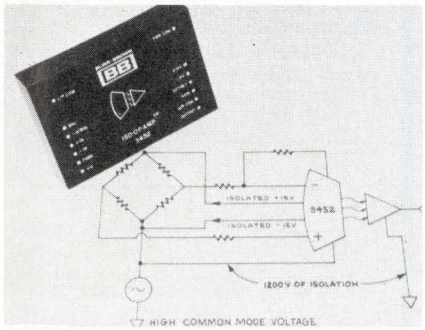


mains valid all the way down to zero input. Other features of the converter are a maximum temperature coefficient of 100 ppm/°C, a 10-kilohm input resistance, and the capability to settle within 0.01% of the new pulse rate within one pulse interval after a step change at the input. As a V-f converter, the module has an output pulse width of 7 microseconds; the output is short-circuit-protected and can drive 12 TTL loads. In its f-V mode, the unit puts out 0 to ±10 v with an output impedance of 0.1 ohm and a maximum current of 5 milliamperes. This output is also protected against short circuits. The VFV-100K, priced at $79, is available from stock to four weeks.

Datel Systems Inc., 1020 Turnpike St., Canton, Mass. 02021 [383]

Isolation amplifier is rated at 1.2 kilovolts

Intended for industrial and medical applications, the model 3452 isolation op amp has an input-output isolation rating of ±1,200 volts dc. In addition, the unit has an isolated ±15 v dc power supply, capable of supplying ±10 milliamperes, available at its input. This feature is ex-

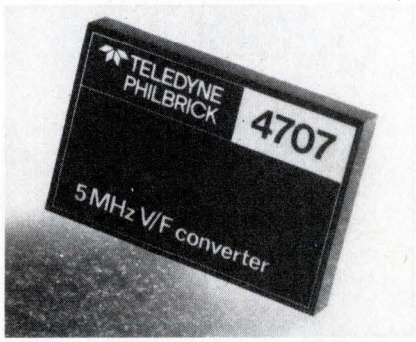


New products

pected to be of interest in medical work where there is a need for isolated supplies for bridge excitation. Unlike simple unity-gain isolation amplifiers, the 3452 is a true op amp that can be operated in noninverting, inverting, and differential modes. Priced at $135 in unit quantities, the 3452 has an input impedance of 10^{11} ohms, a bias current of −20 picoamperes, common-mode rejection of 90 dB at ±10 V, and a minimum isolation-mode rejection of 160 dB. Small-quantity deliveries are from stock.
Burr-Brown, International Airport Industrial Park, Tucson, Ariz. 85734 [384]

V-f converter goes up to 5 MHz

Believed to be the highest-frequency voltage-to-frequency converter currently available, the model 4707 produces output-pulse-repetition rates from 100 hertz to 5.05 megahertz for input voltages from +1 millivolt to +10 V dc. Linearity of the unit is within 0.004% over this operating range, and differential linearity is better than 14 bits, making the module suitable for digital frequency synthesis, nuclear data acquisition, optical data links, and IRIG telemetry. In fm applications where a carrier frequency is to be generated with a certain percentage deviation, the 4707 can be offset to the desired center frequency, using its current-input pin. The 4707 sells for $149 and is available from stock.
Teledyne Philbrick, Allied Dr. at Rte. 128, Dedham, Mass. 02026 [385]



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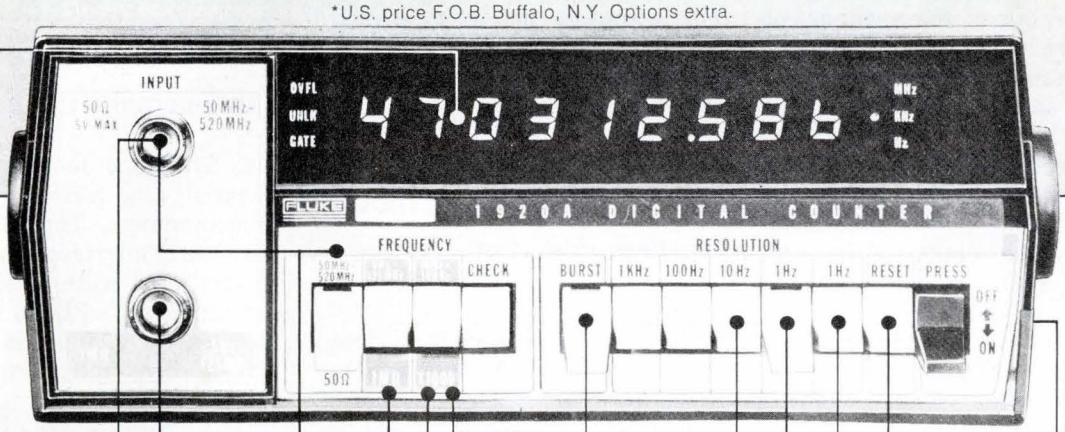
Information Only circle 162 on reader service card. Demonstration Only circle 131 on reader service card.

