SEPTEMBER 1, 1977

FLUOROCARBON BAN POSES INDUSTRY-WIDE THREAT/65

Single-chip microprocessor achieves bit-slice performance/91

TV receiver displays picture within a picture/102

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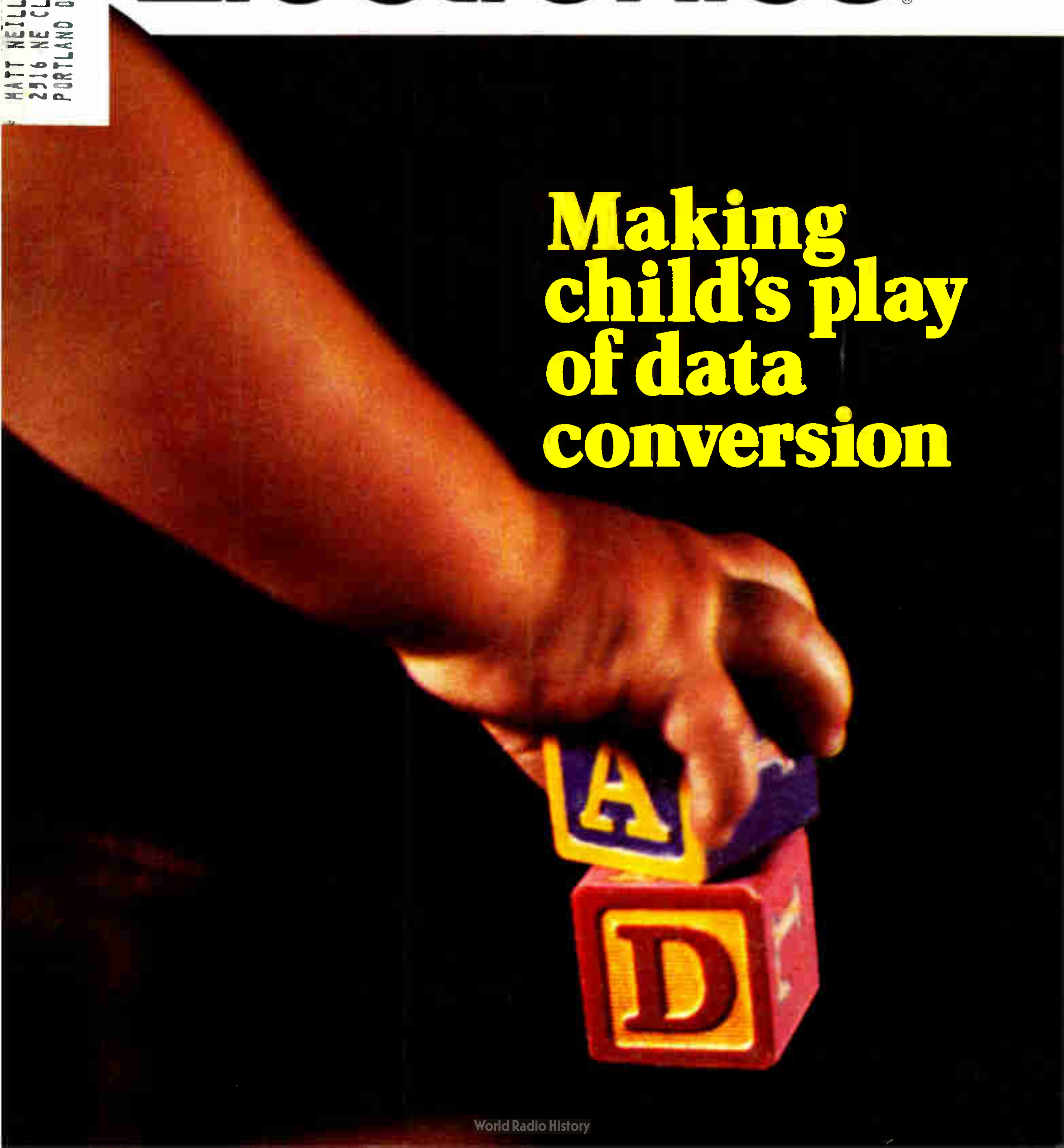

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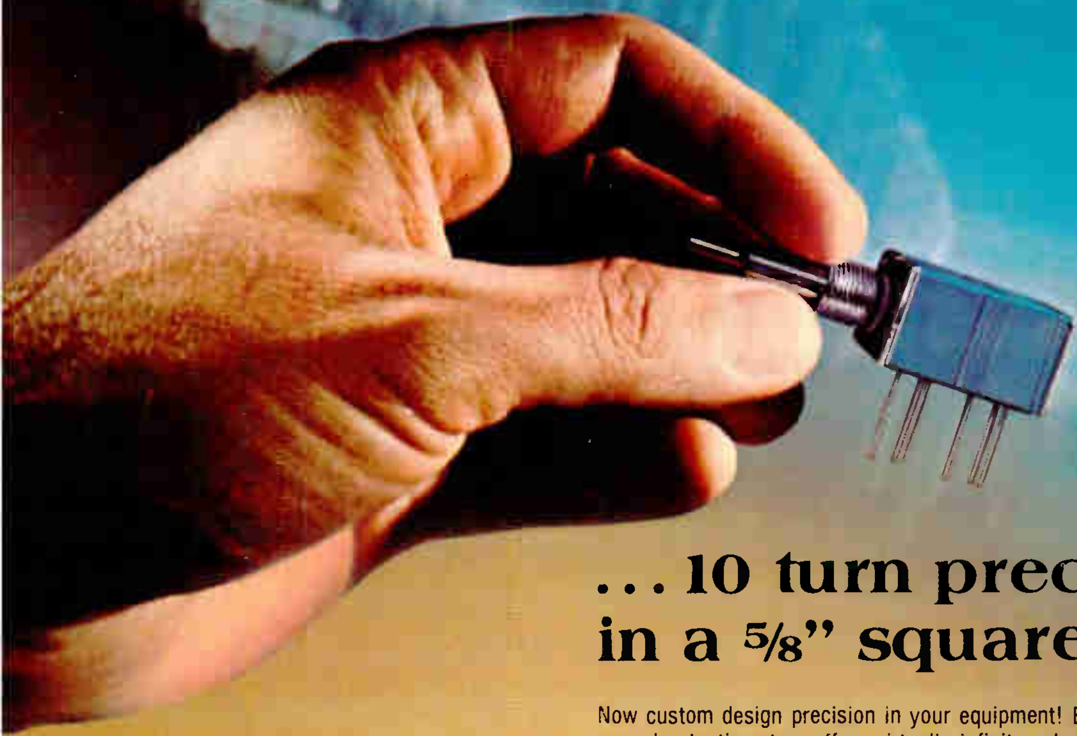

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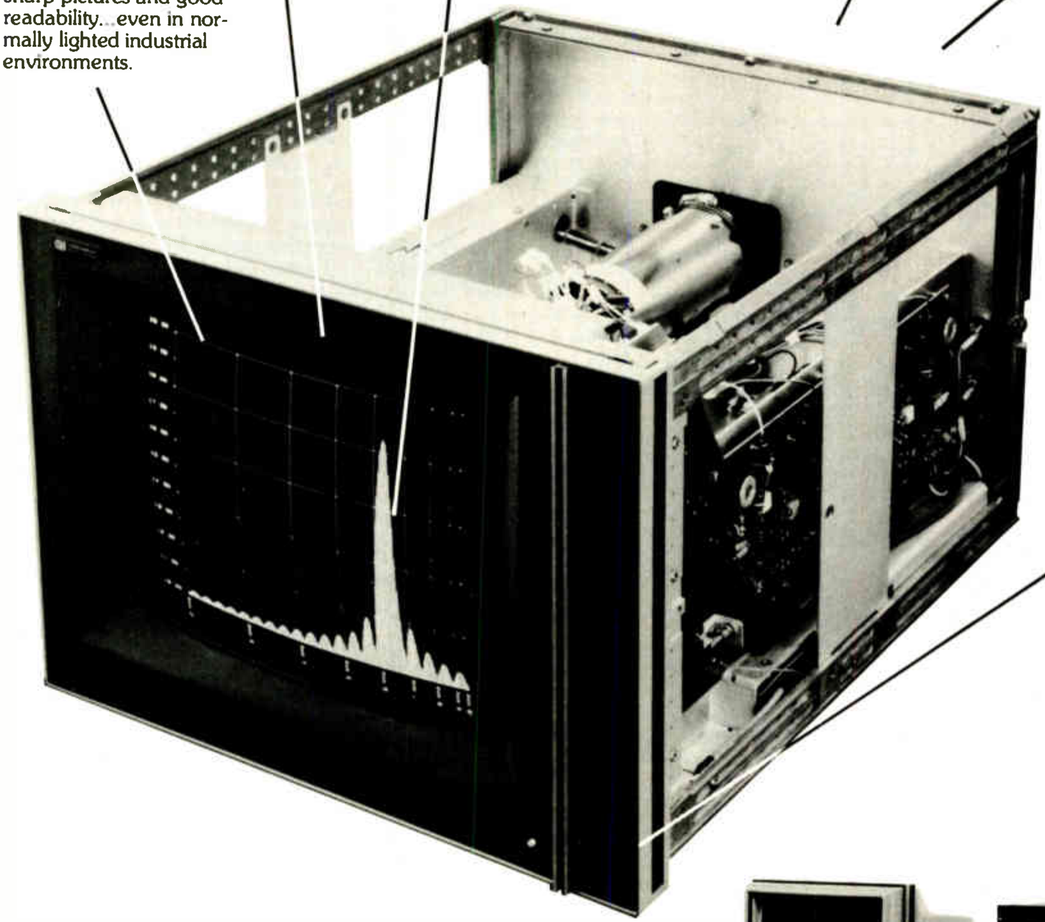

08/9

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Circle 1 on reader service card

Electronics

The International Magazine of Electronics Technology **Vol. 50, No. 18 • September 1, 1977**

Highlights

Cover: Analog I/O adapts to microprocessors, 81
Linking analog inputs to microprocessors and vice versa can take considerable hardware and software. To simplify system design, new converters have begun to resemble miniature systems and to relate to the processor as a peripheral.

Color TV a bright spot in Europe, 69
As European television-set makers pack for their biennial trip to West Germany's International Radio and Television Exhibition, they look to a bright future for their color models—for both the short term and the long run. In fact the entertainment sector is one of the European electronics industries' few strong areas.

Bipolar microcontroller chip rivals bit slices, 91
Advances in bipolar Schottky technology allow the design of a single-chip microprocessor with performance that approaches that of bit-slice machines. Yet the device has an easy-to-use fixed-instruction set.

TV receiver shows two pictures at one time, 102
Providing a small inset monitor picture simultaneously with the main picture poses some tricky technical problems for television-set designers. One solution is the careful tailoring of two bucket-brigade-device memories and a control integrated circuit to the job.

In the next issue . . .
Wescon 77: the widening horizon of the microprocessor . . . a special report on flexible circuitry . . . nonbinary logic in today's designs.

Electronics

Publisher's letter

There has long existed a healthy rivalry between bipolar and metal-oxide-semiconductor technology—or rather between the proponents of the two approaches to integrated-circuit fabrication. Advances in one area, it seems, stimulate workers in the other to take some more steps forward.

There's no reason why the complex IC called the microprocessor should be immune from the rivalry. It should be no surprise, then, that, thanks to bipolar Schottky technology, there is now a single-chip microprocessor that bridges the gap between the computational abilities of MOS devices and the performance of bipolar bit-slice units. You'll find the full details on the 8X300 microprocessor in the technical article that starts on page 91.

Design of the 8X300 began three years ago at Signetics Memory Systems Inc., which was a subsidiary of Corning Glass Co. SMS, a systems house, initiated the design and planned the architecture, and another subsidiary of Corning, Signetics Corp., did the fabrication. Then, when Signetics was purchased by Holland's Philips, it obtained the rights to the 8X300 design and was free to market the device as a commercial product.

Author John Nemec was a newcomer to the semiconductor industry, having been a systems designer in Ford Motor Co.'s aerospace operations. "One of the first projects I was assigned to at Signetics was the 8X300," he says. "But I found that, as people were assuring me, it was easy to use and understand. I was able to pick up the instruction set quickly, and I began working with the chip right away."

He then went on to support the marketing effort for the device. And though he is no longer associated with it—he is now marketing manager of custom programs in the logic division of Signetics—he is pleased with its success. "The strong points about the 8X300 are that it was designed by a systems house, and that it's been in extensive use for a few years," he notes. "It's a well-seasoned part—not something new with bugs in the design that people have to worry about."

And, speaking of microprocessors, you'll want to read about what the need to interface efficiently with them has done to the design of components for analog data conversion. On page 81, our components editor, Lucinda Mattera, describes the ferment that is going on in the field and sorts out just what all the latest developments mean.

From new chips through hybrid circuits and modules to whole boards, the key to the frenetic pace of change is the microprocessor. "One thing is clear," she says. "The microprocessor is changing the whole design process, right down to the very terminology of analog data conversion, and that has caused some confusion."

For example, she says, "such terms as 'data converter' and 'data-acquisition system' are giving way to 'analog input/output system.' Designers are going to have to learn a whole new vocabulary and 'microprocessor-compatible' is going to be the biggest buzzword."

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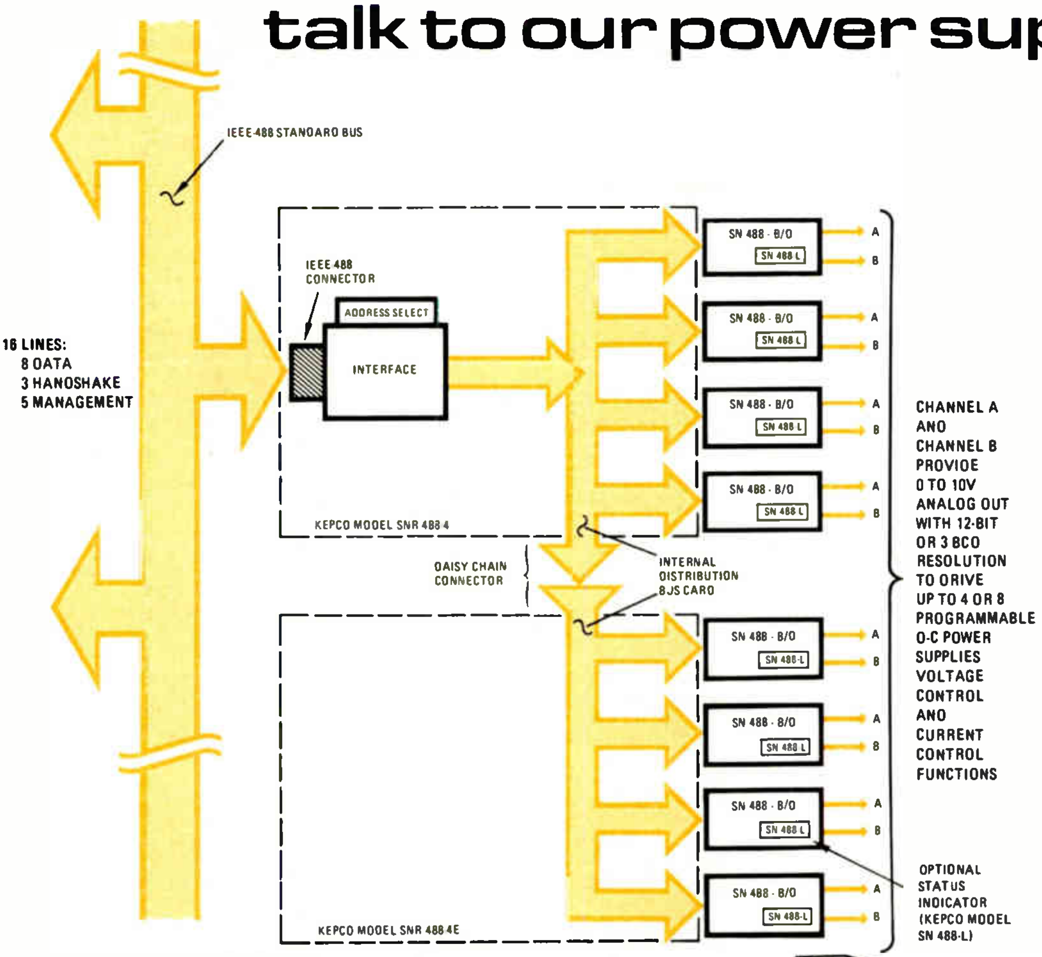

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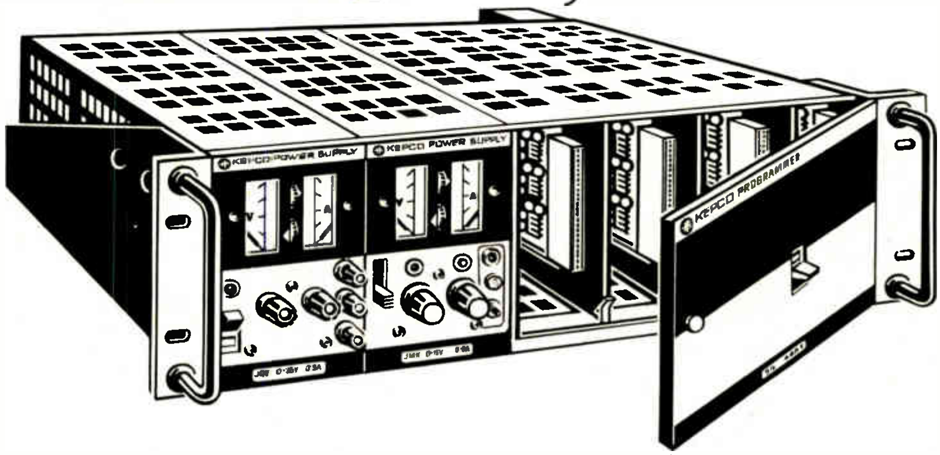

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Readers' comments

Pardon our gremlins

To the Editor: I recently derived a program for my SR56 from the one for the HP25 that you published [Calculator Notes, July 7, p. 117]. Unfortunately, it would seem that gremlins attacked the noise figure equation published. The denominator of the last term should be:

$$\log^{-1}(g_i/10)$$

—a small but significant difference!

P. R. Minchinton
Welwyn Garden City
Herts., U. K.

United we stand

To the Editor: I do not see the solution of engineers' problems [*Electronics*' career survey, "Part 3: EEs appraise career trends for 1980s," Aug. 4, p. 87] in hard work only. Instead, I see the need for concerted action, since, while some succeed as a result of their expertise or management ability, others suffer and never make the grade. . . . The solution is union or unity, lobbying in Congress, education of the public with something other than *Star Trek*, up-to-date registration requirements: *a union* (and I say "union") similar to the American Medical Association.

Eugene F. Pereda
Albuquerque, N. M.

Peak prices

To the Editor: In your article on the Office of Technology report on photovoltaics ["Report by Congressional committee favors small power installations," Aug. 4, p. 32], there are two figures quoted that should be corrected. The article states: "Silicon costs, OTA says, represent about $2 of the $17/kw charged for typical cells in 1976. ERDA's goal is 10¢/kw."

Silicon cells in 1976 cost approximately $15 to $17 per peak watt, not per kilowatt. ERDA's eventual goal is 50¢/peak watt by 1986, rather than 10¢/kw. Photovoltaics priced at $17/kw would turn the market loose, just the stimulus it rightfully deserves!

Blaine Ouimette
Kansas City, Mo.

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News update

■ The experimental millimeter-wave radar system designed and built for the U. S. Army by United Technologies Corp.'s Norden division in Norwalk, Conn., has passed preliminary tests. The 95-gigahertz radar is destined for the Aquila remotely piloted vehicle, a small unmanned aircraft for battlefield surveillance that the Army hopes to field by the early 1980s [*Electronics*, Sept. 30, 1976, p. 30].

The brassboard model is built out of off-the-shelf components to demonstrate the utility of the millimeter-wave radar concept. It has three modes of operation: high-resolution ground mapping, moving target indication, and fixed-target enhancement. "We successfully proved out the three modes in static tower tests," says Russell J. Wagner, technical project coordinator for the U. S. Army Electronics Command at Fort Monmouth, N. J. The tests were conducted at Norden's plant and at Fort Huachuca, Ariz.

The Army and Norden are now preparing for flight tests of the brassboard model in a manned aircraft "some time during fiscal 1978," which begins Oct. 1. "We will be making some minor modifications to the equipment to upgrade the system," Wagner says.

Norden's RPV radar is designed for foul weather, when electro-optical sensors are ineffective. "As opposed to optical systems, which are limited to operation in clear weather, a millimeter-wave radar sensor is effective in adverse weather, including dense cloud cover, fog, and rain," says Norden's Robert S. Graziano, a senior research engineer. While millimeter-wave radars offer much better resolution for a given of antenna size than radars operating at lower frequencies, their range is not as great. But that is no problem with RPVs, says an Army spokesman, since they have to be close to the target anyway. The importance of the millimeter-wave radar, the spokesman adds, "is that we can look at real-time information, as opposed to a photo that has to be developed, if the [conventional] RPV returns."

Bruce LeBoss

Designer's guide to the hot numbers in LICs.

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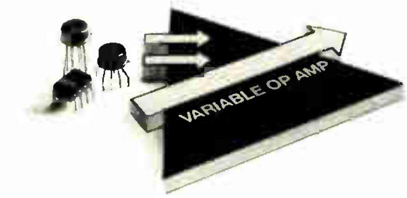

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Circle 11 on reader service card

People

Lt. Gen. Marsh prefers to define systems in phases

The new commander of the Air Force Electronic Systems division would like to see changes made in the way Congress funds the development and procurement of the big-ticket command, control, and communications systems he oversees from his headquarters at Hanscom Air Force Base, Bedford, Mass. Lt. Gen. Robert T. Marsh says such programs are too big and complex to be precisely and completely defined from their inception, as Congress traditionally wants.

"These systems are a different animal from space, missile, and aircraft systems, which have pretty definable characteristics such as thrust, payload, and penetrability," he says. As an example of the systems with which he is dealing, he cites the E-4 advanced airborne command post from which military operations could be directed in an all-out war. Equipment is housed in a Boeing 747, with three purchased and three more under consideration. Depending on the equipment, the cost of six command posts is projected as high as $924 million.

Data demands. The problem with defining the system at the outset lies in the great amount of data processing it must handle, Marsh states. Just how much equipment is needed will not be known until the system is tried. "We had to re-scope the program along the lines of what we knew could be done in the near term," he says, while providing for growth in on-board data processing and, possibly, a larger on-board data base. "But the extent of those additional requirements isn't even yet defined, and we won't move on them until we have a better understanding of what's needed."

The cigar-smoking Marsh, who looks younger than his 52 years, sees it as part of his job to push for acceptance in Congress of phased, evolutionary definition and funding of such systems. He plans to do that by first selling the concept to his superiors at the Air Force Systems Command and also to the service's Air Staff.

Definer. Lt. Gen. Marsh says funding must often evolve as the system is defined.

He realizes his views may not find ready acceptance, but his easy affability, combined with the determined grasp he conveys of what he wants to accomplish, suggest his voice will be heard. Marsh says it is better to admit that the Electronic Systems divison's kinds of systems cannot be precisely defined from the start than it is "to go back [to Congress] and alter what we exquistely defined last year and ask for changes."

For Hayes, knocking on doors was way to get the job done

J. L. "Jerry" Hayes, the man behind the Navy's innovative approach to test gear calibration, did not at first realize how tough the task of automating the procedure would be. "If I had sat down and rationally faced the obstacles, I probably wouldn't have even tried it," says the technical director of the Navy's Metrology Engineering Center, Pomona, Calif. His goal was for his Mecca system to make it easier for relatively untrained technicians to handle complex calibration chores.

"Our major obstacle was money," continues the Navy civil service veteran of 25 years, 20 of them in metrology. "We hardly had any." Test equipment makers also believed the market was a long way off. But the new types of control and calibra-

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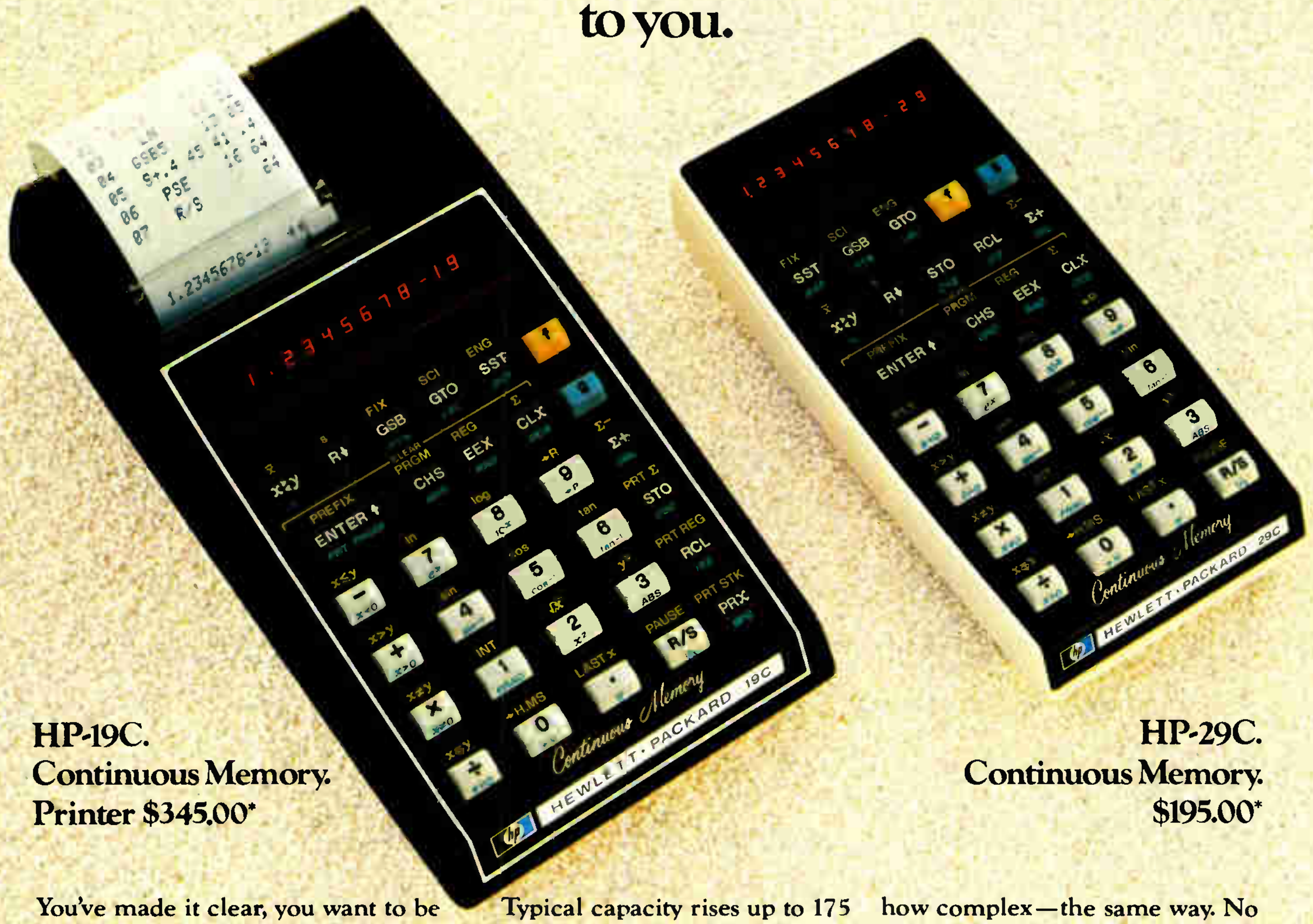

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616/47

Circle 15 on reader service card

Cajoler. Door-to-door discussions got Jerry Hayes' calibration system off the ground.

tion gear that Hayes envisaged [*Electronics*, August 19, p. 31] are starting to be produced by industry leaders like Tektronix and John Fluke Manufacturing.

Hayes' campaign to persuade industry to do much of the development with its own funds began five years ago. For a time, it was a matter of making the rounds of instrument houses lugging a prototype and cajoling executives, Hayes recalls. On one side, they had to be convinced of the business prospects, he says, while on the engineering side, "none were really aware technology was exploding so fast." What made the system possible, he believes, was the "marriage of the microprocessor, the plasma-display panel, and the IEEE-488 standard instrumentation bus."

Hayes' door-to-door approach not only worked, it paid dividends. The bargain-basement cost to the Navy has been in the region of $750,000, or about one quarter the investment that would have been required had the project been contracted through normal procurement channels, Hayes says. This figure is further dwarfed by industry spending to come up with production hardware.

Says an official of a major instrument maker: "Jerry and his guys deserve immense credit. When was the last time you heard of a good idea coming to us out of a government agency? Usually, it's the other way around."

MIL-SSR UPDATE

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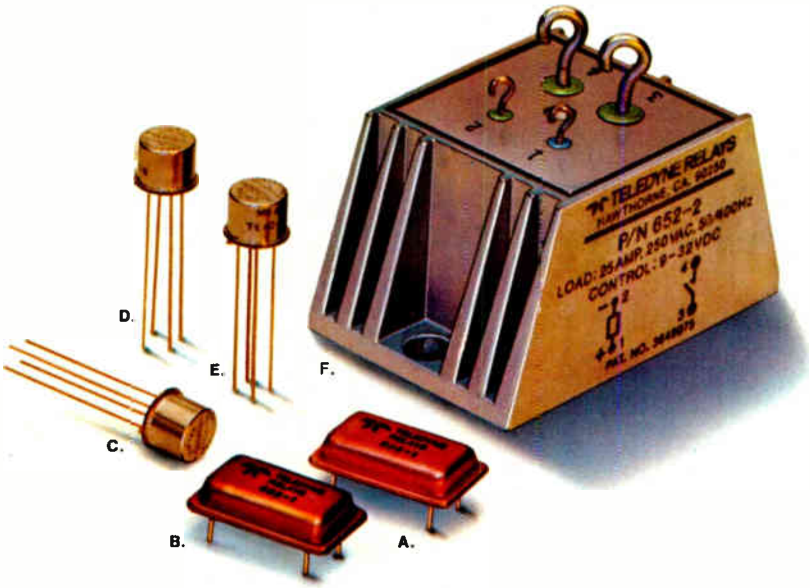
For complete specification data, contact your nearest Teledyne Relays sales office listed in EEM, Gold Book or Electronics Buyers' Guide. You'll find we have the experience, products, and technical support to meet all your SSR needs — including a quick reaction capability to design SSRs specifically for your application.



TELEDYNE'S MILITARY SSRs

A. **P/N 683-1 DC SSR**
DIP package, with output rated at 600mA/50VDC

B. **P/N 682-1 AC SSR**
DIP package, with output rated at 1A/250VAC

C. **P/N M640-1W Bi-polar SSR**
Mil P/N M28750/5. TO-5 package, with bi-polar (AC/DC) output rated at 60mA/40V

D. **P/N M643-1W DC SSR**
Mil P/N M28750/6. TO-5 package, with output rated at 300mA/40VDC

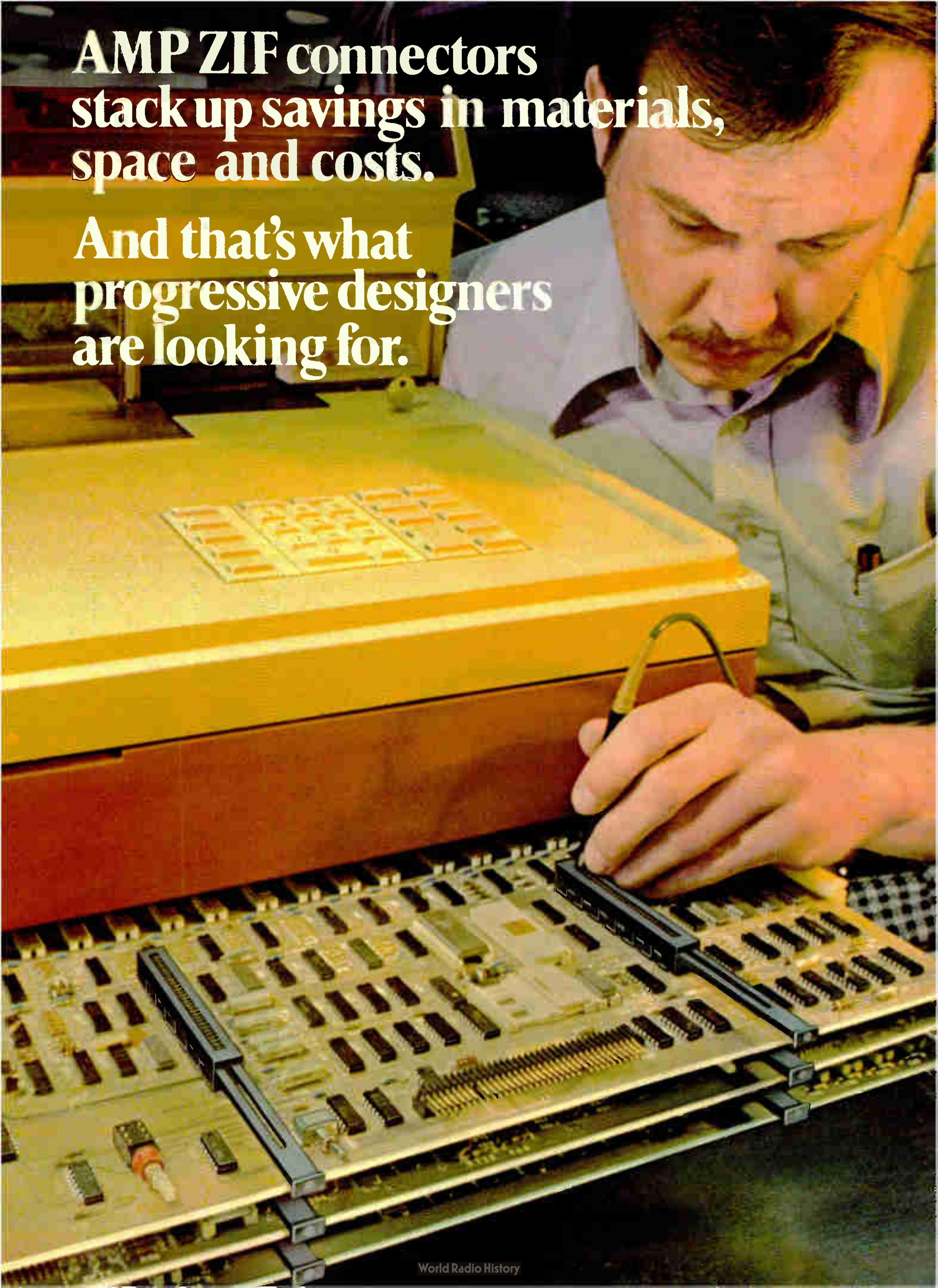
E. **P/N M643-2W DC SSR**
Mil P/N M28750/7, TO-5 package, with ouput rated at 100mA/250VDC

F. **652 Series AC Power SSR**
Output rated at 25A/250VRMS

TELEDYNE RELAYS

3155 West El Segundo Boulevard, Hawthorne, California 90250
Telephone (213) 973-4545

Circle 17 on reader service card


AMP ZIF connectors
stack up savings in materials,
space and costs.
And that's what
progressive designers
are looking for.

Take our stacking zero insertion force connectors, for example. They effectively reduce costs, not only because they prevent board insertion damage but also because they eliminate board routing, beveling, and gold card edge fingers.

Their stacking design permits high density, bus organized packaging, eliminating backplanes and allowing shorter electrical paths from board to board. And card cages are no longer necessary. Add all these advantages and you can see why AMP stacking ZIF connectors are ideal for the new generation of microprocessors, intelligent terminals, and distributed processing systems.

There's another important advantage, too. AMP technical support. And it's available even when your product is in early development. In fact, that's when we urge you to get us involved. So you can take full advantage of the capabilities and willingness of our people to help you find a better way to increase your product's effectiveness.

There are more benefits in AMP ZIF stacking connectors: Maintenance is simplified because every board is accessible without the need for extender boards. Contacts are on .100″ grid spacing and feature the AMP Action Pin to reduce board hole damage.

Why not get the complete story on our Zero Insertion Force Stacking Connectors, as well as card edge types with side-entry capability. Just call Customer Service at (717) 564-0100. Or write AMP Incorporated, Harrisburg, PA 17105.

AMP has a better way.

SEE US AT
WESCON, SAN FRANCISCO

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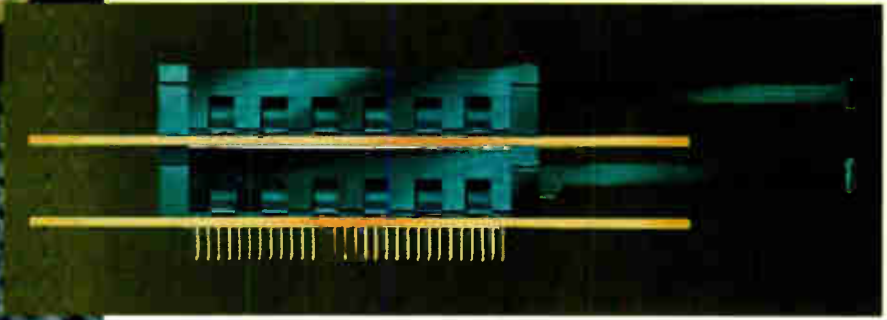
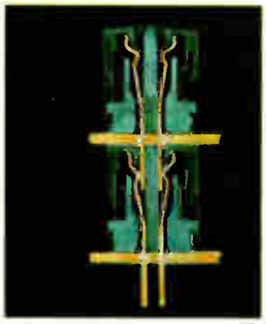
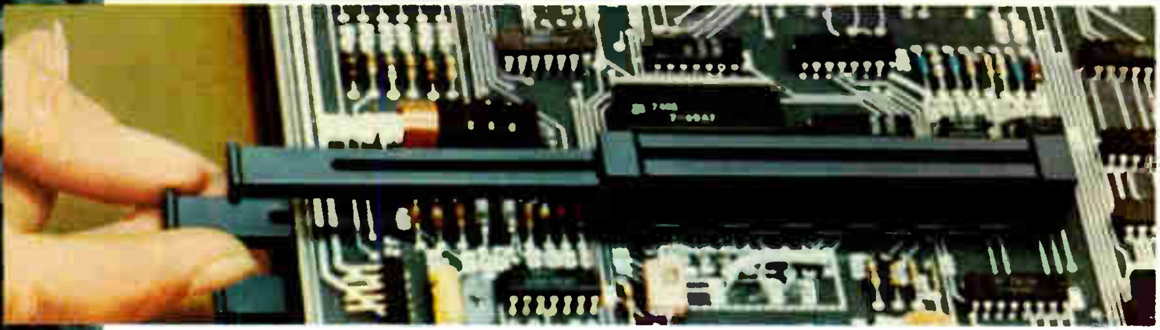






AMP is a trademark of AMP Incorporated

Circle 19 on reader service card

ESSCIRC 77—Third European Solid State Circuits Conference, IEEE *et al.*, Ulm University, Ulm, West Germany, Sept. 20–23.

Eascon—Electronic and Aerospace Systems Convention, IEEE, Sheraton National Hotel, Arlington, Va., Sept. 25–28.

International Electrical Electronics Conference & Exposition, IEEE, Automotive Building Exhibition Place, Toronto, Canada, Sept. 26–28.

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

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

Advanced Techniques in Failure Analysis Symposium, IEEE, Marriott Hotel, Los Angeles International Airport, Sept. 27–29.

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

Industry Applications Society Annual Meeting, IEEE, Marriott Hotel, Los Angeles, Oct. 2–4.

Euromicro—Third Symposium on Microprocessing and Microprogramming, IEEE *et al.*, Free University, Amsterdam, the Netherlands, Oct. 3–6.

Nepcon 77 Central, Industrial & Scientific Conference Management Inc. (Chicago), O'Hare International Trade and Exposition Center, Chicago, Oct. 4–6.

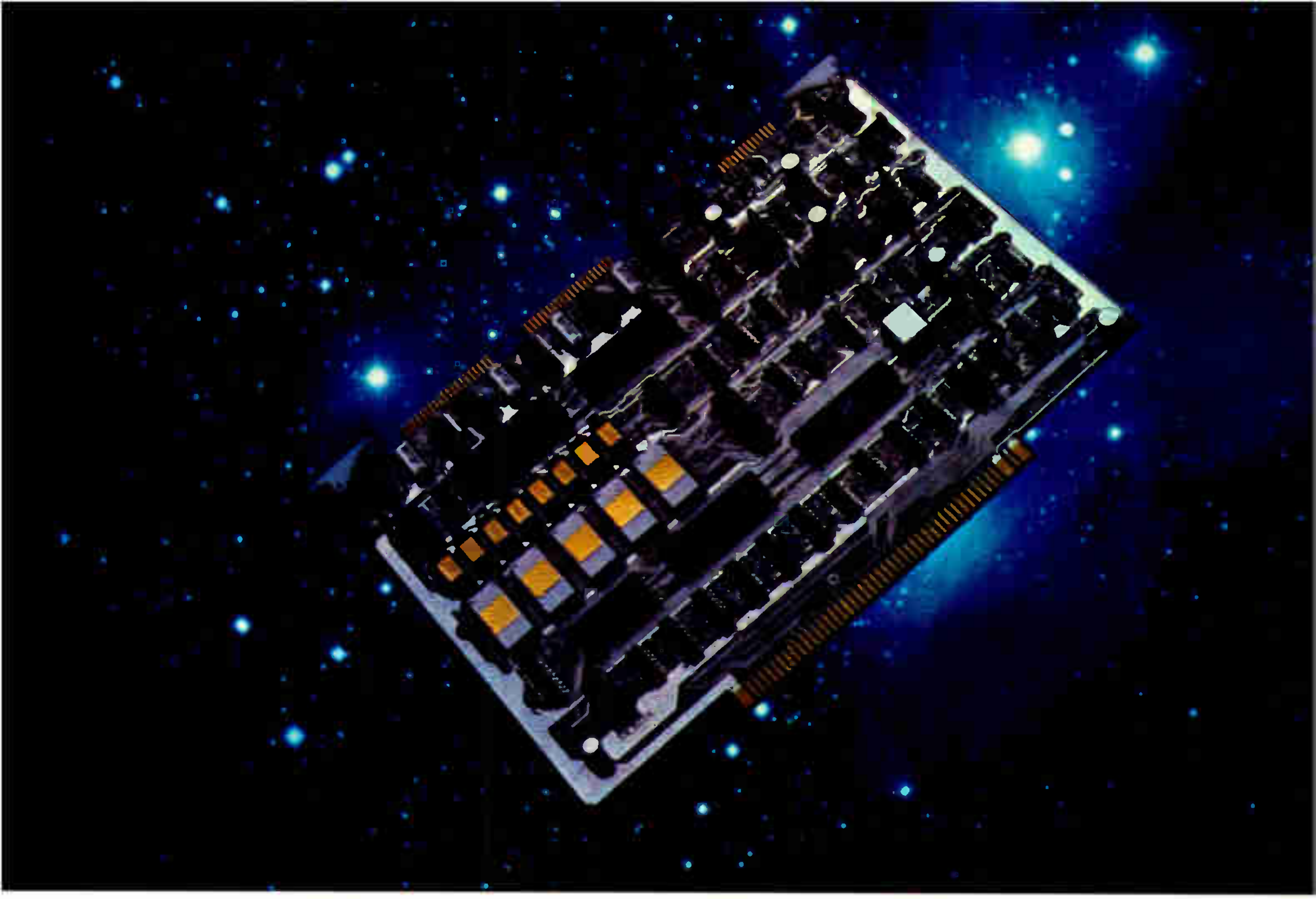
Gidep—Government-Industry Data Exchange Program Conference, Gidep (c/o Dennis Starling, Datagraphix, Inc., San Diego, Calif.), South Coast Plaza Hotel, Costa Mesa, Calif., Oct. 5–7.

Interkama 77—International Congress and Exhibition for Instrumentation and Automation, NOWEA (Düsseldorf, West Germany), Fairgrounds, Düsseldorf, Oct. 6–12.

Electrochemical Society Electronics Division Symposium, The Electrochemical Society (Princeton, N. J.), Hyatt Regency Hotel, Atlanta, Ga., Oct. 9–14.

IntelCom 77—International Telecommunication Exposition, Horizon House International (Dedham, Mass.), Georgia World Congress Center, Atlanta, Oct. 10–15.

Tenth Convention of Electrical and Electronic Engineers in Israel, (c/o Daphna Knassim Ltd., New York, N. Y.), Tel Aviv, Oct. 10–13.



Mostek's*$995 SDB-80 delivers Z80 power and 16K bytes of RAM.

The solution for OEM applications.

For OEM applications, the SDB-80 is one of the most powerful, yet low-cost microcomputers available in the industry. For $995 (single unit cost), the SDB-80 single-board microcomputer provides Mostek's Z80 CPU (MK 3880), eight MK 4116 16K RAM memories, two PIO's (MK 3881), one CTC (MK 3882), serial ASCII interface (110-9600 baud) sockets for up to 5K bytes of PROM or 20K bytes of ROM, plus a fully-buffered and highly-sophisticated system bus for complete expandability (including multi-processor applications).

The solution for software development.

For software development, the SDB-80 is available with a complete package of software development aids in ROM. This optional 10K byte firmware package may be located in sockets on the board to provide the ability to generate, edit, assemble, execute, and debug programs for all types of Z80 applications.

For users requiring even greater system capability, the SDB-80 is expandable with the use of optional add-on boards. In this way, the user may configure his system to include any amount of PROM, ROM, RAM or I/O desired, plus add such features as in-circuit emulation, floppy-disk interfaces, and PROM programming capability.

For more information on the SDB-80 and the complete range of optional support boards, software, and boxes, contact your local Mostek sales office or representative.

MOSTEK

1215 West Crosby Road • Carrollton, Texas 75006 • (214) 242-0444 • **MOSTEK GmbH** • West Germany • Telephone: (0711) 701096 • **MOSTEK ASIA** • Hong Kong • Telex: 85148MKA HX

*Single unit cost. Prices apply within the U.S. and Canada. Eurocard version available. Contact Mostek GmbH.

A new direction in microprocessor design aids.

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

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

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

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

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

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

THE TEKTRONIX 8002 MICROPROCESSOR LAB

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

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

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

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

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

Backed by years of experience, Tektronix also offers you a rare commodity in the field of microprocessor development tools: local Field Engineers and local service. A nation-wide network of Field Offices and Service Centers is ready to help you realize the full benefits of the 8002.

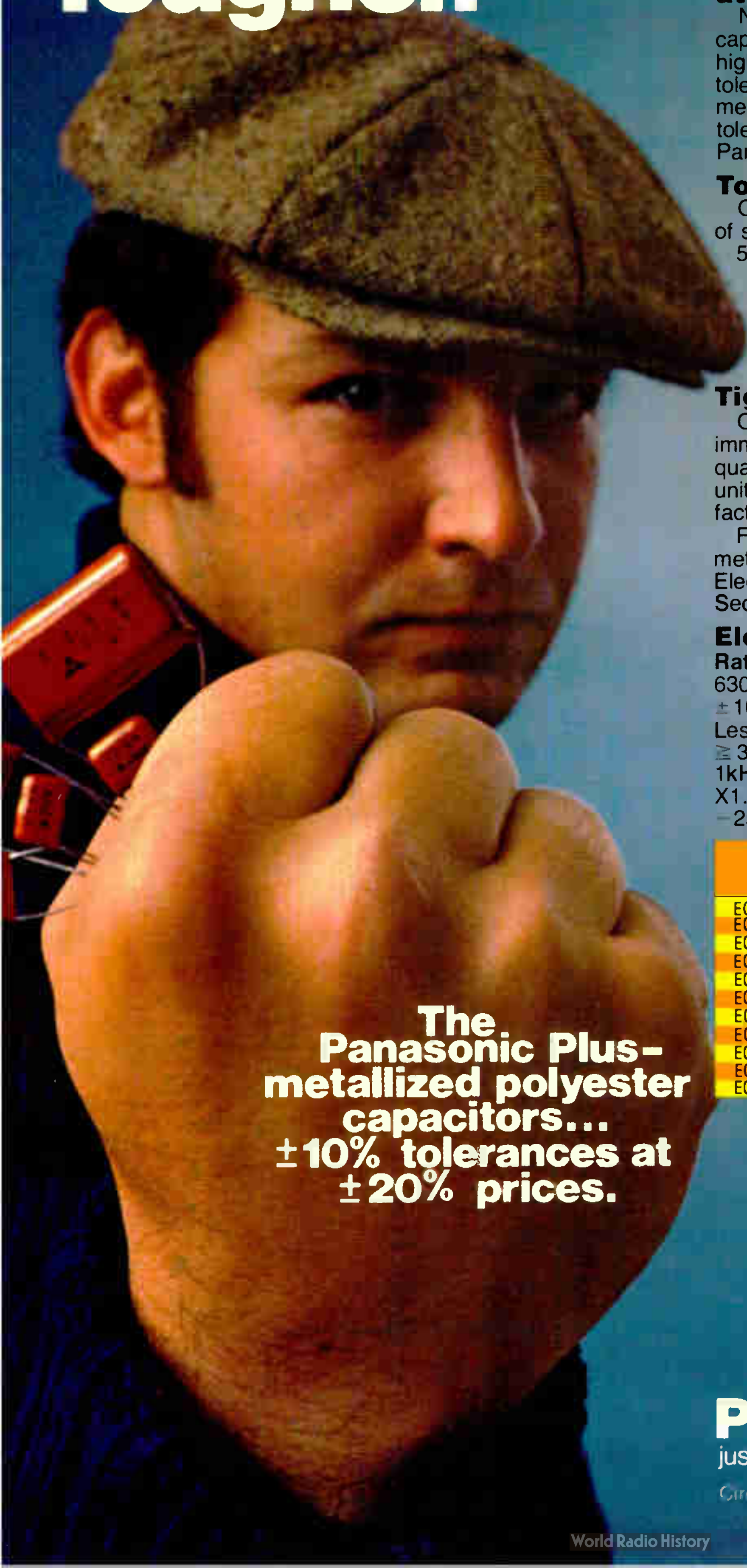
For more information or a demonstration of this new software development tool, write Tektronix, Inc., P.O. Box 500, Beaverton, Oregon 97077.