Fluke's new portable telecommunications frequency counter 1920A for only $859*

*U.S. price F.O.B. Buffalo, N.Y. Options extra.



Easy-to-Read
9-digit LED display
Large 7-segment characters
Full leading zero suppression
Automatic annunciation and overflow

High Frequency/ High Sensitivity
520 MHz prescaler with better than 15 mV sensitivity and AGC standard
Optional prescalers to 1 GHz and 1.25 GHz
Low-level threshold – if input is below threshold display reads zero

Resolution Multiplier (Optional)
Coherently multiplies audio tone signals by 1000, providing a resolution of 0.001 Hz in 1 sec

Easy-to-Operate
Direct input and corresponding switches color-coded blue
Prescaled input and corresponding switch color-coded yellow

Burst Measurements
Measures frequency of RF bursts having 2 ms or greater duration. Display is automatically reset to zero if burst width is less than gate time selected

Rapid-Access Gate
In the absence of signals, gate logic "free runs" to be in a position to open gate for selected gate time as soon as signal is sensed, thereby avoiding measurement delays

Display Check
Pressing reset switch when counter is in self-check mode lights all digit segments

Auto Reset
A new measurement sequence is started every time any front panel switch is activated

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John Fluke Mfg. Co. Ltd. Counter Division, P.O. Box 1094 Station D, Buffalo, N.Y. 14210, Phone (716) 842-0311, TWX 610-492-3214

Data handling

Tape sensing is capacitive

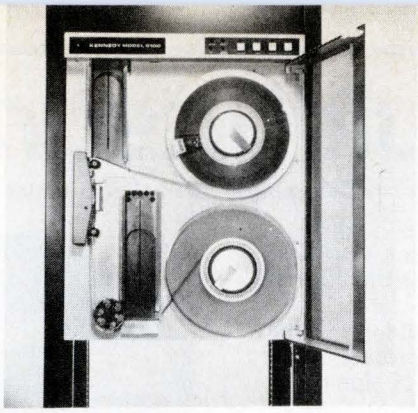
Method smoothes motion in drive that's aimed at minicomputer-based systems

Use of capacitive sensing in tape transports helps reduce tape wear and improve recording accuracy, but it is ordinarily designed into only the more expensive machines. Now, Kennedy Corp. has incorporated a capacitive tape-location detector in a vacuum-column tape transport aimed at lower-priced minicomputer and data-collection systems requiring moderate speed. The transport is priced at $4,750 to $5,450 depending on options. Quantity discounts are available.

The new drive, designated the model 9100, operates at 75 inches per second and handles IBM- and ANSI-compatible tapes. It uses a metalized Mylar diaphragm as one plate of a variable capacitor extending the length of the vacuum column. A vacuum pump produces a lower pressure above the tape than below it, so that the diaphragm is displaced in proportion to tape location and causes a linear variable-capacitance output. This output controls the tape drive mechanism, smoothing the motion of the tape and therefore minimizing the stretch, wear, and jitter often caused by step-type drives. Reel-tape tension is a constant 6 ounces.

The capacitive sensing, plus a wide vacuum column, also reduce the vacuum needed, so the transport comes with a quiet, low-rpm motor. Russell Bartholomew, marketing manager, says the transport is quiet enough to be used even in medical applications.

Although the standard tape speed of the Kennedy transport is 75 in./s (190.5 cm/s), lower speeds are available on special order, and a faster model (125 in./s) will be introduced



late this year, the company says.