The 8002... with multiple microprocessor support.

Tektronix®
COMMITTED TO EXCELLENCE

For Technical Data circle 22 on reader service card
For Demonstration circle 23 on reader service card

Tighter and Tougher.



Tighter tolerances at tough-to-beat prices.

Now you can have metallized polyester capacitors with tighter tolerances, *without* paying higher prices. At Panasonic, we offer you ±10% tolerances for what you'd expect to pay for metallized polyester capacitors with ±20% tolerances. And that's just another example of the Panasonic Plus.

Tougher leads.

Our specs call for our leads to withstand 2.2 lbs. of steady pull applied radially to the lead wire for 5 seconds. That's really tough. And we back up our specs with a special offer: send back any Panasonic Type ECQ-E (Z) metallized polyester capacitor that loses a lead in normal manufacturing, and we'll replace it with two units free of charge.

Tighter lead times.

Our popular 250VDC capacitors are available for immediate, off-the-shelf shipment in OEM quantities. And our 100, 400, 630, and 1,000VDC units are available almost as quickly, with normal factory lead time.

For free samples and a catalog of Panasonic metallized polyester capacitors, write: Panasonic Electronic Components, One Panasonic Way, Secaucus, N.J. 07094. Or call (201) 348-7268.

Electrical Specifications

Rated Voltage: 100V.D.C., 250V.D.C., 400V.D.C., 630V.D.C., 1,000V.D.C. **Capacitance Tolerance:** ±10%(K), ±20%(M). **Insulation Resistance:** Less than 0.33μF ≧ 9,000MΩ; 0.33μF, or more ≧ 3,000MΩ·μF. **Dissipation Factor:** ≦ 1.0% at 1kHz. **Withstanding Voltage:** Rated Voltage X1.5 (1 min.) **Operating Temperature:** −25°C ~ +85°C.

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

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Electronics newsletter

SMC gains patent on 1-transistor memory cells

Standard Microsystems Corp. of Hauppauge, N. Y., which recently received fees from Texas Instruments, ITT, and others for nonexclusive licenses on its basic patent covering an oxide-isolated MOS process called Coplamos [*Electronics*, Aug. 4, p. 72], is receiving another patent that **could have as profound an effect on the $8 million MOS LSI manufacturer.** The new patent covers an advanced MOS one-transistor cell with divided and balanced bit lines, coupled by regenerative sense amplifiers, and balanced access circuitry. This technique, which is now being used by some major manufacturers to design and build 4-k dynamic RAMS, could "play a major role in the eventual realization of single 5-v-supply 16-k and 65-k dynamic RAMS," says Paul Richman, president. Also, Richman says, the Patent Office has notified him that it will allow all claims relating to the company's still undisclosed Clasp technology [*Electronics*, Aug. 4, p. 72].

Algol-based structured language offered by Data General

Data General Corp. is releasing its version of an Algol-like language that it claims is the minicomputer industry's first high-level structured programming language. Called DG/L, it is for sophisticated original-equipment manufacturers and systems houses and has been used by the Southboro, Mass., minicomputer manufacturer in-house for several years. Since it is Algol-based, the language is highly efficient; but the beauty of DG/L, says Data General, is that **it can be used on every product in the company's line,** from the Micronova right up through the Nova and Eclipse series.

The nearest competition to DG/L is the Hewlett-Packard Co.'s version of Algol—System Programming Language, or SPL, which runs on its HP-3000 series only. Digital Equipment Corp. offers a version of Algol, called Bliss, on its DECsystem 10 and 20 computers only. DG/L will be available at a one-time cost of $5,000, which includes an on-site engineer on loan for 40 hours.

Intersil to unveil line of standard n-MOS memories

One year after the Intersil–Advanced Memory Systems merger, **look for a blitz of sophisticated standard memory products** from the new Intersil Inc. Using advanced n-MOS processing, the Santa Clara, Calif., company is now going into production on a 4,096-bit 2114-type static random-access memory that is as fast as the Intel original but dissipates 30% to 60% less power; a 4-k-by-1-bit static RAM with the same specs; a high-speed—150 ns—version of Mostek's 4-k 4027 dynamic RAM; and a 2708 ultraviolet-erasable programmable read-only memory. By the end of the year the company also expects to be in production with a 5-v, 16-k 2716-type UV-erasable PROM; a high-performance, 8-k static RAM; and a second-source version of Mostek's 16-k 4116 dynamic RAM.

Sylvania develops radar detector for combat troops

A hand-held unit that detects radar signals and warns combat troops that they are under surveillance before the radar can pinpoint their position has been developed by GTE Sylvania Inc.'s Electronic Systems Group, Waltham, Mass. It's said to be the first off-the-shelf product for this purpose in the U.S. **The 8-lb device, designated the RWR-1000, consists of a wideband receiver, a signal-processing and self-test circuit, a light-emitting-diode display, and a control panel.** Having a frequency range of 8 to 18 GHz, it can detect continuous-wave or pulsed signals from antipersonnel radars and can monitor and locate front-line anti-aircraft gun radars plus fire-control and mortar-locating radars.

Electronics newsletter

Rockwell's first n-MOS ROM to be a 32-k device

Rockwell International's first n-MOS memory will be a 32,768-word read-only device. The Anaheim, Calif., microelectronic device operation previously specialized in p-channel technology. Featuring a 250-nanosecond access time, **the Rockwell ROM is "essentially available" now,** a marketing official says, with delivery eight weeks after receipt of user codes. Initial price is about $20 in 1,000 lots.

Motorola becoming second source for TI 4-bit controller

Watching the ever-growing popularity of Texas Instruments Inc.'s 4-bit controller, the TMS1000, Motorola Inc. has decided to copy it. When it sees its first parts this month, Motorola's Austin, Texas, operation will become the 4-year-old microcomputer's first true second source.

But while maintaining hardware and software compatibility with TI's p-channel MOS device, **Motorola will implement it in complementary-MOS, opening up markets that may need the better noise immunity** of C-MOS, including automotive and power-systems control. And where TI's 15-volt TMS1000 uses 90 mw, Motorola's MC141000 dissipates only 2.5 mw at 5 v, or as low as 500 μw with a 3v supply.

TI is not far behind, however. It is readying its own C-MOS version, designated the TMS1000C, for fourth-quarter availability. It will be fully compatible with other TMS1000 families, and will carry specifications roughly similar to Motorola's.

Boston bank gets microwave data link

One of the first microwave data-communications links tieing a bank's central computer to remote terminals has been installed at the First National Bank of Boston by Microwave Associates Inc., Burlington, Mass. The link connects the bank's central IBM 370 to cathrode-ray-tube terminals at the main office four miles away. The $177,000 system handles 64,000 characters a second and is **designed to compensate for component failures with no loss of data**—a critical consideration in financial transactions.

Fast 65-k ROM due this month

Watch for Mostek Corp. to join American Microsystems Inc. and National Semiconductor Corp. in sampling 65,536-bit read-only memories this month. Although built with an n-channel process, the new part, according to Mostek, will have a **typical access time of 150 to 200 nanoseconds, and maximum speeds well under 300 ns** with under 200 milliwatts maximum active power dissipation and under 50 mw standby power. The Carrollton, Texas, memory maker is building its MK36000 with its standard n-channel silicon-gate MOS process, yet has kept chip size to 34,770 square mils.

Addenda

Motorola Semiconductor's Integrated Circuits division is evaluating the first devices in its low-power version of Texas Instruments Inc.'s 4-bit TMS-1000 microprocessor series. **Motorola expects to be marketing the device, the C-MOS 14100, before year-end,** officials say . . . . Low-cost microprocessors are responsible for a whole new area in the navigation field, particularly in Omega and Loran equipment, according to Frost and Sullivan Inc., a New York market-research firm. The firm projects a total accumulative Omega market for airborne and marine applications ranging from **$118 million to $144 million for calendar years 1977 through 1982.**

The 8080A diagram

At this writing, National Semiconductor is offering 60 support products for its 8080A microprocessor. (Most are off the shelf; all are compatible with National's standard MICROBUS,™ and with microprocessors of the future.)

Micro Bus

Digital I/O

Part No.	Description
8202	Tri-State 8-Bit Bus Driver
8203	Tri-State 8-Bit Bus Driver (Inverting)
82LS05	1 Out of 8 Binary Decoder
83C06	8-Bit I/O Latch
8208	8-Bit Bidirectional Bus Driver
8212	8-Bit Input/Output Port
8213	Bidirectional 8-Bit I/O Port
8216	4-Bit Bidirectional Bus Driver
8226	4-Bit Bidirectional Bus Driver (Inverting)

Peripheral Control

Part No.	Description
8244*	90-Key Keyboard Encoder
8245	16-Key Keyboard Encoder
8246	20-Key Keyboard Encoder
8247*	4-Digit Display Controller
8248*	6-Digit Display Controller
8253*	Programmable Interval Timer
8254	Programmable Bit Addressable Interface
8255	Programmable Peripheral Interface
8257*	Programmable DMA Controller
8258*	Advanced Programmable DMA Controller
8259*	Programmable Interrupt Controller
8272*	Floppy Disk Formatter/Controller
8276*	CRT Controller
8285	Character Generator
8292	8-Bit A/D Convertor with 16-Channel Analog Mux
8294	3-3/4-Digit DVM with Multiplexed BCD Outputs
8298*	LLL 8080A "Basic" Interpreter Plus Hex Debugger

Intel couldn't run.

Intel offers only 29 support products.
Which leaves us with 31 more ways we can help you get the job done.
And that's kinda nice.

8080A Microprocessor

Part No.	Description
8224	Clock Generator and Driver for the 8080A CPU
8228	System Controller and Bus Driver for the 8080A CPU
8238	System Controller and Bus Driver for the 8080A CPU

Communications

Part No.	Description
8250	Asynchronous Communications Element
8251	Programmable Communications Interface
8252*	Advanced Programmable Communications Interface
8261*	Programmable Communications Subsystem
8274*	Multi-Protocol Communications Controller-SDLC, ADCCP, Bisync, DDCMP
8283*	Advanced SDLC, ADCCP Protocol Controller

Memory

Part No.	Description
8356	2048X8 ROM, 128X8 RAM I/O
8154	128X8 Static RAM with 16-Bit I/O
8364/ 8364E*	8192X8 MOS Mask ROM (E is 2708 Compatible)
8316A/E	2048X8 MOS Mask ROM
8332E	4096X8 MOS Mask ROM (2708 Compatible)
1702A	256X8 EPROM
8704	512X8 EPROM
2708/8708	1024X8 EPROM
8101A-4	256X4 Static RAM with Separate I/O
8111A-4	256X4 Static RAM with Common I/O
8102A	1024X1 Static RAM
74C920	256X4 CMOS Static RAM with Separate I/O
74C921	256X4 CMOS Static RAM with Common I/O
74C929	1024X1 CMOS Static RAM
2114	1024X4 Static RAM
MM257	4096X1 Static RAM
DM87S296*	512X8 Bipolar PROM
5290	16K Dynamic RAM
8316A/E	Mask ROM (2708 Compatible)
DM74S472*	512X8 Bipolar PROM/20-Pin DIP
MM5204	512X8 EPROM

*Available soon.

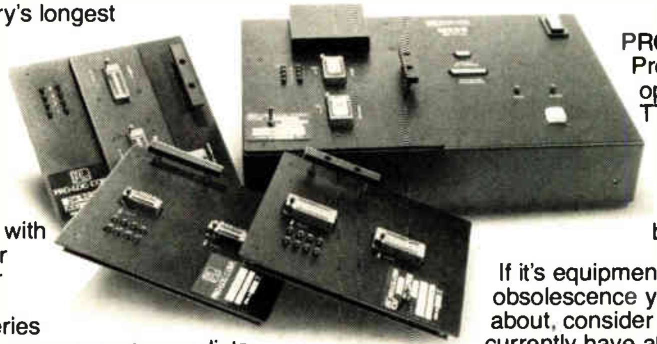
Pro-Log taught the PROM programmer to think so you can relax.

Way back in 1973, Pro-Log revolutionized PROM programming with a microprocessor-based programmer that simplifies programming and lets you relax.

Because it analyzes PROMs as they're being programmed, it minimizes dropped data and mis-programming, and maximizes PROM yield.

It leads you step by step through each programming operation to lessen the chance of mistakes.

Our microprocessor-based control unit is so reliable we back it with the industry's longest warranty, 2 full years parts and labor.



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

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

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

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

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

If it's equipment obsolescence you're worried about, consider this. We currently have about 2,000 Series 90 PROM Programmers in use worldwide. And every one, oldest and newest alike, accommodates every one of our field-proven PROM Personality Modules including our new Generic PROM Personality Modules.

Try programming your next PROM the relaxing way. For a demonstration or for the latest version of our 48-page PROM User's Guide, contact Pro-Log Corporation, 2411 Garden Road, Monterey, CA 93940. Phone (408) 372-4593.

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PRO-LOG CORPORATION

Microprocessors at your fingertips.

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New committee opposes Hogan in IEEE election

Good Government Group is rapped for being 'elitist'; fight is over extent of professional activities

In the series of offensives and counteroffensives that by now characterize the Institute of Electrical and Electronics Engineers' annual elections, the latest is the formation of a grass-roots committee to oppose the Good Government Group set up recently by top industry officials and academicians.

Called the Electrical and Electronics Engineers' Committee for a Member-Oriented Institute, the new committee wants to reelect Carleton Bayless as IEEE executive vice president and defeat his opponent, GGG candidate C. Lester Hogan [*Electronics*,, Aug. 4, p. 70]. The broader issue is whether the IEEE should give priority to professional or technical activities. Bayless, a division manager for Pacific Telephone & Telegraph Co., won the seat of IEEE executive vice president as a petition candidate last year. He was renominated for the post by the board of directors this year. Hogan is vice chairman of Fairchild Camera and Instrument Corp.

In its initial solicitation sent to about 400 IEEE members, and in a follow-up mailing to 4,000-plus IEEE activists, the new committee says Hogan "is supported by a group [the GGG] that is primarily appealing to an 'elitist' point of view. Some members of this group held high IEEE offices during the 1960s and did nothing to avoid the painful situation that developed for many of our members at the turn of the decade. They appear to want the institute to return to the narrow technical base of that period."

Engineers' committee member Robert Rivers, president of Aircom Inc. in Union, N. H., declines to identify other members of the San Francisco-based group. His reason: "The GGG is a very powerful group, and the potential for retaliation is very great." What's more, he says the Good Government Group's reference to itself as the IEEE/GGG "is illegal, since it's not a duly constituted IEEE committee." And "they are pretty well-heeled, with enough money to buy the entire IEEE member voting list."

A spokesman for the IEEE in New York confirms its voter mailing list "was supplied to the GGG at a cost of 2.2¢ per label," or about $3,100. Also, he points out that IEEE president Robert M. Saunders wrote to GGG secretary F. Karl Willenbrock advising him against using the description IEEE/GGG.

In his turn, Willenbrock, who is dean of the Southern Methodist University School of Engineering, regrets any confusion of GGG with official IEEE groups and adds that in the future it will be calling itself "the Good Government Group, an independent organization of IEEE members." He further notes that the group has indeed bought the IEEE voting list using voluntary contributions and plans to make a full mailing in support of Hogan.

Presidential opinion. Where do presidential candidates Ivan Getting and Irwin Feerst stand in all this? Hogan says he's "completely satisfied" with Getting, the president of Aerospace Corp. in El Segundo, Calif., who, however, is noncommittal on whom he is endorsing for the executive vice presidency.

Feerst, on the other hand, in his September newsletter calls the GGG "a hard core of moneyed Neander-

IEEE, Guarrera counter Hogan criticism

The IEEE and its professional activities vice president, John Guarrera, are objecting to accusations to the effect that Guarrera led a takeover of the IEEE's leadership and that the institute's response to professional interests has since been at the expense of technical activities.

In a letter to members drumming up support for his campaign to become IEEE executive vice president, C. Lester Hogan charged that a group under Guarrera "led a revolt in 1971 and took control" of the IEEE. "Instead of serving their terms and passing from the scene . . . they have formed an insidious machine that has kept control of our organization."

Says IEEE president Robert Saunders, the "development of the professional aspect of the institute has occurred at the same time that the institute has been advancing its technical programs beyond all expectations." Guarrera, also a former IEEE president, says that the attempt to label him the "sole candidate for leadership of the '70s is sheer demagoguery" and "nothing more than a transparent attempt to create dissension internally."

thals who have banded together to return IEEE to its previous existence as a purely technical society." The election of Getting or of Hogan "would be a disaster of the first magnitude," he claims. "It is not merely that professional activities will be discouraged, they simply will not be tolerated."

A consultant and perennial petition candidate, Feerst notes the $3,100 spent on the IEEE member voting list represents a small fraction of the cost of GGG's planned mailing. He estimates it will cost a further $5,700 to $19,000 for postage to the IEEE's 20,600 foreign and 122,400 American voting members, so that the Good Government Group has committed between $8,800 and $22,100 to inflict its will on the American working EE." □

Data security

Fairchild introduces set of bit-slice chips for high-speed data-encryption marketplace

Another semiconductor maker is taking aim at the requirements of the National Bureau of Standards' new data-encryption standard for Government computing facilities. This time it is Fairchild Camera and Instrument Corp., which joins Motorola Semiconductor [*Electronics*, July 7, p. 40] and Rockwell International (see "Rockwell's data encryptor bows," below).

But Fairchild's high-speed, bit-slice approach has a different aim from the others' single-chip solutions. "We considered the single-chip approach but abandoned it when it became clear that it was adequate only for data terminals, a small portion of the total market available for data encryption," says Krishna Rallipalli, advanced products marketing manager at the LSI division in Mountain View, Calif.

Ten-plus megahertz. Fairchild's 9414 set of four bit-slice chips is capable of data rates as high as 10 to 12 megahertz, four to six times faster than the rates possible with the single metal-oxide-semiconductor chips. The goal of speed virtually dictated the choice of a bit-slice design and its inherent speed advantage over byte-oriented processors. Rallipalli also points out that a four-chip approach means less density per chip and the chance for higher yield in manufacturing than the larger single-chip MOS designs. Moreover, Fairchild's bipolar injection logic is faster than MOS.

"There are numerous computer-to-computer communications and data-storage applications where a 10-MHz capability is needed, and which also must be kept safe," Rallipalli says. Single-chip devices capable of 2-to-4-MHz cycle times are adequate for terminal-to-terminal and terminal-to-computer communications.

Fairchild's four chips encrypt and decrypt 8-bit data bytes in 2-bit slices. The chips are virtually identical except for the microcoding in their read-only memories—each has two 64-word-by-4-bit ROMs. This difference in microcoding is necessary because the Fairchild approach splits the data-encryption algorithm among the four chips. The 8-bit data-word input and the enciphered output are also divided among them.

Availability. The Fairchild devices will be available in sample quantities in November. Target price for production quantities, available by January, is $30 per set, and Rallipalli looks for a $10 price as volume increases.

For storing the data, each chip has a pair of 8-bit shift registers, loaded so that eight words are operated on at a time. Also, the encryption key, a 56-bit data word plus error-checking bits that operates on the data, is broken up into four chunks and stored within four other 8-bit shift registers also on each chip. The devices also contain error-checking circuitry.

The chips communicate over 10 input and 10 output lines, and three control lines are used to specify the desired operation—encrypt, decrypt, or change keys. (Actually, two keys can be stored at any one time and the encryption system can choose one or the other. But it is also possible to alter a key simply by changing the bits stored in any one chip.)

Rockwell's data encryptor bows

A new competitor in the market for data-encryption systems meeting the NBS standard is Rockwell International Corp.'s Collins Government Telecommunications Group in Dallas. Unlike Fairchild, Collins, a supplier of secure communications systems to the military and national security agencies for more than 20 years, will not sell chips. It is going after the end user, such as the financial community, with a 15-pound unit suited for desktop or rack mounting. Introduced last month, the CR-100 network encryptor stores the standard encryption algorithm on a 40-pin chip. The encryption key can be entered in hexadecimal format on thumbwheel switches under a locked cover. The CR-100 actually has a pair of encryption chips, so it can operate synchronously or asychronously in full-duplex mode.

The Rockwell-fabricated encryption chip is large. It is built with p-type depletion-load metal-oxide-semiconductor technology and contains 16,500 devices. Designed to operate under microprocessor control, the chip is capable of a 19,200-bit-per-second data rate when driven by a 1.6-megahertz clock. Higher data rate options will also be offered.

Original-equipment manufacturers will be able to encrypt Rockwell-style when a single-board version of the system bows in October. Called the CR-300, the board will operate at lower speeds than the CR-100 and will find its way into terminals and mini- and micro-computer systems that transmit data over communications links. Price of the units has not yet been set.

Besides the standard market for communication encryption, Rallipalli sees an even bigger one in data storage, such as disk memories. "Here it is important to keep the information confidential not only while it is being communicated to a host computer or terminal but also while it is in storage," he says. "Computer crime, the altering of computerized records, for example, does not usually occur while the information is being communicated from one place to another. More likely, it is done while it is sitting in memory." Encrypted data-storage systems, he says, would make this kind of computer crime harder. "And if it did occur, it would be easier to trace," he says. □

Consumer

Bathroom scales go electronic with lure that appears more intangible than real

For no very weighty reason, bathroom scales are starting to go electronic, and the price leader emerged last month, when the world's largest bathroom scale maker, The Brearley Co., Rockford, Ill., started shipping an under-$50 scale with electronic readout.

The scale is no more accurate than its mechanical forebear, since both use the same weight-sensing device, and the lure for the customer is more intangible than real—"space age styling" and technological snob appeal. Other manufacturers are also introducing bathroom units, as well as electronic versions of the sliding-beam scales found mainly in hospitals and doctors' offices, but for prices of $140 to $300.

To get the volumes it wanted, Brearley first "determined the price and then designed toward it," says chief product engineer Robert Guinter. With its Counselor brand and various private labels, Brearley makes some three million scales a year. The company originally pegged volume of the new scale at 100,000 units through 1978; based on orders at trade shows where prototypes were shown, however, the firm has since doubled its commitment to Fairchild Instrumentation and Systems group, San Jose, Calif., its electronics supplier.

"The only approach we found economically feasible was to use a shaft-encoder on a conventional bathroom scale," Guinter says. So, like its mechanical counterparts, Brearley's new Digi-Tell scale relies on a lever system that transmits the load to an elongating coil spring. In the mechanical model, the spring's position is read off a geared dial printed with numbers and visible through a window in the platform.

Dial count. On the electronic model, however, slots are cut in the dial equivalent to every 4 pounds, and a pair of phototransistors count the edges of each slot as it passes by. "The second phototransistor is a half-slot off, so each edge as seen by the two phototransistors represents 1 lb," Guinter explains. The half-slot differential puts the sensors' square-wave outputs out of phase, which also enables the scale's custom complementary-metal-oxide-semiconductor chip to determine the direction in which the dial is rotating. It counts both up and down and displays weight readings as the mechanism oscillates around its final position. The chip also handles pound-to-kilogram conversion if the user wants it.

Fairchild supplies a circuit-board

On a different scale. Four light-emitting-diode digits display weight on $50 Digi-Tell electronic scale introduced by Brearley.

Electronics plays role in other scales, too

Other scale manufacturers are weighing into the consumer electronic market, too, but with more expensive products aimed less at homes than at doctors and hospitals. They forecast unit sales in the thousands, rather than the hundreds of thousands that Brearley plans to sell. Detecto Scales Inc., New York, for example, is readying a $300 home scale with waist-high LED readout accurate to 0.2 pound, built around a PIC 1650 one-chip microcomputer from General Instrument Corp. Available this month, the scale relies on a foil strain gauge bonded to a solid metal beam that deflects only thousandths of an inch; sensor resistance changes in proportion to the load applied.

A similar mechanism is used in the $400 Computer Scale Brearley introduced last fall. It has a pair of strain gauges that function as a voltage divider to achieve 0.1-lb accuracy. Analogic Corp. of Wakefield, Mass., supplies all the electronics on a single printed-circuit board. Chicago's Borg-Erickson Corp. started shipping a $150 scale earlier this year. The scale's mechanism is similar to Brearley's $50 Digi-Tell, but the light-emitting-diode readout is in a separate box that can be mounted on a wall. A single phototransistor reads lines on a printed disk that is held in place until the weight-sensing mechanism has stopped at its final position. The disk is then released, spins to the mechanism's position, and the weight is read out.

Finally, the Heath Co. got into the bathroom scale business last month with an electronic scale built around four strain gauges, wired in a bridge, and a handful of standard complementary-metal-oxide-semiconductor circuits. The Benton Harbor, Mich., kit producer sells the fully assembled scale for about $140 and the kit for $99.95.

module measuring 2.0 by 4.8 by 0.5 inches. It carries the C-MOS counting chip, a pair of binary-coded-decimal-to-seven-segment decoder and light-emitting-diode driver chips, a biasing network to convert the phototransistor outputs to logic levels, a series protection diode to guard against reversed batteries, and LED die that form the display's four 0.8-inch-high digits. The integrated circuits are unpackaged chips, and the entire circuit board is dipped in urethane for protection against humidity. Finally, a plastic light-pipe assembly over the LEDs brings the images of the digits up to the scale's display window.

The unit operates from four penlight batteries, good for about 1,000 readings, "and the chip is always powered from somewhere between 5 and 25 microamperes to keep internal counting circuitry at zero when the scale is turned on," adds Ken Rinaldo, manufacturing engineering manager for Fairchild. The scale is turned on with a kick-switch on its base, gives a live readout that settles in 4 to 6 seconds, and turns off after about 12 seconds to conserve the batteries. □

Data acquisition

Industry's first one-chip data-acquisition system lowers the cost of analog interface

While the microprocessor has slashed the cost of a system's digital circuitry, the analog portion has remained stubbornly expensive, often costing more than all the chips in the microcomputer itself. That situation is changed by the industry's first-ever data-acquisition chip. From National Semiconductor Corp., Santa Clara, Calif., the package costs less than $20, yet it can replace $100 to $200 worth of hybrid or discrete-component analog cards.

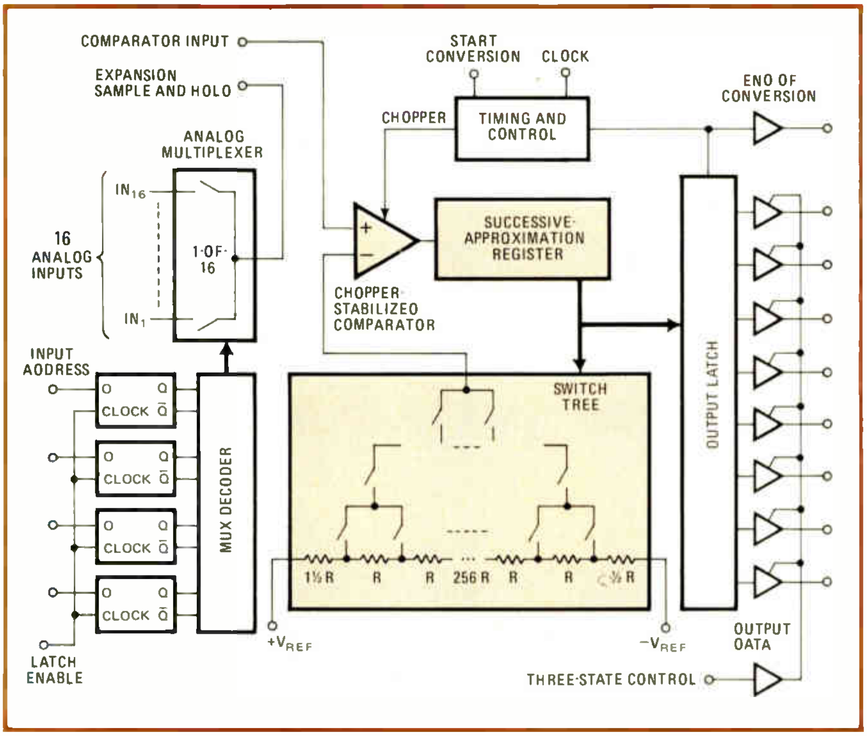
The complementary-metal-oxide-semiconductor ADC 0816 has a 16-channel analog input and 8-bit-word digital output and uses a single 5-volt supply. The one restriction on its usefulness is a conversion speed specified at 100 microseconds. For most hybrids the figure is 25 μs. But National chip designer Jake Buurma points out that the ADC 0816's typical speed is 50 μs—quite fast enough for many applications with slow-changing inputs from, say, pressure, temperature, and velocity sensors. (Fairchild Semiconductor will be introducing a bipolar data-acquisition chip in October.)

On the chip. With its high-density, low-voltage analog C-MOS process, National designers were able to pack onto the chip a classically structured data-acquisition system. Included are a true 8-bit analog-to-digital converter with bus-oriented (microcomputer) outputs, a 16-channel expandable multiplexer with address input latches, latched tri-state outputs, provision for handling external signal conditioning, and all the logic control needed for interfacing the chip to all the standard microcomputers.

Yet these functions consume only 15 milliwatts of power between them, thanks to National's micropower C-MOS process. Also, by using a chopper-stabilizer comparator, the design reduces both long-term drift and temperature coefficient errors to hybrid-version levels, yielding a linearity error of less than ±½ least significant bit over the commercial temperature range of −40° to +85° C.

As shown in the diagram at left, the heart of this single-chip data-acquisition system is the 8-bit a-d converter. The converter consists of a comparator, a 256-step resistor ladder network, and a successive-approximation register. Since the comparator is responsible for the ultimate accuracy of the entire converter, National chose to use a tougher-to-implement but more accurate chopper-stabilized comparator design.

In operation, the chopper-stabi-



Chip design. Key to accuracy of data-acquisition chip from National is chopper-stabilized comparator (in color), which minimizes drift of on-chip a-d converter. Converter elements include resistor ladder and successive-approximation register.

lized comparator converts the dc input signal into an ac signal. This signal is then fed through a high-gain ac amplifier where its dc level is restored. "This technique limits the amplifier's drift," Buurma says, "since drift is a dc component that is not passed by the ac amplifier, and makes the entire a-d converter extremely insensitive to temperature, long-term drift, and input offset errors."

As for the resistor ladder, Buurma points out that the 256-step resistor, or 256R, ladder network was preferred to the conventional R/2R ladder "because of its inherent monotonicity. Monotonicity is particularly important in closed-loop feedback control systems. A non-monotonic relationship can cause oscillations that could be catastrophic." Additionally, the chip's 256R ladder network in the converter does not cause load variations on the reference voltage.

One especially nice feature of the new data acquistion chip, according to Buurma, is its ability to perform without external components in systems using ratiometric transducers, such as potentiometer strain gages, thermistor bridges, pressure transducers, and so on.

"Since in these systems, only the change in the parameter is measured, the device can operate without an external voltage reference," he says. Here the transducer is hooked directly across the supply voltage and the outputs connected directly into the multiplexer inputs. "On the other hand, for systems that require an absolute-value measurement, a standard commercially available voltage reference will be required, in addition to the ADC 0816," Buurma says. □

Consumer

Blaupunkt adds many program-selection features to microcomputer-based TV tuner

European TV addicts afraid of missing a favorite program can relax. One of West Germany's major set makers, Blaupunkt-Werke GmbH, has unveiled a color television set that turns itself on automatically according to instructions keyed in up to a year ahead of time.

German consumers seem to go in for such TV-set gadgetry, but the technology behind it—a standard three-chip F8 microprocessor from Fairchild Semiconductor—is of interest to many others. The application of the microprocessor in the $1,100, 27-inch-diagonal set represents the latest trend in TV design.

Other set makers are also adding microprocessors, primarily to simplify channel selection and tuning. In the United States, for example, both GTE Sylvania and Quasar have already announced such top-of-the-line sets. But Blaupunkt has added many extra features.

"Strictly speaking, the viewer no longer controls the set but instructs the microcomputer to control it for him," says Wolfgang Baum, who developed the new receiver at Blaupunkt's design and applications laboratories that are in Hildesheim, which is near Hanover.

The microcomputer automatically tunes the set's digital tuner to any of 19 channels selected by the viewer with a 30-key remote-control unit. It stores the dates and hours of as many as 20 TV programs as far as one year in advance, turning the set on and switching to the desired channel automatically. It also will search for transmitting stations and turn the receiver off at preset times and when the broadcast day ends.

The microcomputer system also stores digital equivalents of a half dozen analog operating parameters set by the viewer as he or she adjusts the picture. Implemented in earlier German sets with a lower level of circuit integration, these parameters are the coarse and fine tuning levels, volume and picture contrast, brightness, and color-saturation levels. The microcomputer then ensures they are maintained every time the set is turned on, although the viewer can override them.

F8 plus ROM. The Fairchild F8 microprocessor at the core of the system consists of a central processor unit plus a pair of one-kilobyte read-only memory chips that are the program-storage units. Channel information keyed in by the user or adjusted on the set is stored in a 1,400-bit electrically alterable read-only memory, a nonvolatile p-channel metal-nitride-oxide-semiconductor chip supplied by General Instrument Corp. This device stores as many as 20 program-selection instructions, the frequency data for as many as 19 TV stations, and the six operating parameters.

The F8's on-chip clock, which accepts the input from a quartz crystal, supplies the system's timing signals, ensuring in part that the computer switches the receiver on and off at the programmed dates and hours. Sample-and-hold circuits keep the volume, contrast, brightness, and saturation levels at the preselected values and also control

Terminal. Keys on infrared-transmitting remote-control unit adjust channels whose frequencies are stored in a microcomputer memory inside a new Blaupunkt receiver.

Circle 37 on reader service card

Sylvania, Quasar have microcomputer tuning

GTE Sylvania Inc. and Quasar Electronics Co. are two companies in the United States that have introduced microcomputers into top-of-the-line TV sets. But every manufacturer of television receivers is probably looking into the possibilities of microcomputer tuning and control. "It's the kind of thing you'll find in every major TV set in the next couple of years," says Ed Sack, group vice president for microelectronics at General Instrument Corp., Hicksville, N. Y. "Those that haven't introduced it yet are probably a little embarrassed." Sack quickly ticks off the advantages of electronic tuning over mechanical techniques: "It's more reliable, instantaneous, and holds tuning on all channels. It's also easily remote-controllable and allows random access to the channels." He points out, too, that the microprocessor is not only cheaper than earlier small- and medium-scale approaches to electronic tuning but lends itself to other applications, including playing games and processing the inputs from external sensors in the home.

Sylvania and Quasar use their microcomputers in 82-channel electronic-tuning systems. With a push-button control unit, the microcomputers "give the customer a very easy and understandable interface with the set and the flexibility to handle unusual reception conditions," points out Joe DeMarinis, director of engineering for Sylvania's Entertainment Products division in Batavia, N. Y. In its new Supersets, Sylvania uses the Omega Supreme electronic-tuning system and its dedicated microprocessor developed by General Instrument [*Electronics*, April 1, 1976, p. 86]. (GI has also sold its system to Philips and Electrohome in Canada, as well as a smaller 16- or 20-channel system called Economega to Telefunken and other TV makers in Europe.)

Quasar's Japanese parent firm, Matsushita Electric Industrial Co., developed a custom microprocessor for its Franklin Park, Ill., manufacturer. In addition to push-button tuning, it does such things as handle a search-and-stop feature, ramping the tuning voltage until the presence of a TV signal is sensed. The processor also enables the system to tune in carriers that are offset from their correct frequency, a condition that is common in master antenna installations and in some cable TV hookups.

the coarse and fine tuning settings. They scan the stored values 130 times each second and correct for any deviations long before the viewer can recognize them.

For all the jobs the F8 handles, programming it by the remote-control keyboard is child's play, points out Blaupunkt's Baum. In addition to the numbers 0 through 9, function keys represent such items as program, date, and time. For example, a viewer wanting to watch a show on Sept. 9 at 8 p.m. on channel 2 would first push the P (for program) key to signal the computer that an instruction is coming. Next to be keyed in is: 0909 (for Sept. 9), D (for date), 2000 (for 8 p.m.), T (for time), and 2 (for channel 2). Finally, the instruction is entered into the memory by pushing the E key.

As data is keyed in, it can be checked for accuracy on a six-character light-emitting-diode display on the set that uses inch-high digits. On command the LEDs also show such information as time (hour and minutes), the date and hour of the preselected TV show, and the channel number. □

Audio

Special algorithm strikes out noise

Present audio filters are upstaged by a combination of real-time digital-processing and audio technology from Rockwell International Corp. that can clean a signal as it is received or enhance a recording.

"The processor can remove from 40 to 50 decibels of noise with virtually no degradation," says James E. Paul, who developed ADAP—the automatic digital audio processor—at Rockwell's Electronics Research Center in Anaheim, Calif. "Present audio filters are simple bare-bones affairs that typically take out only about 30 dB," he says. "And I'm not aware of any other digital audio processing, except on a special basis, taking less than hours of computer time."

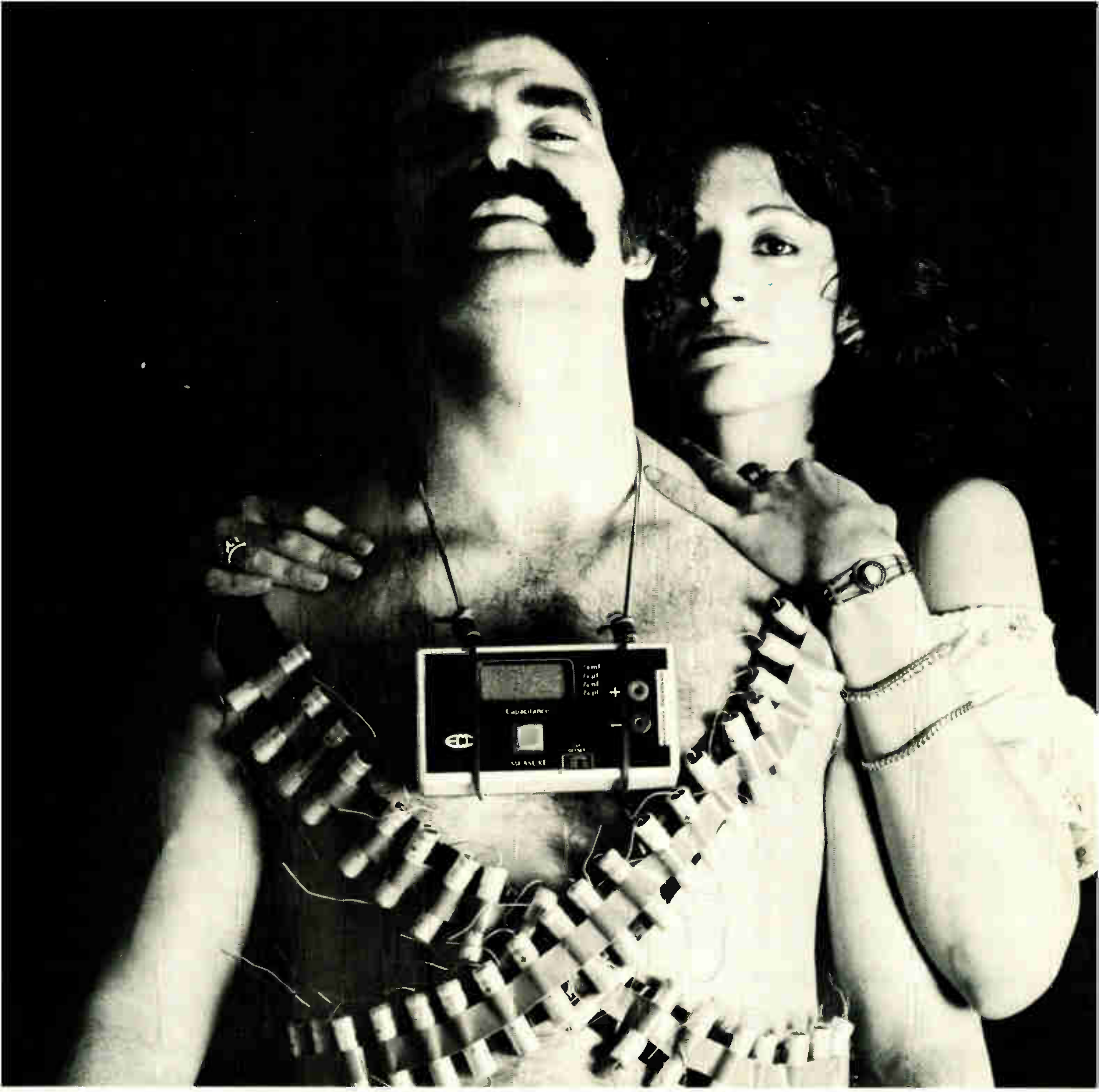
Paul stresses that his machine is not merely a filter: it is a new approach to noise cancellation that relies on noise that is correlated—repetitive and predictable. "We observe an audio waveform continuously, while a special filtering algorithm takes 300 to 400 milliseconds to converge to an optimum solution and eliminate the noise. It arrives at its solution by looking for components in the waveform that are 'stationary' and for those that are not."

Pauses, word changes, and the frequency components in a spoken work are not stationary—they change rapidly with time, explains Paul. On the other hand, noise—such as background music, traffic sounds, room reverberations—is stationary and predictable to varying degrees for relatively long periods.

Rockwell's machine has a special-purpose digital computer with pipeline architecture to facilitate speed. It takes out background noise and—a more subtle problem dogging even high-performance recording and transmission equipment—convolutional noise. Paul says this is the signal interfering with itself because of poor acoustics, resonances, and noise in the recording gear.

Twin modes. The algorithm works in one of two ways. In what Paul calls a "predictive deconvolution mode," it detects noise only when a single channel of audio is available. Such noise is correlated. The algorithm estimates the noise on the basis of a statistical analysis of components in the waveform. After subtracting this estimate, the signal is fed back into an adaptation processor that continuously adjusts for optimum audio output.

In the second, the adaptable-filter mode, two input channels are used. On the first channel goes the audio to be cleaned up. The second channel



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Circle 39 on reader service card

News briefs

Collins gets $100 million for Saudi microwave net
Collins Systems International Inc., Dallas, has received a contract in excess of $100 million from Western Electric for microwave radios to be installed in the $400 million intrakingdom network in Saudi Arabia. The network will interconnect all major population centers with transmission facilities for automatic long-distance telephone service and television distribution.

Low-cost TI solid-state switch bows
Looking for new markets to conquer, Dallas' Texas Instruments is getting into the solid-state switch business with a Hall-effect integrated circuit that sells for a low 36 cents each in hundreds. Housed in a TO-92 plastic package, the chip contains a Hall-effect sensor and signal-conditioning circuitry that triggers its output transistor. Designated the TL170, the device offers bipolar operation so it may be triggered by either pole of an external magnet. It requires a minimum magnetic field density of ±350 gauss over its full operating temperature range of 0°C to 70°C. Major applications include keyboards, push-button switches, and pinball machines.

RCA unveils $1,000 video cassette recorder/player
Forecasting a $1 billion video cassette recorder market only three years away, RCA Corp.'s Consumer Electronics division in Indianapolis chose this month to begin selling a $1,000 video cassette recorder-player. SelectaVision VCR, $300 cheaper than Sony Corp.'s Betamax, is based on a new 4-hour-format video home system from Matsushita Electric Industrial Co. of Tokyo [*Electronics*, April 14, p. 46]. It records 2 or 4 hours of color TV programs. Meanwhile, development of RCA's video disk recorder continues.

Hinkelman to be new director of SIA
the Semiconductor Industry Association, Cupertino, Calif., has picked its first full-time executive director, Thomas Hinkelman, who has till now been the director of product management at Monsanto Commercial Products in Palo Alto, Calif. He takes over from Bernard Marren, one of the founders of the organization.

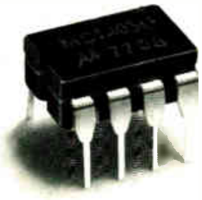
monitors the noise in the area surrounding the input microphone. The signal to the second channel is considered a white-noise source and uncorrelated in nature. However, the noise appears on both channels in phase, so it is correlated. The processor continuously analyzes the noise components common to the two inputs and cancels them. Depending on the amount of noise, it does this in 200 ms to 5 seconds. Although the two-channel method is preferred, the application—such as cleaning up a "bugged" phone conversation—may restrict operation to the single-channel mode.

"We've successfully demonstrated ADAP by cleaning up a number of law enforcement voice recordings and cockpit recordings from aircraft accidents," Paul says. "We've also used it to enhance vintage music records by eliminating the tinny sound and bad acoustics." The Rockwell unit is entirely self-contained; measuring 3½ inches high, 19 in. wide, and 21 in. deep, it weighs slightly less than 40 pounds.

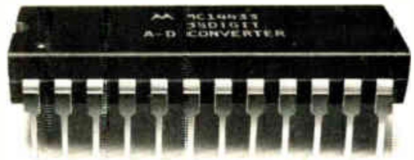
Although the $25,000 price tag puts it out of reach for the stereo

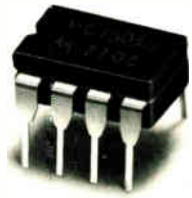
Cleaner. Rockwell's automatic digital audio processor eliminates unwanted noise from audio signals and recordings in real time.

The Rockies may crumble, Gibraltar may tumble, but Our MC1403/1503 Linear VREFs will never drift away.



Keep Your MC14433 Honest

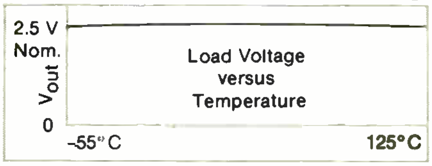




Your leading linear source announces another rock-solid winner . . . a family of precision band-gap voltage references designed for critical low-voltage instrumentation and D/A conversion.

The MC1403/1503 linear units are stable, 2.5 V references powered from 4.75 to 40 V sources. T_C is laser-trimmed to guarantee low maximum selections and V_{REF} to ≤ ±1%.

20 PPM/°C Accuracy

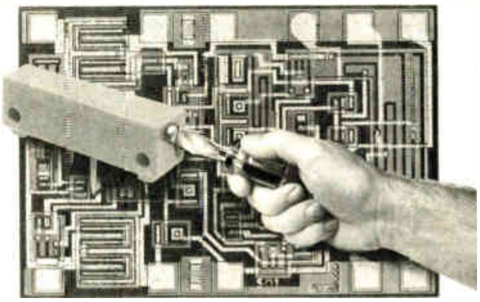


Ever see a delta curve that flat? At load currents down to zero? Change in V_{REF} over the -0° to +70°C range for the MC1403 is typically 3 mV—less than 20 PPM/°C or a change of only 0.1%.

Equal accuracy's offered for V_{out} versus I_{load} and V_{line}, too. Change in V_{REF} over the complete 0 to 10 mA load current range is typically 2.8 mV, or 0.1%, and change in voltage over the 15 to 40 V_{line} reg spec is 0.5 mV typical, or less than 0.02%.

The '1403 was just made for it. With its accuracy, stability and low-voltage pull, it's ideal for use with MC14433 3-1/2-digit DVMs. Or, for that matter, D/As using MC1406/1506, 1408/1508, 3410/3510 and 3408 D/A converters. All need stable current referencing and all you do is add a series resistor or two. An additional variable pot provides full-scale adjust.

Laser-trimmed T_C?



Yes. We've learned to adjust T_C with lasers. Unique circuit configuration allows correlating T_C to an absolute voltage value allowing trimming at probe level to that voltage. We know exactly what the T_C will be before it goes into the package. In fact, we can MAKE the T_C what we want rather than leave it to chance.

Then we automatically 100% test over temperature range. The highest possible yields to the tightest possible spec—and the lowest possible cost to you—result.

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buff, professionals are not balking, Paul says. "Of 20 or so law-enforcement-related Government agencies that have seen demonstrations, more than half have said they intend to buy." Next comes demonstrating the processor to broadcasters. □

Lasers

Sanders illuminator emits at 0.85 μm

A laser material that can outperform some of the most widely used lasers in many military and some civilian applications has reached commercial reality at Sanders Associates Inc., Nashua, N. H. The host material is lithium yttrium fluoride, which, when doped with erbium, emits at a wavelength of 0.85 micrometer [*Electronics*, May 26, p. 36]. That is in the near infrared and a good match as an illuminating wavelength with readily available detectors, say Sanders engineers. Those detectors include silicon and infrared film.

Solid state. The material, which Sanders calls er:YLF, has been under development at Sanders' Defense Systems division since 1971, with company, Air Force, and Defense Advanced Research Projects Agency funds. It is used in a flash-pumped, solid-state laser transmitter that puts out 50 millijoules per pulse, has a pulse-repetition rate of 1 to 10 hertz, and could be built to order for approximately $35,000, including power supplies and cooler.