Data transfer with nine tracks is 60 kilohertz at 800 bits per inch, 120 kHz at 1,600 b/in. A seven-track, dual-density model using 200/556- or 556/800-b/in. densities is also available.

Controls include a tri-level clipping circuit that automatically switches from normal to low- and high-threshold settings during reread in order to improve data recovery. A lamp warns when tape skew exceeds preset gate limits and can also be used to check mechanical adjustments and head alignment.

The model 9100 has an instantaneous speed variation of ±3%, with long-term variation of ±1%. Start/stop displacement is 0.19 inch and start/stop time at 75 in./s is 5.5 milliseconds maximum. Rewind speed is 200 in./s nominal.

Power requirements are 115/230 volts ac, 50 to 60 hertz, single phase. The transport fits in a standard Retma 19-inch rack.

Kennedy Co., 540 West Woodbury Rd., Altadena, Calif. 91001 [361]

Powerful 32-bit minicomputer has high-speed processor

Interdata Inc. has expanded its 32-bit processor line with what it claims is the "most powerful minicomputer in the world today," the model 8/32 Megamini. It is priced at $51,900 with 128 kilobytes of memory, and $179,400 with one megabyte of memory. The 8/32, in its basic configuration, is a nine-board processor packaged in a 16-slot Retma chassis, with four slots for 32-kilobyte-memory modules. Three expansion slots are reserved for input/output logic.

The 8/32 is fully compatible with the company's medium-performance 32-bit model, the 7/32, available since mid-1974, but it processes up to eight times faster than the 7/32. High-speed Schottky logic is used in all processor circuits, and processor time is 240 nanoseconds. The unit is designed to accept both core and semiconductor memory systems or a combination of the two.

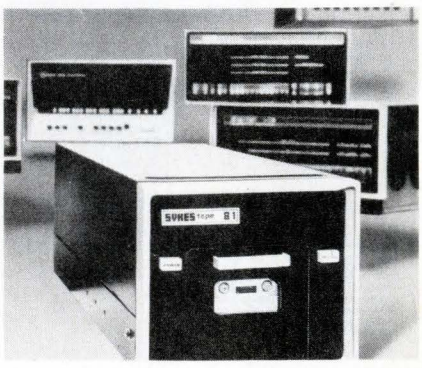
The Megamini's I/O system uses dual bus architecture. Each bus has a separate I/O function. The multiplexer bus, a man-machine channel, supports up to 1,024 slow-to-medium terminals. The direct-memory-access bus is used for high-speed machine-machine links, as in disk, magnetic-tape or multiple-CPU configurations.

The 8/32 has a user-level instruction set of 219 commands with subsets for special commands for data communications, bit manipulation, floating point, and list handling. Primary applications for the 8/32, according to Interdata, will be simulation, data communications, general-purpose science, and industrial automation. Production deliveries will begin in June.