Evan Chiklis, manager of the Sanders division's laser department, stresses that the initial 0.85-μm product is specified conservatively, and that the material is capable of pulse-repetition rates up to 60 hertz. There is nothing exotic in the technology, including the crystal pulling, he says, so that in volume production er:YLF lasers should be able to compete in price with neodymium-doped YAG, ruby, gallium-arsenide, and gallium aluminum arsenide lasers, which are about half the price of the initial Sanders product.

Sanders sees the material as a candidate for illuminators in military surveillance and target-acquisition systems, in underwater mining and in commercial holography. Chiklis says the material's performance—a single-shot pulse width of 100 nanoseconds—makes it ideal as an illuminator in covert photography and for gated-viewing systems.

One advantage of er:YLF over gallium arsenide as an illuminator is that the newer material needs no cryogenic cooling but operates at room temperature. Further, its beam divergence is only about 0.1° versus approximately 30° for gallium arsenide. "The beam divergence of gallium arsenide dictates expensive optics to collimate the beam," Chiklis explains, adding that with er:YLF only converging and collimating lenses are required at the rod's output. Er:YLF has the same beam-divergence advantages over gallium aluminum arsenide, he says.

Sanders investigated the material because it is one of the few fluorides with a natural rare-earth site in its lattice in which to deposit dopants. And as a fluoride, it is easier to grow than most oxides, Chiklis says. The er:YLF is a low-threshold, four-level material in which engineers have observed more than 20 transitions. Three-level lasers, such as ruby, require more power to operate, Chiklis says. That is because half the ions must be pumped from a ground level through a pump band to an upper level.

In contrast, "in a four-level laser, we start with more ions at the upper level," he points out. Combined with er:YLF's much lower threshold than ruby, this means that an illuminator using the Sanders laser would need less than 10 joules compared with some 200 joules per pulse needed for a ruby laser to achieve threshold.

Chiklis believes the material has advantages over Nd:YAG as well, for some applications. One he mentions is in a gated-viewing system for deep-sea mining. "In certain types of sea water," he says, "frequency-doubled er:YLF at 0.425 μm has very high optical transmission, much higher than frequency-doubled Nd:YAG at 0.533 μm." □

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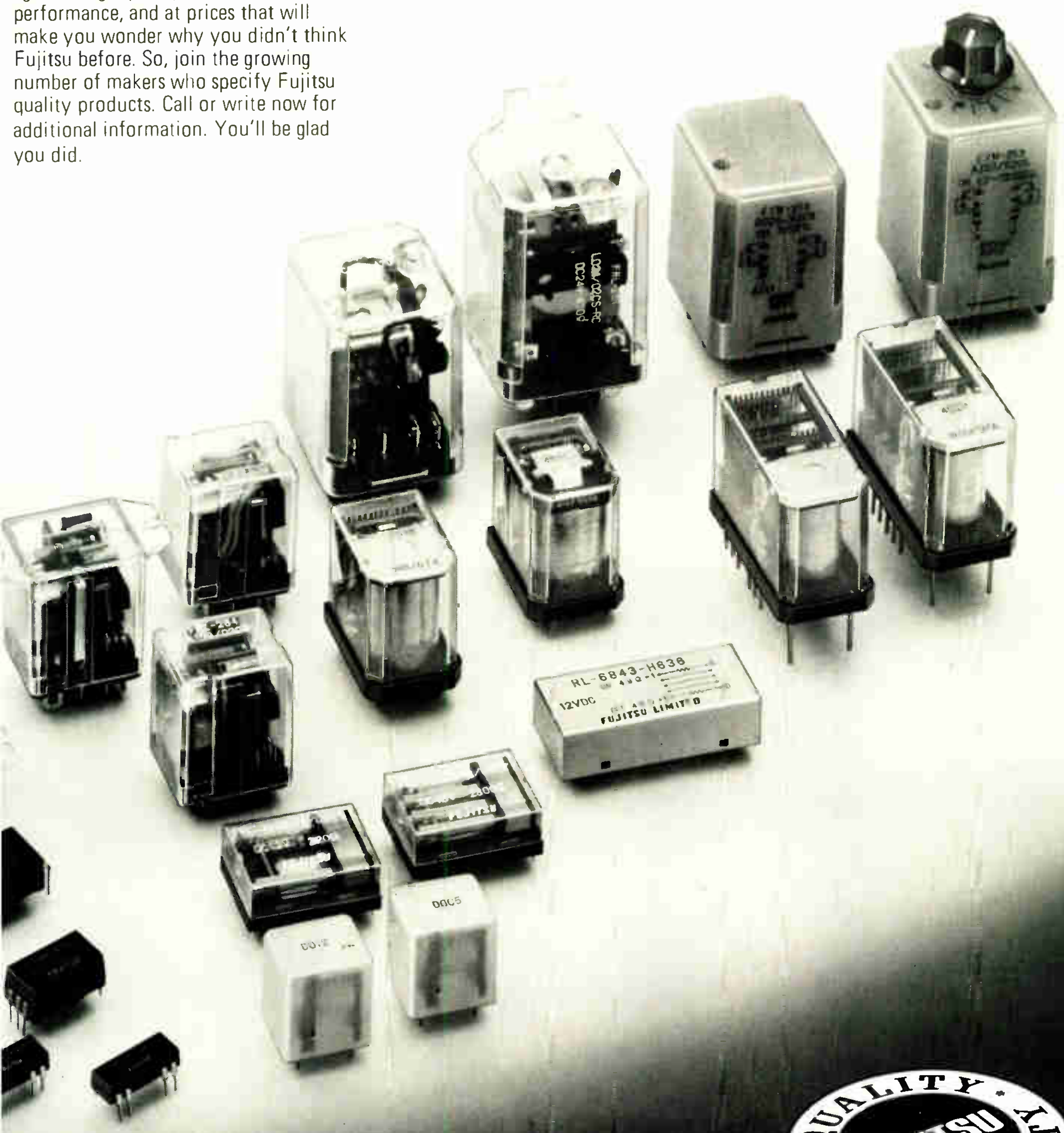

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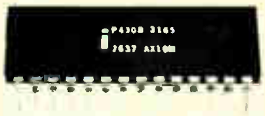

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Medical device notifications to FDA to begin Sept. 22

Manufacturers of hundreds of different electronic medical devices, from pacemakers to electroencephalographs, **will be required to register with the Food and Drug Administration by Sept. 22** and submit a premarketing notification for each sophisticated product that is new or substantially different from others already on the the market. Rejecting objections from device manufacturers, the FDA has ruled that companies are prohibited from marketing new devices until 90 days after submitting all information requested by the agency.

The industry says the 90-day clock should start ticking the day the original notification is submitted, because repeated FDA requests for information could indefinitely delay new product marketing. The FDA replies that it will expedite reviews of supplemental information. The industry gained one key concession: **notifications will not be available for general public review for 90 days** as long as the company itself does not disclose its product.

The FDA's notification requirements include: name of the device; its intended uses; samples of proposed labeling and advertisements; and engineering drawings, photographs, and data that indicate the similarity of the device to others. The company must prove that its device is similar to others or conduct elaborate tests to prove safety and efficacy. The FDA has printed registration forms for device manufacturers, but each company will be responsible for the format of marketing notifications. Information and registration forms are available at regional FDA offices or at the Silver Spring, Md., headquarters of the FDA's Bureau of Medical Devices.

Interface compromise will complicate Federal EDP buys

The National Bureau of Standards has come up with a compromise input/output interface to guide Federal procurement of computer equipment. The technical specifications, as previously proposed, require IBM-compatible equipment—satisfying the makers of peripherals that already meet IBM specifications. But the standard has **a loophole that permits Government agencies to consider systems that do not have the standard interface**—appeasing systems manufacturers like Honeywell and Control Data. The loophole: the vendor must promise to sell an interface converter later if the agency wants it. The compromise enables the Government to "take advantage of the whole marketplace," an NBS official says, but he warns that it will severely complicate the Government's computer procurement process.

Pentagon to seek $260 million for Missile X next year

With the B-1 bomber dead and cruise missiles still an imponderable in the Strategic Arms Limitation Talks, the Carter Administration is planning to push the development of the Air Force's awesome Missile X. As a result, the Missile X guidance contractors—Northrop Corp., Rockwell International Corp., and Honeywell Inc.—**can expect to split the lion's share of the $260 million** for the program that the Pentagon tentatively plans to request of Congress in the defense budget that will go to Capitol Hill next January.

Missile X funding stands at $140 million for fiscal 1978, starting Oct. 1, and the Defense Department is scheduled to decide by September 1978 whether to put the weapon into full-scale development.

Washington commentary

Aerosat's cancellation: a festering sore

As fast as President Carter moves to bind up the wounds in America's relations with its European allies, someone in his Administration produces a new one. What makes matters worse is that no one in the White House seems to notice. The Federal Aviation Administration provides the most recent example.

In 1974 the FAA signed an intergovernmental memorandum of understanding with the European Space Agency and Canada, committing the U. S. to the joint development and operation of Aerosat—the first transatlantic satellite for commercial aeronautical communications. The ESA, which committed itself to pick up a 47% share of the estimated $75 million costs of Aerosat's space segment, was delighted. So were the FAA, which also held 47%, and Canada, whose 6% share was determined by its anticipated use of the system. Last month, however, the FAA pulled the U. S. out of Aerosat, abrogating the diplomatic agreement [*Electronics*, Aug. 18, p. 59]. Government and industry officials here agree that "ESA is mad as hell." The FAA rationalizes its action by laying the blame on Congress, which deleted the bulk of the agency's fiscal 1978 Aerosat funds from the budget. There is far more to it than that.

Congress makes many mistakes, but cutting the money for Aerosat was not one of them. "The FAA could have had every dime that it asked for the program, but no one there pushed for it. They seemed almost indifferent to it," explains one congressional appropriations staffer. "Then the airlines kept telling us it wasn't needed and that it was too expensive. What else could we do?" Congress covered itself by leaving the FAA $1 million for "a feasibility study" of the 10-year-old concept.

Advocates and opponents

Indeed, Aerosat's only remaining advocates in America appear to be Comsat General Corp., which had been named by the FAA to carry out U. S. end of the program, and General Electric Co., the Aerosat consortium's selection to design and build the L-band satellite.

But Aeronautical Radio Inc., the communications carrier for the U. S. airlines that control it, is not unhappy. Arinc chairman and president George F. Mansur says, "We are not opposed to an ocean satellite communications system, but Aerosat is not one we felt we could support." Mansur will not say specifically why the airlines oppose Aerosat, though a lot of them make no secret of it.

Transatlantic communications between the ground and aircraft in flight using high-frequency—very-high-frequency equipment are "pretty tacky, there's no doubt about it," concedes one air carrier executive to Washington, "and if the FAA had moved quickly on this a decade ago when the satellite idea first came up, we would have bought it." But that was back when transatlantic routes were becoming more and more crowded and traffic continued to grow. Today, the number of passengers is still high, but the growth curve appears to have peaked. Moreover, aircraft have become faster and larger, and more of them carry foreign flags. Bigger planes require fewer scheduled flights, so routes are less crowded. Bigger planes also mean more vacant seats per flight.

Cost-conscious U. S. international carriers have no technological gripes about Aerosat's proposed use of L-band communications. But they will not accept the cost and weight disadvantages of new aircraft transceivers in today's increasingly competitive marketplace, despite the fact that each carrier's cost-per-plane would be equal.

ESA versus U. S. A.?

The ESA has not said at this point what it now plans to do, beyond protesting the American pullout. But there is no question that the 10-country consortium has the technology to go it alone if that should prove necessary. About mid-September, the National Aeronautics and Space Administration will launch ESA's operational test satellite from Cape Canaveral as the forerunner of a European Satcom network for intra-European telephone, telex and television relay in the 1980s. Built by a team headed by Britain's Hawker Siddeley Dynamics, the OTS system will expand its capability from 5,000 phone circuits in 1980 to 20,000 in 1990, with the eventual goal of expanding television transmissions to earth stations both in North Africa and in the Middle East.

If ESA proves it can coordinate its politics as well as it has its technology, the Aerosat program might still go—without U. S. participation. The impact of that on America's claim to political and technological leadership could be serious in Europe and the Third World. The Carter White House needs to recognize this quickly and seriously reconsider its options before the Aerosat issue festers further.

For openers, the White House might begin by asking Arinc and its airline owners what kind of a transoceanic satellite communications system they would like.

Ray Connolly

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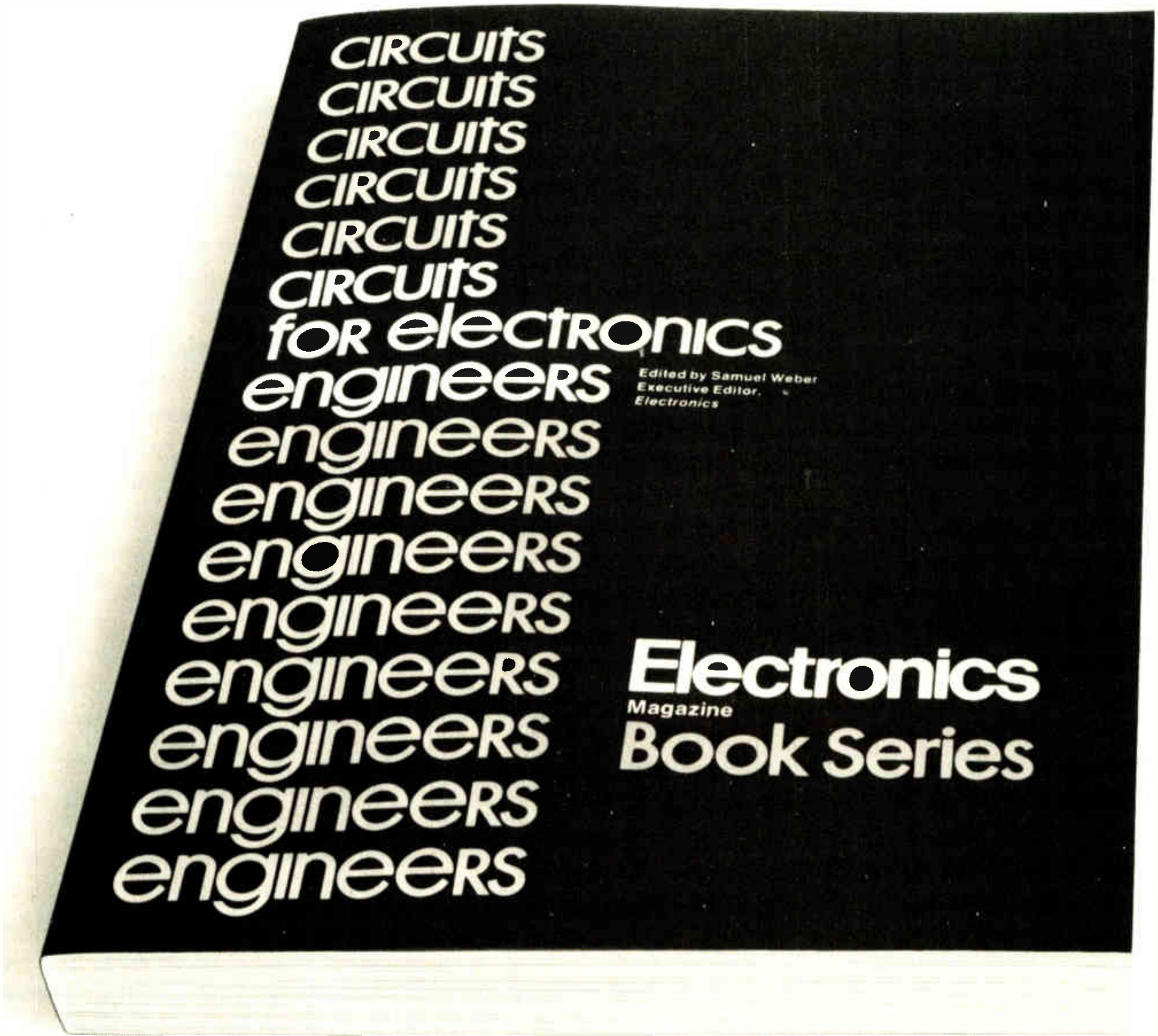

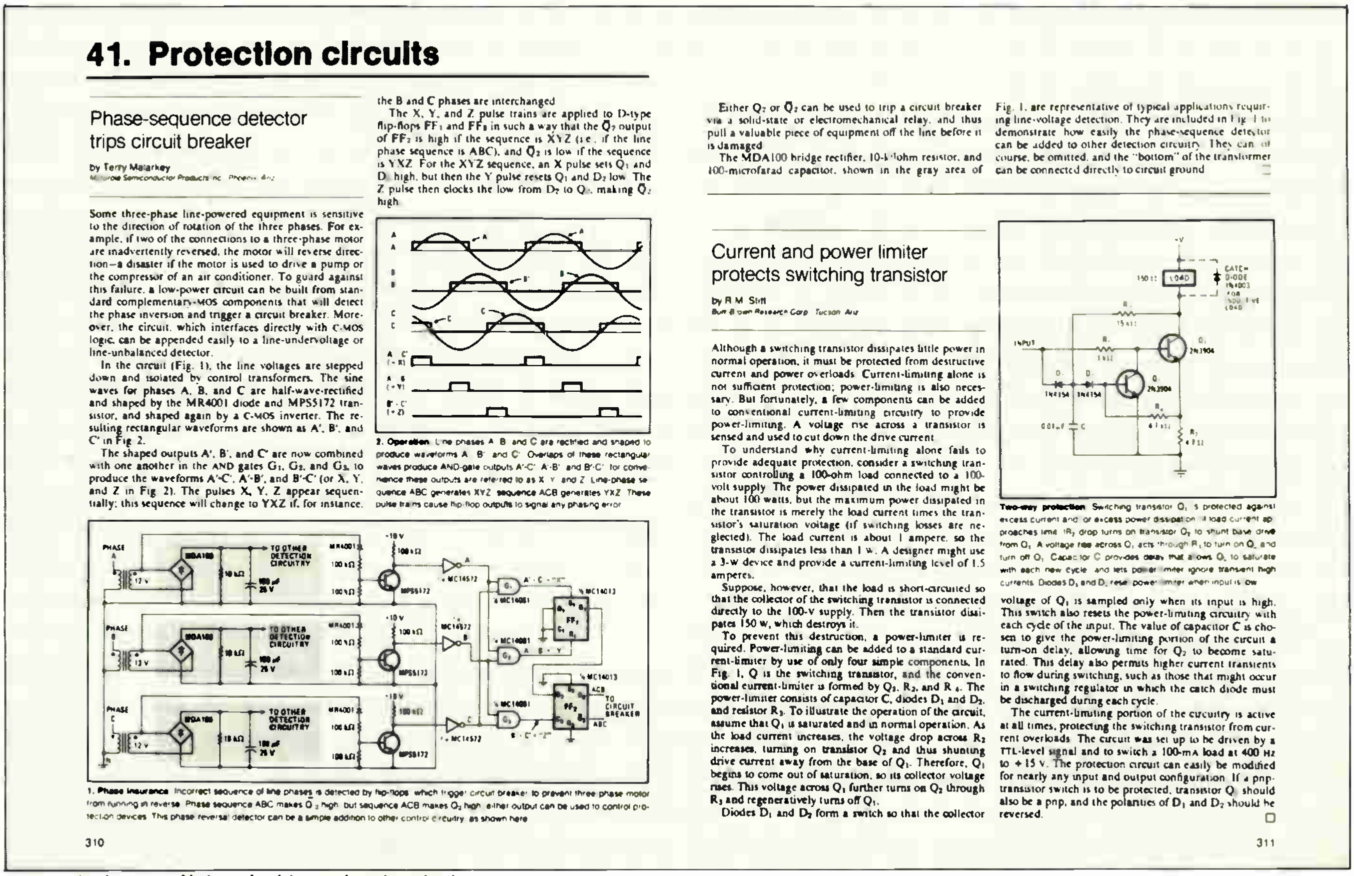

41. Protection circuits

Phase-sequence detector trips circuit breaker

by Terry Malarkey
Motorola Semiconductor Products Inc., Phoenix, Ariz.

Some three-phase line-powered equipment is sensitive to the direction of rotation of the three phases. For example, if two of the connections to a three-phase motor are inadvertently reversed, the motor will reverse direction—a disaster if the motor is used to drive a pump or the compressor of an air conditioner. To guard against this failure, a low-power circuit can be built from standard complementary-MOS components that will detect the phase inversion and trigger a circuit breaker. Moreover, the circuit, which interfaces directly with C-MOS logic, can be appended easily to a line-undervoltage or line-unbalanced detector.

In the circuit (Fig. 1), the line voltages are stepped down and isolated by control transformers. The sine waves for phases A, B, and C are half-wave-rectified and shaped by the MR4001 diode and MPS5172 transistor, and shaped again by a C-MOS inverter. The resulting rectangular waveforms are shown as A', B', and C' in Fig. 2.

The shaped outputs A', B', and C' are now combined with one another in the AND gates G_1, G_2, and G_3, to produce the waveforms A'-C', A'-B', and B'-C' (or X, Y, and Z in Fig. 2). The pulses X, Y, Z appear sequentially; this sequence will change to YXZ if, for instance, the B and C phases are interchanged.

The X, Y, and Z pulse trains are applied to D-type flip-flops FF_1 and FF_2 in such a way that the $\bar{Q}_2$ output of FF_2 is high if the sequence is XYZ (i.e., if the line phase sequence is ABC), and $\bar{Q}_2$ is low if the sequence is YXZ. For the XYZ sequence, an X pulse sets Q_1 and D_2 high, but then the Y pulse resets Q_1 and D_2 low. The Z pulse then clocks the low from D_2 to Q_2, making $\bar{Q}_2$ high.

2. Operation. Line phases A, B, and C are rectified and shaped to produce waveforms A', B', and C'. Overlaps of these rectangular waves produce AND-gate outputs A'-C', A'-B', and B'-C'; for convenience these outputs are referred to as X, Y, and Z. Line-phase sequence ABC generates XYZ; sequence ACB generates YXZ. These pulse trains cause flip-flop outputs to signal any phasing error.

1. Phase insurance. Incorrect sequence of line phases is detected by flip-flops, which trigger circuit breaker to prevent three-phase motor from running in reverse. Phase sequence ABC makes $\bar{Q}_2$ high, but sequence ACB makes Q_2 high; either output can be used to control protection devices. This phase-reversal detector can be a simple addition to other control circuitry, as shown here.

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Either Q_2 or $\bar{Q}_2$ can be used to trip a circuit breaker via a solid-state or electromechanical relay, and thus pull a valuable piece of equipment off the line before it is damaged.

The MDA100 bridge rectifier, 10-kilohm resistor, and 100-microfarad capacitor, shown in the gray area of Fig. 1, are representative of typical applications requiring line-voltage detection. They are included in Fig. 1 to demonstrate how easily the phase-sequence detector can be added to other detection circuitry. They can, of course, be omitted, and the "bottom" of the transformer can be connected directly to circuit ground.

Current and power limiter protects switching transistor

by R. M. Stitt
Burr-Brown Research Corp., Tucson, Ariz.

Although a switching transistor dissipates little power in normal operation, it must be protected from destructive current and power overloads. Current-limiting alone is not sufficient protection; power-limiting is also necessary. But fortunately, a few components can be added to conventional current-limiting circuitry to provide power-limiting. A voltage rise across a transistor is sensed and used to cut down the drive current.

To understand why current-limiting alone fails to provide adequate protection, consider a switching transistor controlling a 100-ohm load connected to a 100-volt supply. The power dissipated in the load might be about 100 watts, but the maximum power dissipated in the transistor is merely the load current times the transistor's saturation voltage (if switching losses are neglected). The load current is about 1 ampere, so the transistor dissipates less than 1 w. A designer might use a 3-w device and provide a current-limiting level of 1.5 amperes.

Suppose, however, that the load is short-circuited so that the collector of the switching transistor is connected directly to the 100-v supply. Then the transistor dissipates 150 w, which destroys it.

To prevent this destruction, a power-limiter is required. Power-limiting can be added to a standard current-limiter by use of only four simple components. In Fig. 1, Q is the switching transistor, and the conventional current-limiter is formed by Q_2, R_2, and R_4. The power-limiter consists of capacitor C, diodes D_1 and D_2, and resistor R_3. To illustrate the operation of the circuit, assume that Q_1 is saturated and in normal operation. As the load current increases, the voltage drop across R_2 increases, turning on transistor Q_2 and thus shunting drive current away from the base of Q_1. Therefore, Q_1 begins to come out of saturation, so its collector voltage rises. This voltage across Q_1 further turns on Q_2 through R_3 and regeneratively turns off Q_1.

Diodes D_1 and D_2 form a switch so that the collector voltage of Q_1 is sampled only when its input is high. This switch also resets the power-limiting circuitry with each cycle of the input. The value of capacitor C is chosen to give the power-limiting portion of the circuit a turn-on delay, allowing time for Q_2 to become saturated. This delay also permits higher current transients to flow during switching, such as those that might occur in a switching regulator in which the catch diode must be discharged during each cycle.

The current-limiting portion of the circuitry is active at all times, protecting the switching transistor from current overloads. The circuit was set up to be driven by a TTL-level signal and to switch a 100-mA load at 400 Hz to +15 V. The protection circuit can easily be modified for nearly any input and output configuration. If a pnp-transistor switch is to be protected, transistor Q should also be a pnp, and the polarities of D_1 and D_2 should be reversed. □

Two-way protection. Switching transistor Q_1 is protected against excess current and/or excess power dissipation. If load current approaches limit, IR_2 drop turns on transistor Q_2 to shunt base drive from Q_1. A voltage rise across Q_1 acts through R_3 to turn on Q_2 and turn off Q_1. Capacitor C provides delay that allows Q_1 to saturate with each new cycle, and lets power limiter ignore transient high currents. Diodes D_1 and D_2 reset power limiter when input is low.

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1st No's above name of Master Charge only R-71A

Japan's VLSI effort yields developmental 100-ns RAM

The cooperative very-large-scale-integration effort in Japan has produced its first random-access memory. The static RAM, a developmental device from Nippon Electric Co., is a **high-speed, 1,024-word-by-4 bit chip built with diffusion self-aligned MOS**—the Japanese version of planar double diffusion (D-MOS). It operates on a single 5-V (±1 V) power supply without an internal bias generator and is fully TTL-compatible. Typical access time is 57 ns, and cycle time is 100 ns. Operating power is 520 mW, and standby power is only 375 mW. Because the power drain is only 4.4 mW, the device can operate with a battery backup of about 1.1 V.

Great Britain buys two U. S. missiles in $700 million program

To sharpen the firepower of all three military services in the 1980s, Great Britain will buy two U. S. missiles and upgrade two of its own in a $700 million, 20-year program. **The U. S. missiles are the Raytheon AIM-9L, an improved Sidewinder short-range air-to-air missile, and the Tow wire-guided, antitank weapon from Hughes** that the British army plans to fire from Westland Lynx helicopters. In England, the Ministry of Defence will have Hawker-Siddeley Dynamics build the P3T, an improved sea-skimming, antiship missile that will be fired from Royal Air Force and Navy planes, and arm the Sea Dart surface-to-air missile with better electronic counter-countermeasure gear. In choosing the missile mix, the ministry scrubbed one British program and rejected the French-German HOT antitank missile.

Electronic-mail survey attracts subscribers in government, business

Seventeen European postal authorities are subscribing to a year-long study of electronic mail in the next decade, to be performed by British consultants Mackintosh International and a university-associated communications specialist group. Reportedly, other subscribers include such international companies as IBM and Rank Xerox, as well as U. S. and Canadian communications authorities. **The study will be as much on marketing, legal, and labor considerations, as on technological aspects.** It is scheduled to be completed by the third quarter of next year. In a related development, the French post office is pushing ahead with its plans for electronic mail. By mid-September, it intends to select suppliers of prototype models of facsimile systems. It sees the French alone using as many as 5 million fax units a year within a decade.

New consumer line in Denmark to use Wire-Wrap

Bang and Olufsen A/S of Denmark is using wire wrapping to replace less expensive soldering methods in the production of a new line of radios and radio–record players it is putting on the market this autumn. **Production officials say they turned to Wire-Wrap because it is particularly adaptable to the makeup of the new line, which will be highly modular.** Bang and Olufsen uses a plastic-foam base plate with a number of metal rods protruding through the plate for the Wire-Wrap connections. The rods also serve as guides for the half dozen or more circuit boards mounted on the plate. The wrapping machine comes from Gardner-Denver Co.'s Pneutronics division, Grand Haven, Mich., while the Danes have developed the automatic feeding unit that directs the flow of assemblies to the wrapping machine.

Telephone decoder combines delta and pulse-code modulations

Bucking the trend to an all-PCM codec, the British Post Office is looking toward a combination of delta modulation and pulse-code modulation. Its goal is a coder/decoder cheap enough to be used on individual telephone lines in a digital-switching telephone network.

The post office is seeking evaluation samples of the new design from two firms. The basic setup has a simple delta-sigma modulation circuit to perform the initial conversion of analog voice to digital format, and a large-scale-integrated chip to convert the digital modulator's 1-bit-per-sample code to the PCM format, which is used in telephone networks for their digital transmissions.

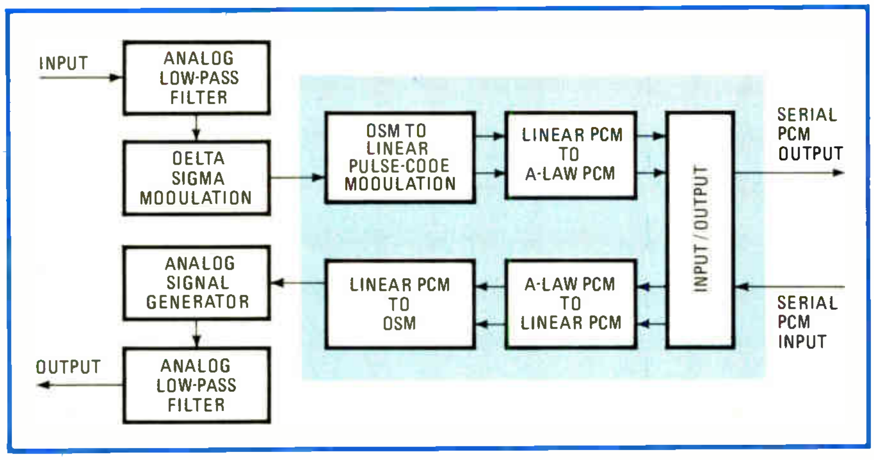
Digital logic. "What we've done is to match the codec design with what could be easily done in this country," says John D. Everard, executive engineer with the BPO Research Department, Martlesham Heath, Suffolk. The codec employs mainly digital logic, bypassing the problem of getting precision analog components, he says. "We've obtained a high-performance codec with a minimum of precision requirements for the external analog components." The digital modulator can be made from a cheap operational amplifier, a D-type toggle switch, and a few resistors.

Ferranti Ltd.'s Electronic Components division has a contract for chip samples, and General Instrument Microelectronics is finishing negotiations with the post office. Should the BPO decide to buy the codec circuits, both suppliers could share in a potential market among exchange manufacturers of more than 100,000 circuits a year. Apparently, the post office gave out only performance specifications, because General Instrument is designing the LSI chip in its tried-and-true n-channel, metal-gate metal-oxide-semiconductor process and Ferranti is using its proprietary bipolar collector-diffusion isolation technology.

The U.S.-owned General Instrument Microelectronics eyes a potentially large international market for the codec circuit. "Many people see these as the TV-game chips of the telecommunications market," observes James Smillie, telecommunications marketing manager. Consequently, the firm is designing its chip to be pin-programmable, so that it may handle either the European A-law PCM companding method or the U.S. μ255 variation. Smillie estimates that the volume price of the codec chip could fall below $8.

The codec is designed so that the chip handles most of the complexity. In the conversion, the delta modulator receives the analog signal from a low-pass analog filter and converts it into the 1-bit-per-sample code. The chip converts that to linear PCM and then to an A-law PCM before sending it out as serial PCM. In short, the DSM-to-PCM conversion is somewhat like digital filtering followed by subsampling at the required output rate of 8 kilohertz, Everard points out. To save chip area and to keep conversion speed up, the initial BPO design largely relegates the MOS transistors to the role of transmission gates. □

Dual modulation. Codec consists of simple delta-sigma modulation circuit and an LSI chip (tinted) that converts the delta modulation to the PCM format and vice versa.



Japan

Choppers to control regenerative braking

Steadily increasing electricity prices have brought about a change of heart at the Japanese National Railways. The company is ready to switch cars over to regenerative braking, in place of the present dynamic braking, thereby saving 30% to 35% of the energy used.

The regenerative scheme, which uses a thyristor-chopper motor-speed control, will appear in cars on the railway's commuter lines, beginning in 1980. These cars will join those of several subway lines and two private railroad companies in using regenerative braking.

The less expensive dynamic braking turns braking energy from traction motors operating as generators into heat. It dissipates the energy in resistor banks slung beneath the coaches. Not only is the energy lost, but the surrounding air is heated, an often-unwanted side effect when the train is operating underground.

Subway and commuter trains are well suited for regenerative braking because of their mode of operation. They accelerate to full speed when leaving a station and usually coast until it is time to apply the brakes in order to stop at the next station. Thus they have left a large part of the energy fed to them.

Savings. Regenerative braking turns the energy back into electricity. It makes for a more expensive car—from $40,000 to $50,000 more. But the Teito Rapid Transit Auth ority of Tokyo, Japan's first operator to put in regenerative braking, in 1971, figures savings in electricity and maintenance pay for the added cost in seven to eight years. Maintenance costs drop because the chopper controls accelerating and braking by varying the duty cycle of silicon controlled rectifiers that send current to the motors, rather than by switching 100 or more resistive elements.

The thyristors used are expensive because they are specialized devices with low demand—only the railways and subways want such large power devices operating above 200 Hz. But the entry of the Japanese National Railways, with its many lines, will greatly expand the market, bringing down device prices. Another factor that should lower prices is improvements in wafer processing.

However, regenerative braking is usually less efficient than it might be. Substations convert the commercial alternating current to the dc power necessary for the trains, and generally they use electronic rectifiers. They will not accept power fed back into the line by regeneration. Only other trains on the same line can accept the power, and if there are too few trains running, the efficiency of the regeneration suffers.

The long-run solution will be to follow the example of Kobe, which put in its subway cars with regenerative braking after Tokyo. The rising curve of electricity costs impelled the city to design substations on the new line so that they can operate in reverse as inverters to feed power back into the ac line. □

Around the world

Paging service will call more subscribers with digital coding

Thirty thousand subscribers will be alerted over each channel of the new 250-megahertz paging service from the Nippon Telegraph and Telephone Public Corp., thanks to the use of digital coding. The channels occupied by the present 150-MHz units have only a third of the capacity, and their 660,000 subscribers occupy all the available channel space.

The 250-MHz models also are more compact, in part because of large-scale integration: a complementary-metal-oxide-semiconductor decoder and a bipolar programmable read-only memory. At 90 grams and 97 by 37 by 18 millimeters, they are two thirds the weight and three quarters the size of present units.

The subscribers are divided into 15 groups by a code of 7 bits, of which 3 are redundant. The individual-subscriber code consists of 31 bits, 15 of which are redundant to provide single-bit correction. Pagers are synchronized with the group transmission format, and all circuits other than those for synchronization are turned off between transmissions to save the battery.

The decoder has about 3,000 elements and includes a crystal-oscillator circuit and the synchronization circuitry. The PROM has only about 70 bits: 38 for the coding, and the rest spare.

Hybrids to star in digital telecommunications, says Philips

Hybrid assembly of monolithic transistor pairs will play a big role in gigabit-per-second data rates for digital telecommunications, reports Philips Research Laboratories in a paper to be delivered at next week's 7th European Microwave Conference in Copenhagen. The British labs say this approach offers higher yields and better cost effectiveness than more complex integrated technologies like emitter-coupled logic and gallium-arsenide junction field-effect transistors.

"The main advantage is that you have very well-matched components with the transistor pairs, which is very important for high-speed switching," says John B. Hughes, principal engineer for the Redhill, Surrey, lab. Thus it is easier to achieve well-defined circuits at very high speeds.

He notes that the common-emitter connection with the beam lead is very good, observing that this is important for high-speed digital switching where the mutual terminal inductance must be low. Other advantages are flexibility—"You can have a new hybrid design within a few weeks," he says—good performance in terms of temperature range and parasitic influences, and inherent reliability because the bonds are gold-upon-gold.

"The only question to answer is whether the assembly technique is economical compared with other devices," Hughes says. The best guess is that the circuit concept offers a potentially good approach for repeaters, terminals, and laboratory and professional equipment in quantities of 10,000 units or less. So far, the company has achieved 1-Gb/s operation, for such functions as multiplexing, phase detection for clock extraction, and data regeneration with decision flip-flops.

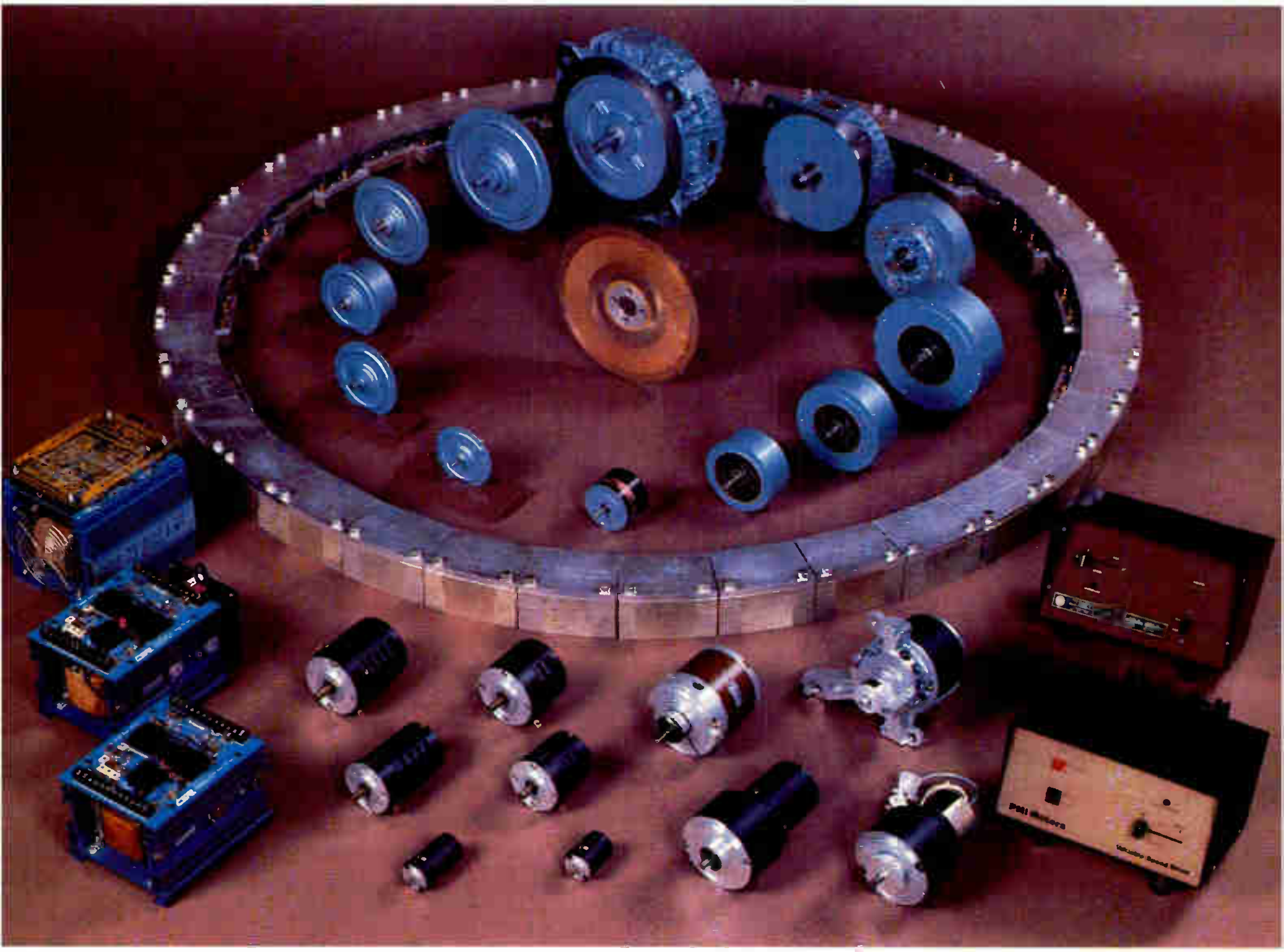
Electronics exports begin to boom

The Philippines is joining the list of Far Eastern countries that find electronics a good way to earn hard currency. Exports of semiconductor devices especially are zooming, says the government's Board of Investments. The 49 electronics and electrical firms registered with the board report 1976 sales abroad of $25.7 million, up 92% from 1975.

These exports represent the second largest category among all products sold abroad by board-registered enterprises. The major markets are the U. S. and Japan, with Europe, Taiwan, Hong Kong, and Australia seen as promising outlets. Semiconductor devices accounted for about 80% of the 1976 total of electronics and electrical exports.

Most of the balance came from electrical equipment, appliances, and electrical tapes. Soon to swell the electronics category are clocks, watch modules and digital watches. These timepieces are just going into local production, both for domestic consumption and for export.

Five new product lines for electronic motion control.



Over 15 years ago PMI created a new technology for motion control by introducing the printed circuit motor. An ironless armature with high pulse-torque capability and very low inertia allowed designers to replace conventional motors, brakes, clutches and hydraulics with an actuator that provided higher performance, greater reliability and lower cost.

Now PMI offers five new product lines for electronic motion control.

TorqueRing™ Motors.

Ring-shaped moving-coil dc motors with diameters from two to over ten feet. Peak torques of over 25,000 lb.-ft., negligible inductance, no cogging, and only 7″ thick. Improved performance compared to torquers and hydraulics for large rotating loads.

Super Minertia Motors.

Ironless cup-armature dc motors with inertias as low as 0.00018 oz.-in.-sec.^{2}, high pulse-torque capability and mechanical time constants below 1 millisecond.

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Low-inertia dc motors providing excellent servo performance at low cost. Nine models 1.5″ to 3.35″ in diameter, mechanical time constants of 3 to 12 milliseconds and thermal time constants up to 27 minutes.

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PMI Motors

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Circle 57 on reader service card

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Feature	The HP 1000	Your old favorite
CPU	2M bytes memory capacity. Standard I/O rates of 2M bytes per second; burst rates up to 11.4M bytes per second.	
Micro-programming	Full software for developing and running 8.5K 24-bit words. 175 ns instruction execution time.	
Memory Speed	Cache speed 350 ns cycle time for all 2M bytes: just $2100* per 32K bytes. 595 ns cycle time: $1600 per 32K bytes (just 5¢ per byte!).	
Operating Systems	One upward-compatible family of Real-Time Executives: memory-based or disc-based RTE up to 2M bytes. BASIC, FORTRAN and Assembly languages. Pick what you need for today's job—expand when you're ready.	
Data Base Management	IMAGE, HP's complete DBM capability, plus QUERY language for easy access to related data, costs just $2500.	
Networking	Over 150 RTE networks installed and running. Modems or high-speed hardwired communications. Also RJE/1000 2780 emulator at 9600 baud.	
IEEE-488 Interface	HP-Interface Bus (HP-IB). HP's implementation of IEEE-488, allows simple link to instruments. Complete software including driver, formatters, message subroutines.	
Cost (Every HP 1000 includes 21MX E-Series CPU; CRT with dual mini-cartridges and soft keys; and RTE operating system.)	Model 20, 64K-byte memory-based system: $21,000. 500K-byte flexible discs optional.	
	Model 30, 64K-byte disc-based system, 15M-byte disc storage: $36,500. 5M- and 50M-byte discs available.	
	Model 80, 128K-byte data base management system with 15M-byte disc storage, IMAGE, mag tape, and line printer: $61,700. 50M-byte discs available.	
Delivery	12 weeks ARO.	

**All prices shown are U.S. Domestic List.*

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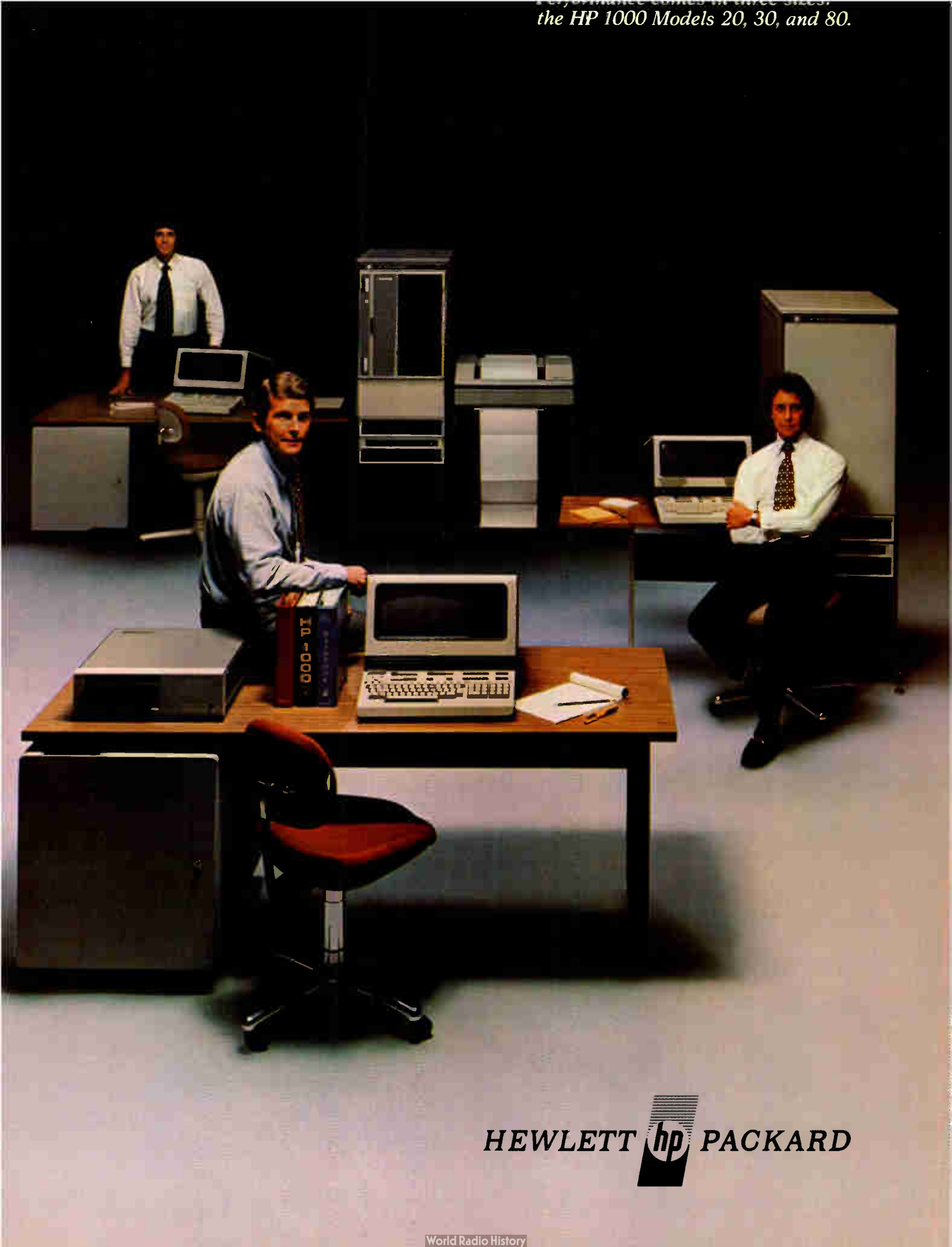
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7208 is a 7-digit frequency, unit or period counter which directly drives an LED display. For a unit counter, add a display, 2 resistors, a capacitor and control switches.

CMOS quartz crystal frequency generators.

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7209 is a versatile high frequency clock generator with a divide-by-8 output stage for a 5 Volt system.
7038A is a micropower oscillator, frequency divider and output driver for 3 Volt synchronous motors. The **7038B** is designed for 1.5 Volt synchronous motors.
7213 is a versatile oscillator, divider and waveshaping circuit providing various outputs including 1-second and 1-minute pulses.
7049A and **7050** are oscillator circuits which include a divider chain, output one-shot and output buffer for 1.5 Volt stepper motors.
7051A is a clock circuit for 12 Volt synchronous motor applications.

Battery operated CMOS counter/timers.

7215 industrial counter/timer has four functions (start-stop, split, taylor and time-out) and times up to 59 minutes, 59.99 seconds.
7205 has split, taylor and reset functions for timing to 59 minutes, 59.99 seconds.
7045A times up to 23.99999 hours. All the above counters directly drive an LED display.

Externally settable counter/timer circuits.

8240 is one of a family of programmable counter/timers which generate long pulse widths with inexpensive RC components. Each circuit contains an oscillator and divider flip flops. Pin connections on the **8240** select an output pulse width from 1 RC to 255 RC.
8250 can be used with thumbwheel switches to count from 1 to 99.
8260 counts 1 to 59 for timing seconds, minutes or hours.

Low cost precision timers.

555 generates time delays from microseconds to hours, with the addition of only one resistor and a capacitor.
556 contains two **555**s in a single package.

Custom circuits also available.

We can develop custom CMOS LSI circuits for your special counting and timing applications. Consult your local sales office listed below for information.