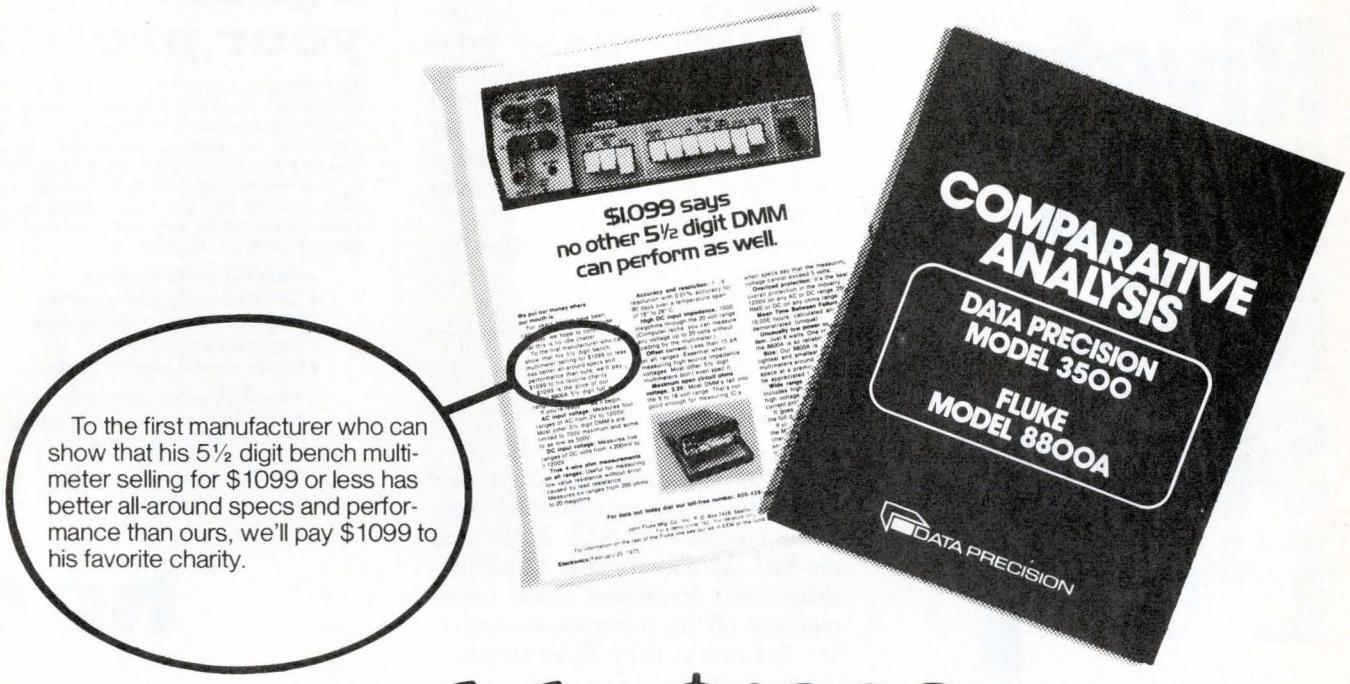
Interdata Inc., 2 Crescent Place, Oceanport, N. J. 07757 [363]

Sequential cassette system handles many different minis

The Sykestape model 80 is a sequential tape cassette system for minicomputers. The unit is available with interfaces and software drivers for a wide variety of minis including DEC's PDP-8 and PDP-11 families, H-P's 2100 family, Varian's 620 family, and Data General's



Dear John,



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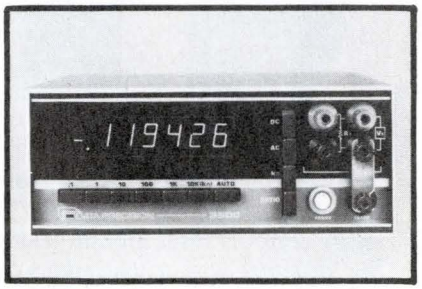

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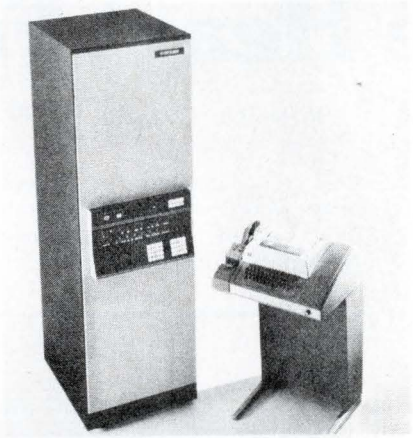
New products

Nova family. The system has a transfer rate of 9,600 bits per second, a rewind speed of 120 inches per second, and a capacity of more than 2.8 megabits—that's more than 30 4,000-word programs. Price of the model 80 is $1,500 in large quantities, and delivery is from stock.

Sykes Datatronics Inc., 375 Orchard St., Rochester, N. Y. 14606 [364]

32-bit microprogramed computer line bows

The first two members of a new hierarchy of microprogramed computer systems—the SEL 32/50 and the SEL 32/55—are true 32-bit machines that are aimed at the upper segment of the minicomputer market. Because of their 32-bit structure the two new machines, and the rest of the SEL 32 Series, allow much faster arithmetic and transfer of



word-oriented data than is possible with eight- and 16-bit minis. The entire series is built around a single bus structure with a continuous data throughput rate of up to 26.6 megabytes/second which makes multiporting memories unnecessary. The SEL 32/50, which has been optimized for the OEM market, and includes internal cooling to allow mounting in a standard 19-inch rack will have a basic price of about $18,000. The end-user-oriented 32/55 is a highly modular system that comes in a wide variety of sizes.