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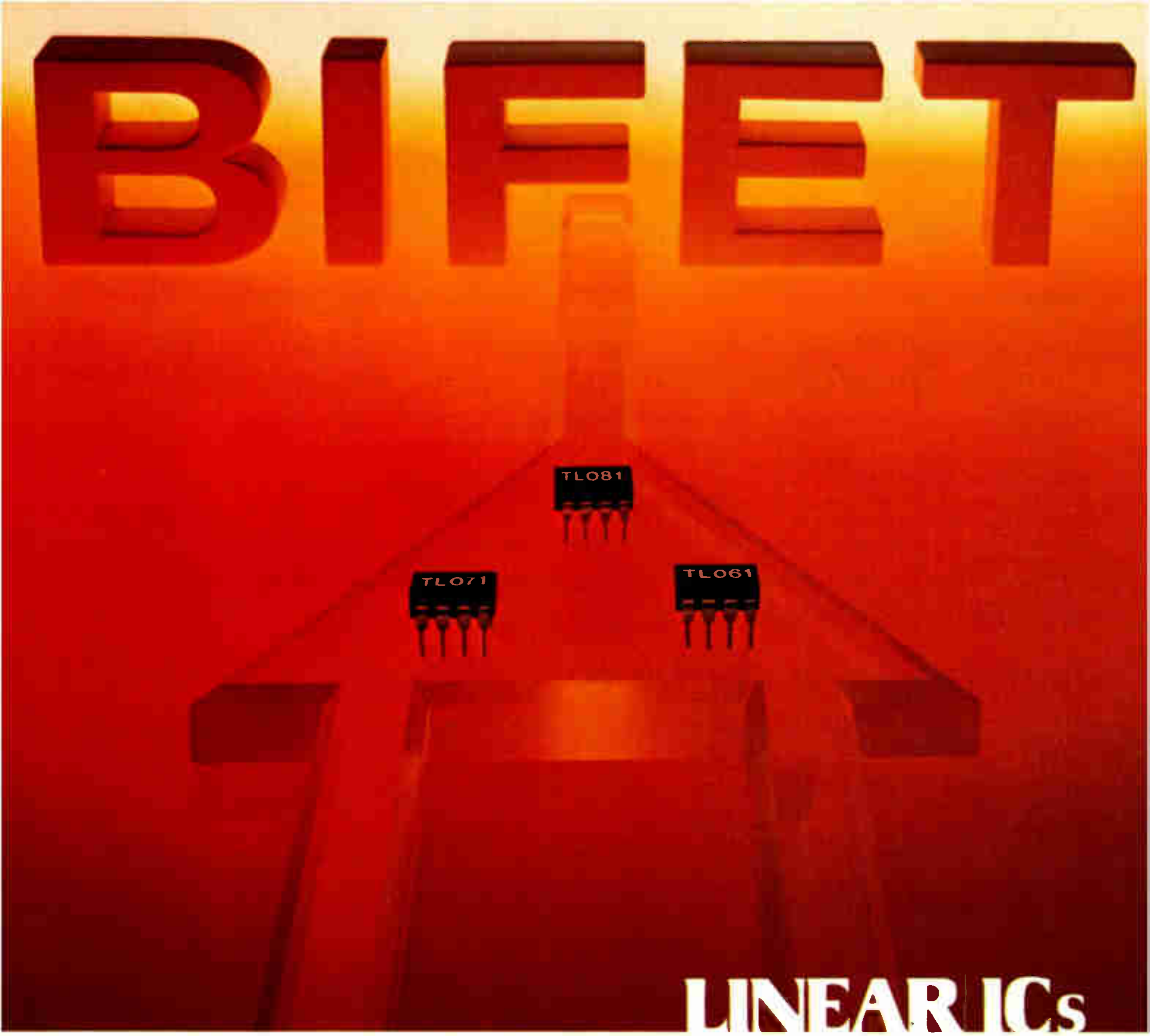
INTERSIL

Circle 60 on reader service card



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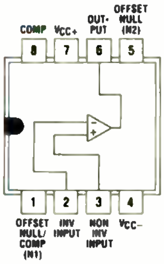
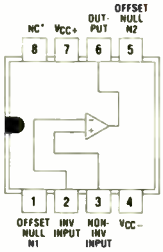
TL080



Uncompensated with offset control.
Pin equivalents:
LM301A, LM308, μA748

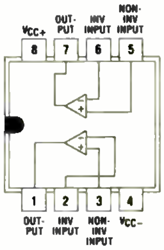
TL061 TL071 TL081



*POWER CONTROL ON TL061 ONLY

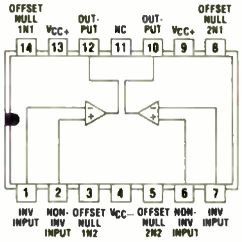
Compensated with offset control.
Pin equivalents:
μA741, LF355, CA3140

TL062 TL072 TL082



Compensated with no offset control.
Pin equivalents:
MC1458, RC4558

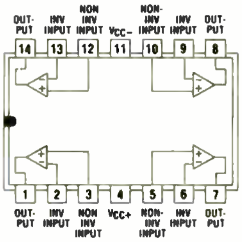
TL083



NOTE: PIN 9 & 13 ARE INTERNALLY CONNECTED

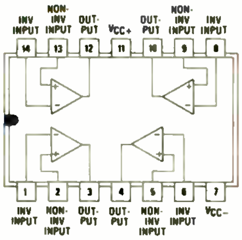
Compensated with offset control.
Pin equivalents:
μA747

TL064 TL074 TL084



Compensated with LM324 pinout.

TL075



Compensated with RC4136 pinout.

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BIFET op amp specifications.		TL081	TL071	TL061
I_{IB}	Input bias current (nA max)	0.4	0.2	0.4
V_{IO}	Input offset voltage (mV max)*	15	10	15
B_1	Unity gain bandwidth (MHz)	3	3	1
SR	Slew rate (V/μs)	13	13	3.5
V_n	Equivalent input noise voltage (nV/√Hz max)	47	18	—
I_{CC}	Supply current (mA max)	2.8	2.5	0.25

*A & B versions available with 6 mV and 3 mV respectively for all three families.

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93177

Circle 63 on reader service card

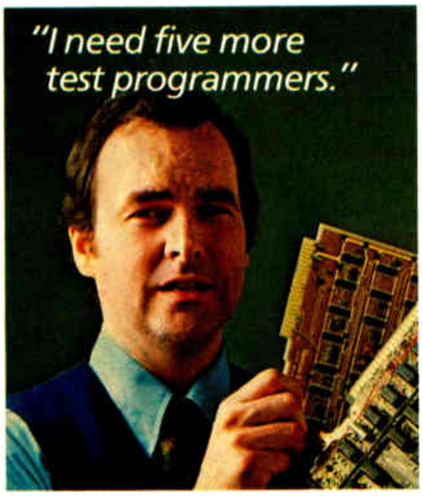
The P400 makes excuses obsolete.

A new product comes on line and the circuit boards start piling up. This is when the excuses begin:

"I can't get near the computer."

"I need more programmers."

"I just got schematics last week."



It's a difficult time for a test engineer because the success of an important product can hang in the balance.

But Teradyne's P400 Automatic Programming System has changed all that. Used with L100 series test systems, the P400 creates the entire test program

automatically. It gives you all input patterns, provides all diagnostic data, and resolves all races. It cuts programming time from weeks to days. And it does it all without tying up the computer on your production tester or increasing your programming staff.

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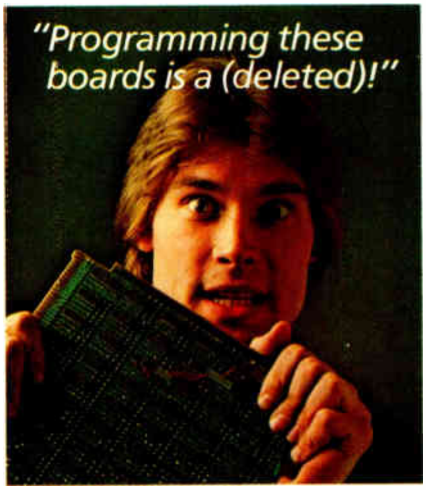
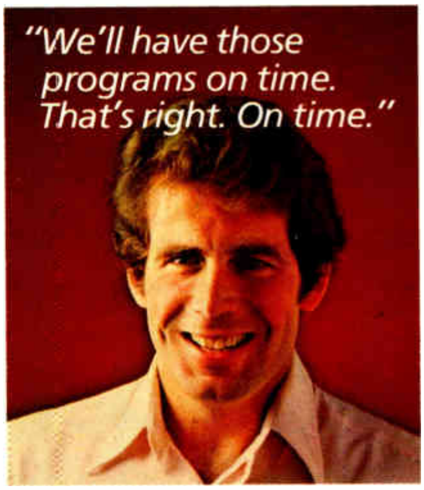
Just as important, the P400 spares you all the boring work it usually takes to deliver new programs. You get typically better than 95% fault coverage simply by using the telephone to access a large computer containing the P400 software.



The P400 Automatic Programming System.

Now there's no reason for being late.

And we think that's the way you want it.



TERADYNE

183 Essex Street, Boston, Mass. 02111

U.S. ban on sprays poses threat

Proposed elimination of chlorofluorocarbons used in cleaners and as chillers for sophisticated gear viewed with alarm

by Bruce LeBoss, New York bureau manager

The proposed Federal ban on chlorofluorocarbons could have a numbing effect on the electronics industries unless a suitable substitute is found—and none is in sight. The reason: CFCs used as cleaning solvents and chillers are essential to the production, operation, and maintenance of sophisticated electronic equipment used in communications, defense, and aerospace. Strangely, though, little protest has so far been heard.

The Food and Drug Administration, Consumer Product Safety Commission, and Environmental Protection Agency decided to prohibit CFCs after reports that they may deplete the earth's ozone layer. This would increase ultraviolet radiation reaching the earth and lead to higher incidence of skin cancer, adverse climate changes, and other ill effects.

The Environmental Protection Agency, which supervises solvents and chillers used by the electronics industries, is dividing its regulatory effort into two phases. Phase I concerns only aerosol propellants. But Phase II addresses all other CFC uses, including their presence as an active ingredient in such aerosol products as the solvents and chillers.

In Phase I, manufacture of the basic chemicals used for the propellants would cease by Oct. 15, 1978, and the manufacture of aerosols using propellants would end by Dec. 15, 1978. The firms would be allowed to sell these products from inventory until April 15, 1979, and distributors would be permitted to sell remaining stock. Phase II deadlines have not yet been proposed.

POSSIBLE ALTERNATIVES TO CHLOROFLUOROCARBONS	
Material	Major disadvantages
Carbon dioxide	inconsistent spray action, higher pressure involved in manufacture and use, lower purity
Hydrocarbons	extremely flammable, can only be used when equipment is not activated, inferior spray characteristics
Hydrogenated fluorocarbons	higher toxicity, corrosive

Sources: DuPont, Miller-Stephenson Chemical Co., Department of Defense

According to an EPA spokesman in Washington, D. C., the timetable of the proposed regulations on nonessential aerosol uses will change only slightly, if at all, following informal hearings held last month. What's more, "only three uses have been deemed essential" thus far, and "not many more are expected to be added to the list. We believe there are alternatives [to CFCs] for every other use," the spokesman continues. EPA estimates that CFC applications by the electronics industry are less than 1% of all uses.

Reprieve until Phase II. Of the three classified as essential, one is of direct benefit to the electronics industries, namely, CFC use as a "release agent for plastic molds." Such aerosols are useful also for epoxy potting and encapsulating and will be available to electronic-equipment manufacturers at least until the Phase II rules go into effect.

The EPA expects to publish its final Phase I regulations this December. Before then, in the first week of October, it plans to begin public hearings on Phase II, with regulations tentatively planned for next June.

The problems created by the rules, and perhaps even more so by the proposed timetable, became apparent at last month's public hearing. Commenting on the impact on the Department of Defense, George Marienthal, deputy assistant secretary of defense (environment and safety), said that the Pentagon has determined electronic and avionic cleaning compounds and electronic diagnostic chilling compounds, among others, to be "essential to defense programs."

"We believe that rather immediate elimination of CFC propellants from some aerosol products will result in shortages of these products," said Marienthal. "If suitable alternatives are not identified and qualified, the shortages could impair national security and defense readiness."

Thus the Defense Department is requesting an extension for several key categories of CFC. A triservice program is also testing available substitute aerosols and seeking to develop new aerosols for applications that lack substitutes. What's more, the program aims to qualify substitutes, identify sources, and write procurement specifications.

The problem here, says Edward Dyckman, materials engineer in the Defense Industrial Resources Support Office in Alexandria, Va., is that "the process that culminates in a spec change will take several years, or longer than the time EPA's present schedule will allow." For that very reason, notes Perry Brunner, CFC work group coordinator in EPA's regulatory group, "we are going to have to consider giving DOD more time. But, we don't know whether we will." That decision will be made toward the end of this year, he notes, "just prior to publishing the [Phase I] regulations."

While the Phase I regulations on propellant uses of CFCs could be costly and time-consuming, the impact of Phase II is that "it could kill the electronics industries," says George Stephenson, president of Miller-Stephenson Chemical Co. of Danbury, Conn., a major supplier of these specialty aerosols. "Phase II is really the discussion of Freon 113 and blends of it," he adds, and if these are banned, "it will be deadly for most electronics systems, since the solvent is so much a part of the system."

High technology. For example, he notes, one high-purity aerosol is used by the 51 NASA satellite stations throughout the world in maintaining ground equipment for defense and weather satellites. It also helps maintain communications satellites and avionics systems, both military and commercial. What's more, adds Stephenson, "CFC-based aerosol and tape-head cleaners are used on communications systems operated by the CIA, FBI, the White House and even the famous computer of the IRS." If these CFC-based products were banned today, he adds, "it would just shut down every military, communication, data-processing and transportation system, as well as the banking and CIA systems," among others.

The problem is two-pronged: qualifying alternatives to CFCs in time to meet EPA's proposed phase-out dates, and the fact that no substitutes are in sight for many applications. Alternative propellants, including compressed gases, such as carbon dioxide and nitrogen, and hydrogenated fluorocarbons and hydrocarbons, have serious limitations (see table). Some of these are high dispensing pressure, toxicity, and flammability, which is why the Federal Aviation Administration and International Air Transport Association will not allow these propellants to be air-freighted.

"Alternative solvents are not available that can replace F-113 in electronic cleaning compounds," says the defense support office's Dyckman, because, for example, it is compatible with most substrates, leaves no residue, is noncorrisive, has low toxicity and is nonflammable, and has high purity and high chemical stability.

The outlook for finding substitutes for CFC propellants in time to meet the Phase I timetable is not very bright. In fact, it's rather grim. "We are working on alternatives and may be able to replace existing chlorofluorocarbon propellants, but it's rather unlikely that substitute materials will be fully commercially available by the time the aerosol ban is effective," says Richard B. Ward, technical consultant for E. I. du Pont de Nemours & Co. of Wilmington, Del., the major supplier of the basic CFC materials.

"There's no need to panic yet," he says. "However, the electronics industries should realize the Federal Government is going to hold these hearings and that those in industry had better tell the Government why their use of these products is essential, or such uses will be banned or regulated." Cautions Ward, "The danger is apathy."

Pffft. Sprays such as these, whose active ingredient and propellant are both CFC, would be banned under Phase II of the proposed new EPA regulations controlling the gas.

Reaction lacking. The reaction does appear apathetic. "I was disappointed that the Aerospace Industries Association and WEMA said they weren't interested in the Phase I hearings," says Edwin Shykind, director of the Department of Commerce's Environmental Affairs division. Yet he is encouraged that both the AIA and WEMA say they will concentrate on the Phase II hearings. Other trade organizations may also get involved.

When the proposed regulations on nonaerosol uses of CFCs are issued, "we're going to organize an effort to provide an industry input to the EPA regarding the technical effects of those proposals," says Ken Hagerty, WEMA's director of Government affairs. He says WEMA is "most concerned" about Quik-Freeze, a Miller-Stephenson aerosol that is exempt from Phase I but subject to being banned under Phase II. He say the product is "used extensively by our industry to locate and test intermittent electronic components on boards and assemblies."

Biff Halenbeck, corporate restricted articles manager at Hewlett-Packard Co. in Palo Alto, Calif., and head of WEMA's technical task force, says, "It's hard to get excited about banning or restricting some of the propellant uses of chlorofluorocarbons. However, some key aerosol sprays used by the Government, the aerospace industry, and manufacturers of state-of-the-art electronics are essential. Unless Du Pont and the other chemical companies come up with alternatives, we will all be in deep trouble." □

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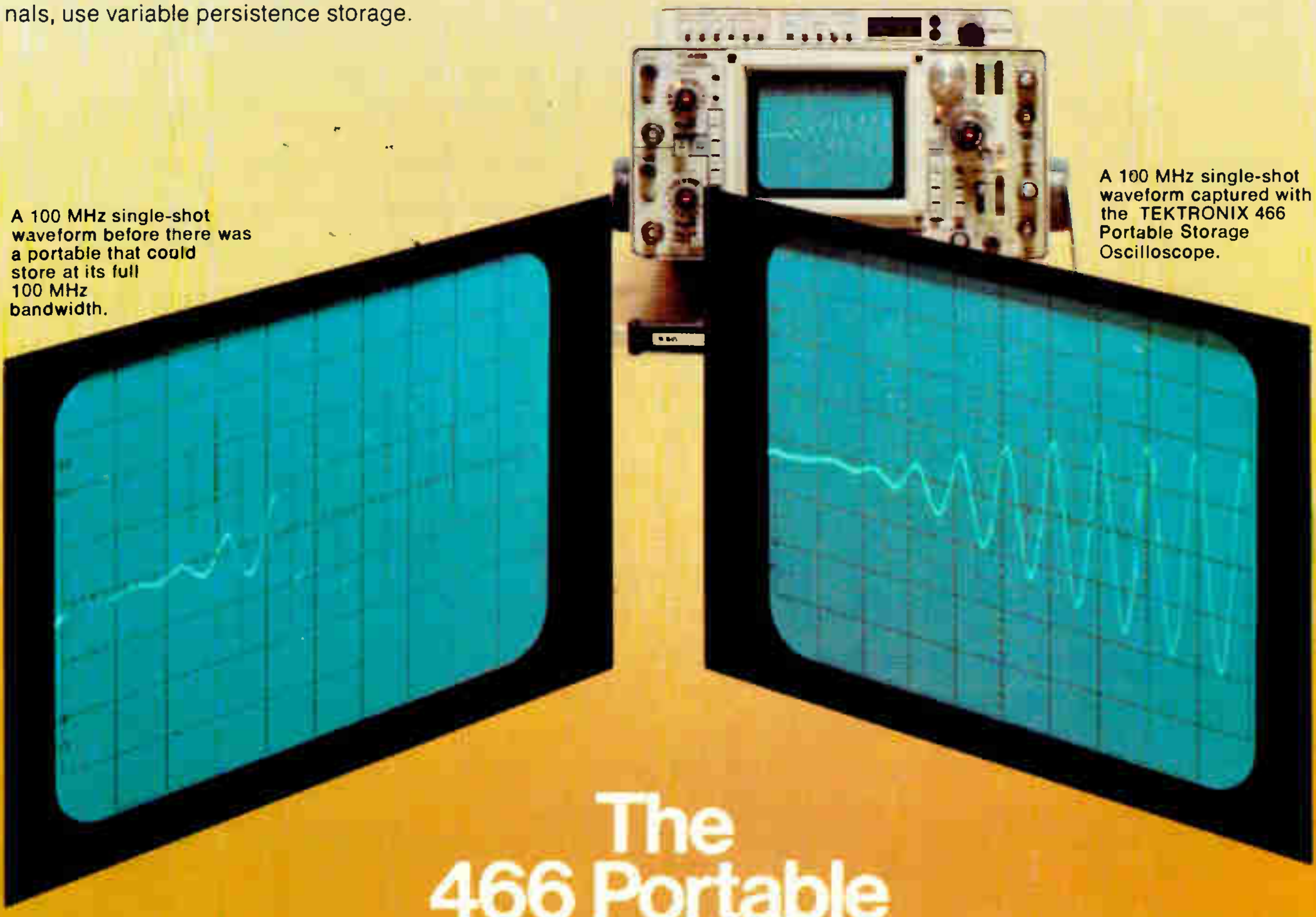

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Electronics abroad

Business still centers on TV

World's biggest entertainment electronics exhibition underlines importance of color television sales to Western Europe

by John Gosch, Frankfurt bureau manager

West Berlin has moved into the limelight again. This time, however, the reason is not East-West politics but the world's biggest entertainment electronics event as the city plays host to Germany's biennial, 10-day International Radio and Television Exhibition.

Gathered at West Berlin's flowered fairgrounds are some 400 exhibitors from 26 countries in Europe, Asia, and the Americas who will be showing everything from simple headsets to elaborate television receivers. And when the blare of hi-fi equipment is silenced and the glow from the TV sets extinguished on Sept. 4, some 600,000 persons will have visited the show.

At the exhibition, and for radio and TV retailers in Western Europe, color TV is the big item.

For the short term, market watchers at Philips Gloeilampenfabrieken, the continent's leading consumer hardware producer, see Western Europe's color set sales climbing by better than 5% this year over the 1976 level. That should bring the total number of sets delivered to about 8.4 million.

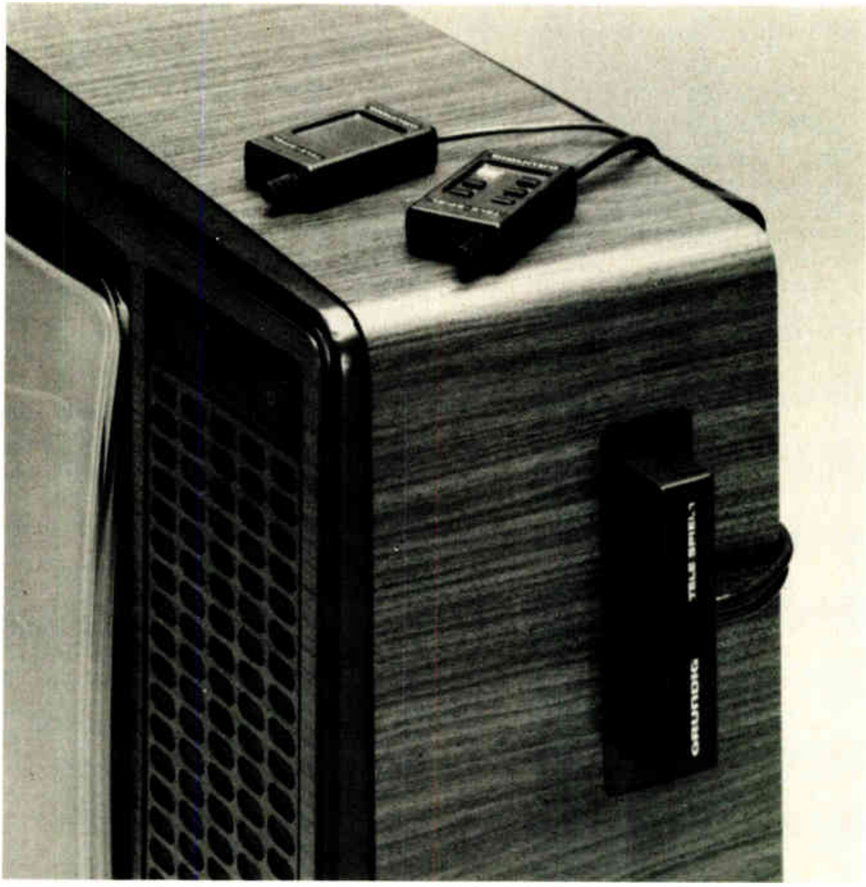
In West Germany, Europe's biggest market, color TV sales this year should be about the same as the average for Western Europe. The reason the country is not doing better is its high color-set density compared with that of most other European nation—more than 50% of West German households have color. Grundig AG, the country's top TV-set maker, sees the number of color receivers sold domestically this year rising by about 6%. Portables alone will shoot up by a spectacular 33%.

For British set makers, the cloudy color market appears to be brightening. "There are signs that it's beginning to pick up again," observes a spokesman from GEC Radio and TV.

If the short-term outlook for Western Europe is not bad, neither are the prospects for the long term. "The skepticism occasionally voiced over color TV sales prospects in West Germany and elsewhere in Europe is without basis," concludes a Grundig market study. "Though the rates of consumption won't reach those of the early 1970s, the demand for color will continue to grow at a steady pace," the German firm says.

Grundig backs up its contention by pointing to the Continent's still relatively low market saturation level. Last year, it was about 31% for Western Europe as a whole and 34% for the nine Common Market countries. By 1980, the respective figures will be 51% and 54%.

In France, as in many other Euro-



Game player. This grundig television receiver, which is being shown at the Berlin exhibition, has a cassette for a video game inserted into the side of its chassis.

New products

pean countries, the most notable change in the TV market between now and 1980 will be the decline in the rate of purchases by first-time users. In 1970, first-time buyers purchased nearly 800,000 sets, while in 1980 there will be a mere 268,000, according to a French market study. This means a drop of 66% in a market that will expand 58% by replacement and second-set sales.