Five points to keep in mind when evaluating Logic-Circuit Testers...

1. When testing complex boards, you spend most of a tester's available time troubleshooting defective boards.
2. Troubleshooting can be time-consuming and costly.
3. Not all test systems troubleshoot equally well.
4. Software is the least understood and the most important part of any test system.
5. The system that provides the best hardware/software integration minimizes troubleshooting time and expense.

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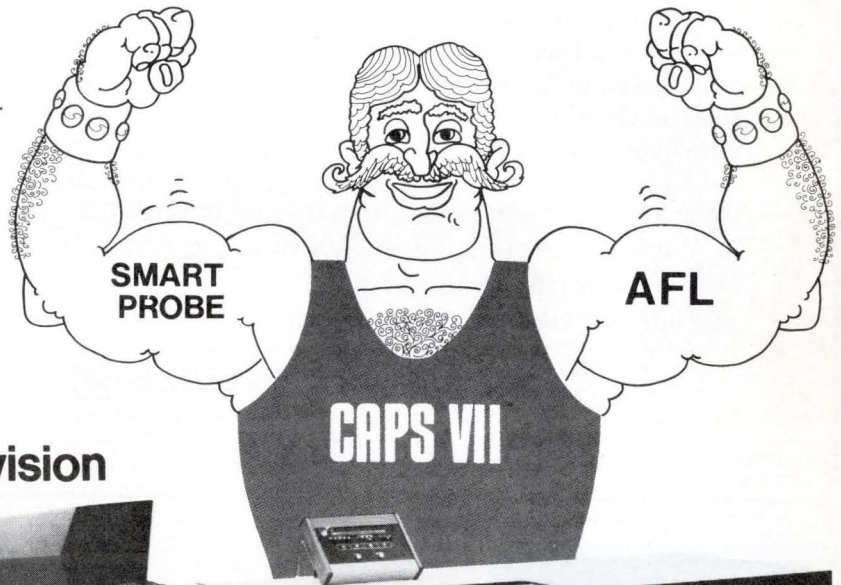

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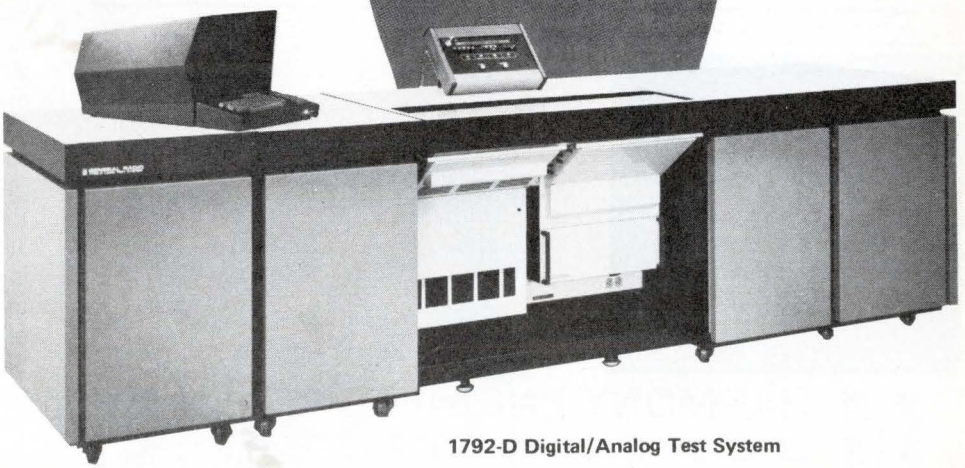

1792-D Digital/Analog Test System

New products

Its prices start at about $25,000. Both units will be in full production by midyear.

Systems Engineering Laboratories, 6901 W. Sunrise Blvd., Ft. Lauderdale, Fla. 33313 [367]

Minicomputer disk system stores 270 megabytes

Capable of storing up to 270 megabytes (135.2 million 16-bit words), the series 9500 disk storage system has an average access time of 30 milliseconds. Because of its capacity, the system is expected to open up many new large-file applications for minicomputers—applications that previously required the use of a large mainframe computer.

It also handles many cumbersome software routines in hardware. The series 9500, which is able to transfer data at 1.2 megabytes per second, is organized into five-disk packs. Three of the disks in each pack (six surfaces) are used in recording, the other two serve as protective disks. Five of the six recording surfaces are used to store data while the sixth is part of the system's head-positioning subsystem. The single-unit price of the memory runs from $15,000 to $30,000; delivery time is 60 days.

System Industries, 535 Del Rey Ave., Sunnyvale, Calif. 94086 [365]

HOW DO YOU GET FROM THE SENSOR TO THE COMPUTER?

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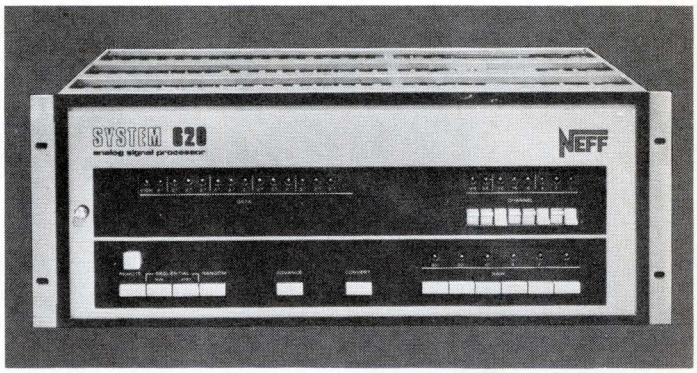

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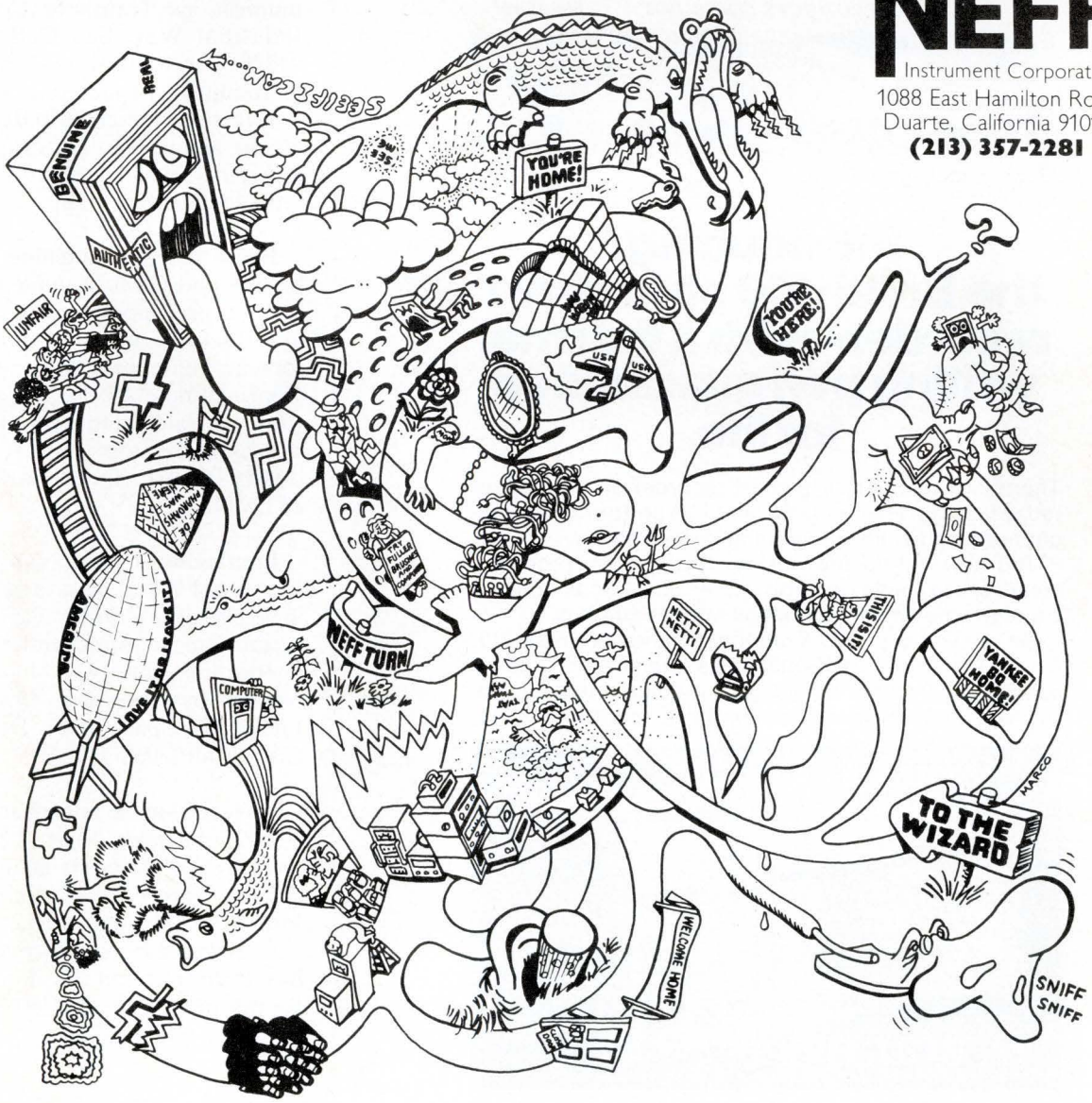

New literature

Relay chart. A stock-relay wall chart, said to be the first specification chart in the history of the relay industry, is available from Magnecraft Electric Co., 5575 N. Lynch Ave., Chicago, Ill. 60630. The chart, which was also published as an insert in the March 20 issue of *Electronics,* includes more than 1,200 stock-relay versions available for immediate delivery, lists 80 of the principal classes of relays, and illustrates 17 relay categories. Circle 421 on reader service card.

900-MHz amplifiers. An applications note which considers, in detail, the problems associated with the design of amplifiers for the 900-MHz land-mobile band may be obtained from M. J. Mallinger, Communications Transistor Corp., 301 Industrial Way, San Carlos, Calif. 94070. The note covers such subjects as circuit-board materials, construction methods, microstrip design and layout, and various performance parameters. Specific design examples are also included. [422]

Phase and gain matching. Entitled "Phase and Gain Matching Simplified," a brief applications note lists and discusses seven significant factors in phase and gain matching. Copies of note AP 500 are available from the sales manager, RHG Electronics Laboratory Inc., 161 E. Industry Court, Deer Park, N. Y. 11729 [423]

Interfacing C-MOS and bipolar. The problems of interfacing C-MOS logic circuitry with bipolar d-a converters are analyzed and solved in application note AN-14, which is offered by Precision Monolithics Inc., 1500 Space Park Dr., Santa Clara, Calif. 95050 [424]

Dielectric-materials chart. A dielectric-materials chart, which describes such materials as adhesives, casting and potting resins, conformal coating and varnish resins, and electrically conductive resins, has been put out by Formulated Resins Inc., P. O. Box 508, Greenville, R. I. 02828 [425]

High-voltage tests. A 10-page bulletin that sets forth a series of standard procedures for testing high-voltage power supplies has been released by Spellman High Voltage Electronics Corp., 1930 Adee Ave., Bronx, N. Y. 10469. Bulletin STP-473, which is entitled "Standard Test Procedures for High Voltage Power Supplies," is especially recommended for determining the validity of published specifications. [426]

Self-heated thermistors. A thermistor E-I curve manual, designated No. L-7, is believed to be the first to present data on the operation of thermistors in the self-heated mode. Including graphs, charts, working tables, and practical problems with solutions, the manual can be obtained from Fenwal Electronics, 63 Fountain St., Framingham, Mass. 01701 [429]

Time-code formats. A 121-page book entitled "Precision Timekeeping and Tape Search" illustrates and discusses in detail the various time-code formats that are available along with their applications. Published by Systron-Donner, the book is for sale at $3.50 per copy from Data Products Division, Systron-Donner Corp., 935 Detroit Ave., Concord, Calif. 94518 [430]

Brownout protection. The latest Ideafile published by Heinemann Electric Co., Magnetic Drive, Trenton, N. J. 08602, deals with the problem of protecting equipment against brownout-induced damage. To combat equipment-destroying low voltages, one of the few actions that can be taken is automatic shutdown. Techniques and equipment for doing this are discussed in Ideafile No. 6. [431]

Display monitors. A 20-page booklet, "Display Monitors," has been published by Tektronix Inc., P.O. Box 500, Beaverton, Ore. 97077, to help OEM buyers choose the right monitors for their systems. The booklet relates monitor parameters to system needs. [432]

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April 3, 1975

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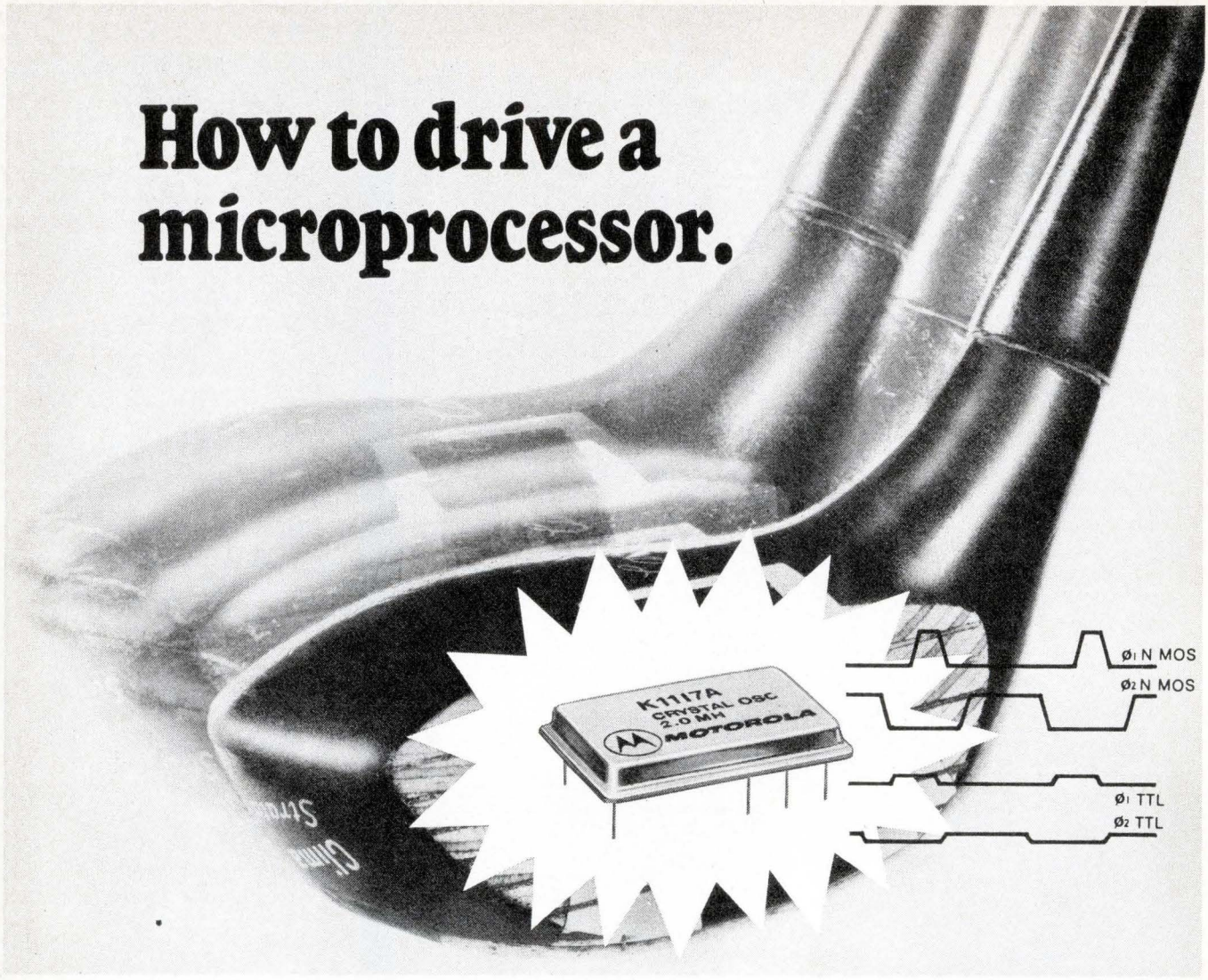

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