While annual growth rates of color TV sales are tapering off, another market for a big-ticket item is shaping up—that for video cassette recorders. Boosting the market are recorders holding more than two hours' worth of color programs.

At the Berlin show, Philips is introducing its N1700 cassette unit, a 130-minute color recorder that is programmable for turn-on and turn-off up to four days in advance. Already on the market is Grundig with its VCR4000, also a 130-minute unit that is compatible with the Philips system.

As for domestic sales, Grundig predicts that by 1982 a little more than 9% of West German color TV-set owners will have a video recorder. That works out to about 1.6 million units within the next five years. Not until 1990 will a saturation level of 35% be reached.

But European producers will not have the recorder and color TV markets all to themselves. "The Japanese, in an effort to offset declining sales in the U.S., are certain to increase their activities in Europe," says a spokesman for a German producer. In Britain, much of the increase in color TV sales so far this year has already been eaten up by Japanese and other Far Eastern producers. As if to underline their intention to launch a new attack on Europe, Japanese companies are showing up in Berlin in full force—68 of them.

What's ahead. More perhaps than its predecessors, this year's radio and TV exhibition is a show of innovations and a vantage point from which to spot new trends in entertainment electronics. One development showgoers are discerning this year is that the TV set is no longer confined to its traditional function: it is taking on the role of a "terminal" in the data-processing sense of the word.

This trend is underscored not only by TV games and tape-recorded programs on the screen. A much bigger step toward the terminal function are the two British-pioneered services: Teletext and Viewdata, both being demonstrated to a mass audience in Germany for the first time.

With Teletext, already a regular part of British broadcasting, digital signals sent out by a TV station ride piggyback on the analog TV signal and put alphanumeric information on an encoder-equipped TV receiver. Viewers can request up to 100 "pages" of information. Viewdata, in premarket trials in Britain, connects a decoder-equipped TV set through the regular telephone network to a remote data bank. By way of an alphanumeric keyboard the viewer can carry on a dialog with the data bank and tap a virtually unlimited number of pages of information. The West German post office, which is demonstrating the service at the Berlin show, may introduce it on a broad scale during the 1980s. Field trials with some 2,000 viewers will be held within a few years.

Television is changing in still other ways. At the Berlin show, there are at least three German set makers—AEG-Telefunken, Saba Werke GmbH, and Grundig—with color receivers into whose regular picture is inserted a small black-and-white picture coming from another station (see p. 102).

France's TV producer, Thomson CSF, has brought to Berlin television sets with a so-called semimodular approach. This allows easy repair and means that sets can be easily and cheaply modified to comply with receiver standards in any country.

Britain's GEC Radio and TV is showing two new color sets, both employing the Philips-pioneered 20 AX picture tube. Also on display is a 12-channel, 26-inch set featuring ultrasonic remote control, an on-screen clock display using National Semiconductor Corp. chips, and a Teletext decoder from Texas Instruments Inc. The company also has a Viewdata set based on discrete circuits. □

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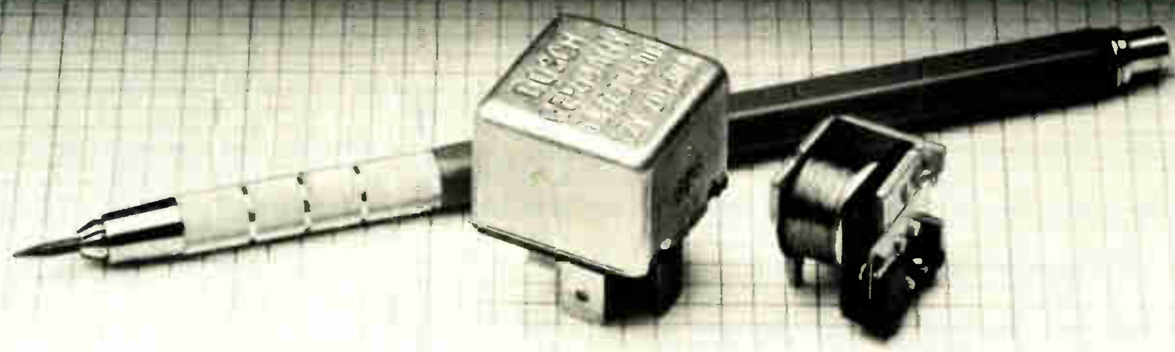

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Companies

Motorola speeds its comeback

Year after arrival of Stein from TI, reorganized IC division reports increased bookings and backlog and a new outlook

by Larry Waller, Los Angeles bureau manager

When Alfred J. Stein took over Motorola Inc.'s troubled Integrated Circuit division in July 1976, he did not lack challenge, to put it mildly. The object of a life-or-death search, Stein came from Texas Instruments Inc., where he won his spurs by straightening out floundering semiconductor operations.

At Motorola, he faced persistent problems that dogged the No. 2 U.S. semiconductor firm even in good times. Generally, the problems grew out of weak divisional management, stretching back almost 10 years, that led to ruinous stop-and-go uncertainties in product planning and to vacillating marketing tactics. While Motorola chairman Robert W. Galvin confessed to these [*Electronics*, Nov. 13, 1975, p. 96] and the new Semiconductor Group boss John R. Welty and his assistant Robert Heikes cleaned up the organization somewhat, a hard-nosed semiconductor process specialist and manager obviously was needed to take over.

Stein was tagged as that person. He now presides over a sprawling complex, with operations divided between the Phoenix area and Austin, Texas. Austin is the metal-oxide-semiconductor specialist, divided into three units: complementary MOS, microprocessors and logic, and memory. In Arizona are bipolar and microcomputer systems, including software and support.

A year after Stein's arrival, there are undeniable signs of a major comeback for the once-shaky semiconductor operation, signs that were there even before Motorola's recent success on the automotive front [*Electronics*, Aug. 18, p. 42]. The corporate parent reported semiconductor bookings rose 14% for the first six months of 1977, with a backlog of 21%.

So the question is: what did Stein do to turn things around so speedily?

"One of the first things changed was putting in true profit-loss product centers," he begins. Here, he did away with a practice that gave responsibility for manufacturing to a separate group staff, not under the control of product-line managers.

At the same time, he beefed up marketing for each product line, tieing it closely to group marketers—again, something new. Right away, this combination of line responsibility and better coordination of market planning enabled each manager to get a better grip and set specific sales goals that could be checked and altered monthly.

In manufacturing, where yield shortfalls especially kept the Austin

Simple as 1-2-3. Alfred J. Stein has overseen major reorganization of Motorola's semiconductor operations since July 1976.

Parts of the picture

In its comeback, Motorola is banking heavily on these major products:

- MC6801—the contemplated 8-bit one-chip heavyweight of the 6800 family: 64 bytes of random-access memory, 1 kiloword of read-only memory, plus clock and 30 ports of input/output. Second quarter, 1978.
- MC6802—introduced in June, a RAM-I/O chip with 128 words of memory and clock combined with the MC6846, a 2,048-bit ROM, programmable timer, and I/O.
- MC3870—The Mostek Corp. one-chip F8, with 2 kilobits of RAM, 64 bytes of ROM, I/O timer. Samples in October.
- MC6809—An enhanced three-chip 6800, with many memory and peripheral options, including a cathode-ray tube and floppy-disk controllers. Third quarter, 1978.
- MCM4027—4,096-bit dynamic Intel Corp. RAM. Released in June.
- MCM6614—4-k static RAM. In production.
- MCM2708—8,192-bit electrically programmable ROM from Intel, but with improved data retention under high temperature. In production.
- MCM6616—Motorola's proprietary 16,384-bit dynamic memory hope. Scheduled for fourth quarter this year.

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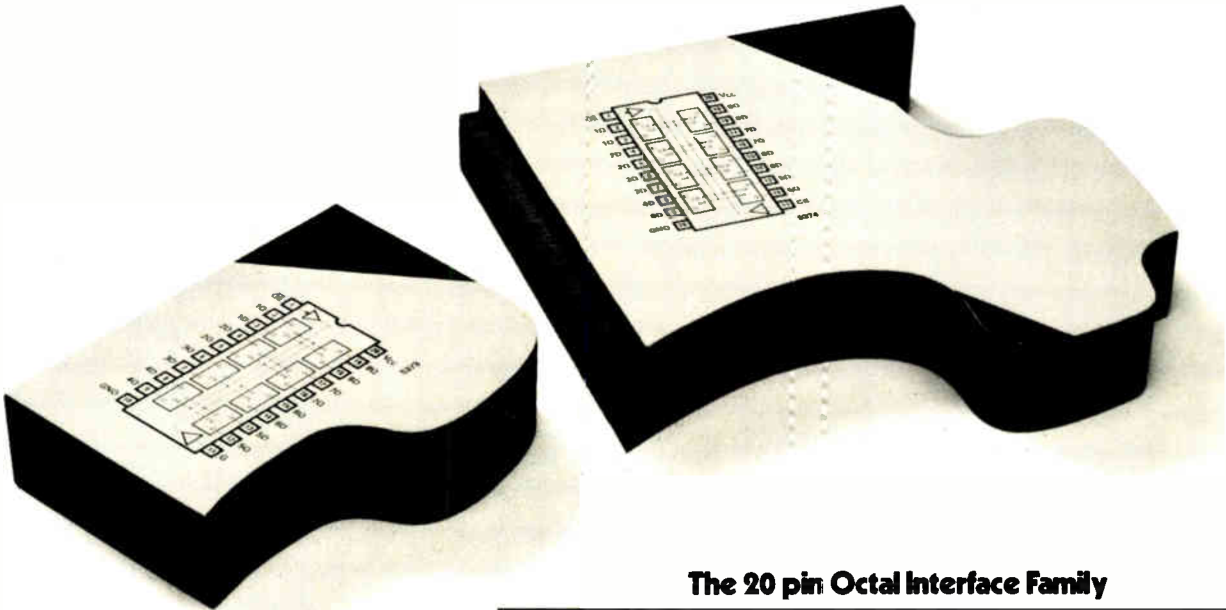

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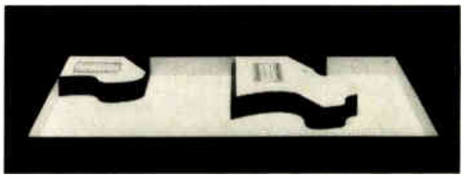


Monolithic Memories

MOS center from getting up to speed, Stein focused on continuing basic process improvements. A key new face, James Fiebiger, brought from TI to run Austin, served to spark a new attitude there.

To plug short-term gaps identified in his microprocessor lineup, Stein quickly went outside to snag second-sourcing rights for the Mostek 3870, convinced it is destined to be the dominant one-chip device in the business. Before the end of this year, parts will be rolling off Austin MOS lines. Concurrently, he got rights to Fairchild Camera and Instrument Corp.'s transistor-transistor-logic line, which he insisted Motorola must have to round out its hardware offerings.

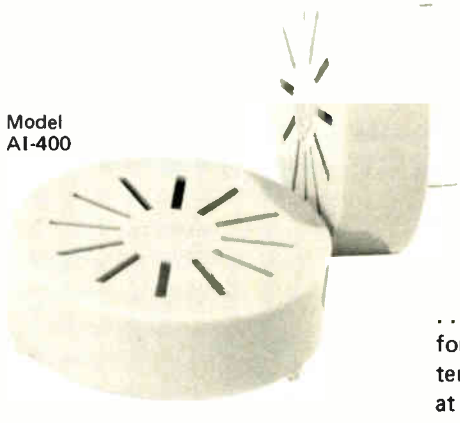
For the long run, Stein and his key planning aide, William Howard, director of strategic operations, have concluded Motorola has to fill out its own 6800 processor line. The company is pushing ahead with the one-chip 6801, two-chip 6802-6846, and expandable multidevice 6809.

The company is pinning its memory hopes on the 16,384-bit dynamic 6616 model, which "has the highest priority in Austin. If we get it in the next quarter, then we'll be okay," says Stein. Planners continue to mull over the question of plunging in fully with bipolar memories for computer customers. Motorola already has the emitter-coupled-logic 1046 memory, and will test the water for charge-coupled devices, under cross-license from Fairchild, this year.

With the dust settling from activity of the past year, the division's future looks bright from the inside. An outside opinion comes from Sal Accardo, long-time Motorola follower on Wall Street who is vice president of Kidder Peabody and Co. "Motorola management evidently has allowed Stein to do what he had to do, tightening up and instilling more discipline."

"But the critical test will come with an economic downturn," he warns. Such dips hurt Motorola worse than its competitors: losses in the 1974–75 recession alone hit nearly $30 million, Accardo estimates. □

Model
AI-400



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Military

Microprocessors to get mil specs

Air Force data will be ready by year's end for three 4-bit devices—AMD's 2901A, Intel's 8080A, and Motorola's 6800

by Ray Connolly, Senior Editor

The first military specifications for Air Force microprocessors are set to emerge from the Defense Electronics Supply Center no later than the end of this year. They could come earlier, says the supply center's C. Robert Jackson, if the Rome Air Development Center in New York, which has final responsibility, completes the complex paper work sooner. Then the supply center expects to accelerate its program, approving specs for four devices each year.

Under consideration are three first-generation devices, all selling well in the commercial marketplace. They include two 8-bit, n-channel metal-oxide-semiconductor devices—the 8080A developed by Intel Corp. of Santa Clara, Calif., and the 6800 from Motorola Semiconductor Products Group of Phoenix—and the 2901A 4-bit bipolar slice developed by Advanced Micro Devices of Sunnyvale, Calif.

All three microprocessors will be covered under the military's general specification for microcircuits, MIL-M-38510, and will bear that nomenclature plus three digits and Air Force identification. Thus Motorola's 6800 will become the MIL-M-38510/400 (USAF). Similarly, the 8080A will be relabeled the /420 (USAF), while the 2901A becomes the /440 (USAF).

Costs. The costs of mil-spec-qualified microprocessors are expected to be significantly higher than those of their commercial counterparts as a result of the battery of tests, including burn-in, proposed under MIL-STD-883, the long-time standard covering test methods and procedures. Also contributing will be the proposed requirement for devices to operate in the standard mil-spec range of −55°C to +125°C—a sharp increase from the 0°C to 70°C of the commercial marketplace.

Less certain than the cost increases is how many manufacturers will bother responding later to military requests for quotes. As one manufacturer's man put it, "As long as private orders keep industry busy, any RFQ for just a few hundred pieces—even a few thousand—is going to be ignored."

Still to be heard from is the industry's own standards organization, the Joint Electron Device Engineering Council. JEDEC, jointly sponsored by the Electronic Industries Association and the National Electrical Manufacturers Association, formed its JC-43 committee on microprocessors early this summer. The committee addressed the standards issue at an Aug. 22 meeting at Sunnyvale, Calif. [*Electronics*, Aug. 18, p. 59]. JEDEC staff member Jack Hessman says the council expects to respond to the proposed mil specs. The utility of an industry response to the supply center is still uncertain: the microprocessor industry's explosive growth almost defies any single group to keep up with it. Also, the JC-43 committee is too recently formed to have made any decisions.

The customers who install microprocessors in their own systems appear to hold the key to both military and industrial standardization problems, contends JC-43 chairman Gordon Smith of Rockwell International Corp. Smith and his panel colleagues agree that there is ample room for standardization but want more user guidance to help them determine how far they can go.

The new JEDEC committee expects that reviewing mil-spec proposals will become one of its important tasks. But, like the supply center and the Rome development center, it is proceeding cautiously until it gets more user help in what Smith calls a sticky area produced by a proliferation of microprocessor architectures for 4-bit, 8-bit, and 16-bit MOS and bit-slice devices. □

The Army-Navy game

Making difficult the military's development of microprocessor specifications is what one observer in the Directorate of Defense Research and Engineering calls "the historical problem of each service playing its own game." The Army has no microprocessor standardization effort at all, he points out, while the Navy has a program for qualifying software under way at the Naval Avionics Facility at Indianapolis as part of its standard electronic modules program. That leaves the Defense Electronics Supply Center working only to Air Force needs. "The obvious consequence of all this is that the government is making its own problems more difficult with a proliferation of specs that are going to require smaller quantity buys at higher prices," concludes the observer.

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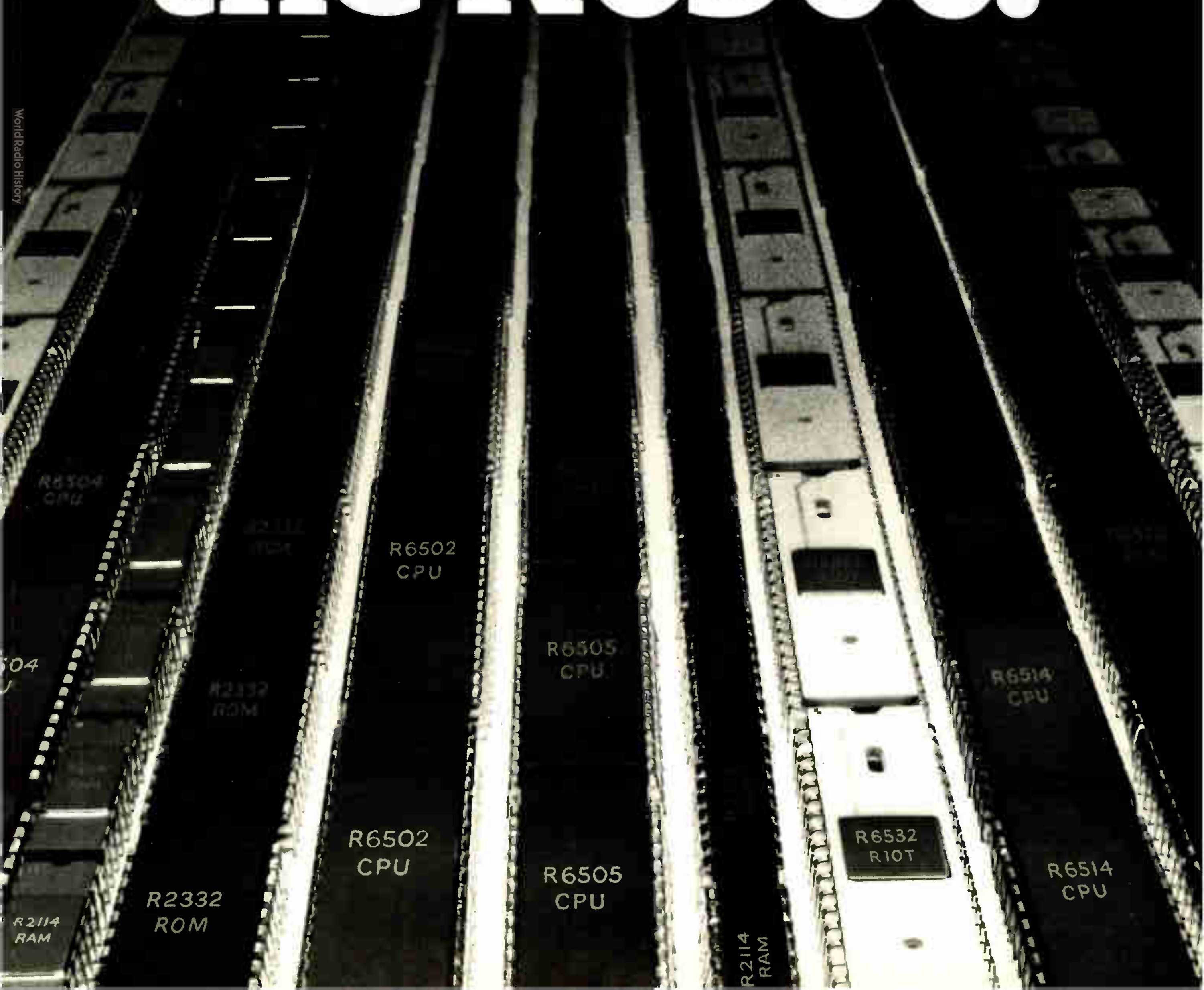

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Data converters latch onto microprocessors

by Lucinda Mattera, *Components Editor*

☐ The rapid rise of the microprocessor has thrown components for analog data conversion into a turbulent state of change. Indeed, with an ever-increasing number of functions being crammed into an ever-diminishing space, they are no longer components in the traditional sense so much as miniature systems. No matter what the technology, though—monolithic chip, hybrid circuit, module, or board—the goal is devices that interface as easily as possible with microprocessors through appropriate lines of communication for addressing, data transfer, and control.

Everything is happening so fast that many designers are becoming confused by the different devices with which the different manufacturers are deluging the market, as well as by the terminology whirling around them. Most engineers realize what a data converter does. Their confusion begins as soon as it does more.

Unscrambling the terminology

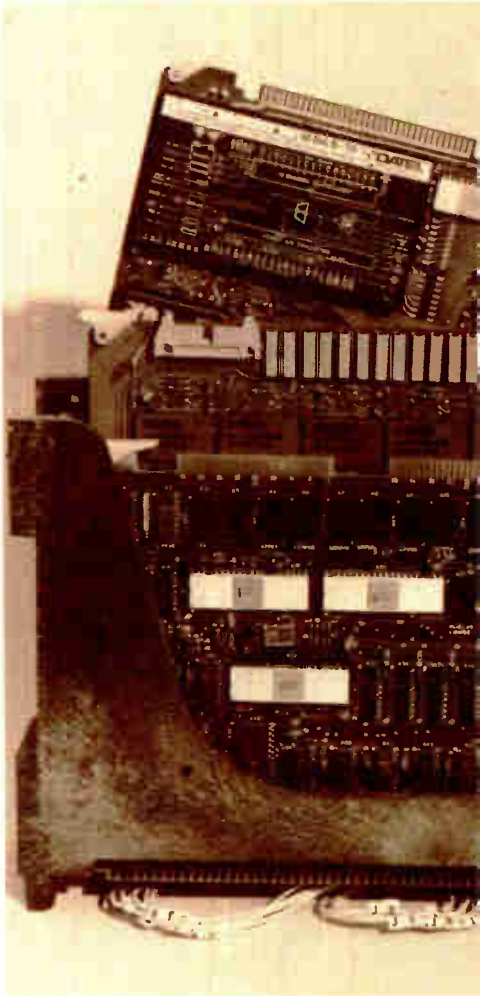
In effect, a data converter is an interface device, linking the analog and digital worlds. Any analog-to-digital converter, as well as any digital-to-analog converter, may in principle be interfaced to a microprocessor if it does not matter how much hardware or software is used. But to make things more convenient for their users, many converters are beginning to include bus-compatible latches for storing data and to come in configurations that make them easier to put under microprocessor control, thus simplifying the software. (See "How converters interface with microprocessors," p. 84.) Such converters are called microprocessor-compatible or microprocessor-oriented devices.

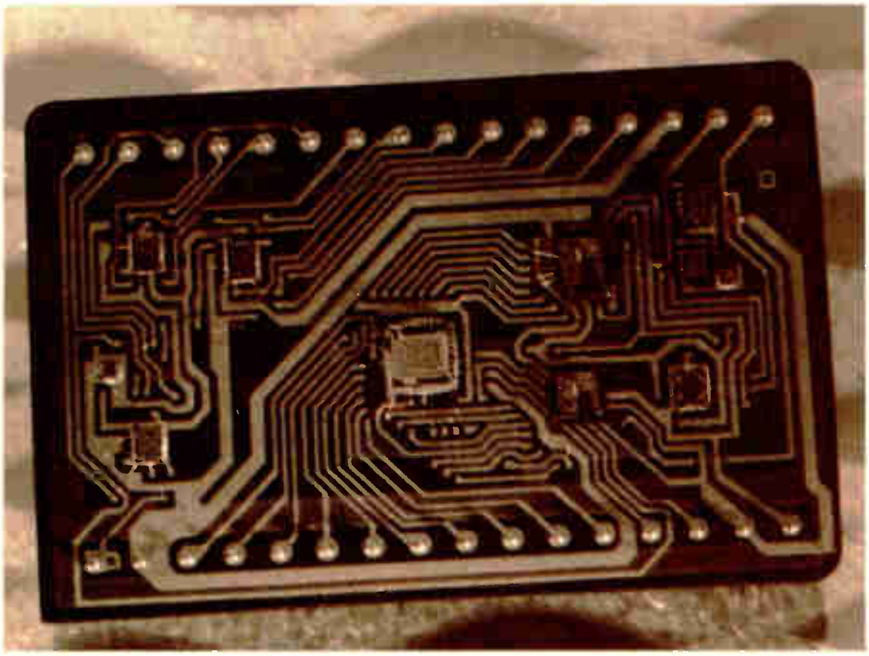
To handle more than just a single channel of data, as is often necessary in an application involving a microprocessor, more circuitry is needed. The component now begins to resemble a system and to relate to the microprocessor as a peripheral. Such a device is coming to be known as a microperipheral or, more specifically, an analog input/output system—an input system if it converts analog data to digital, an output system if it does the opposite.

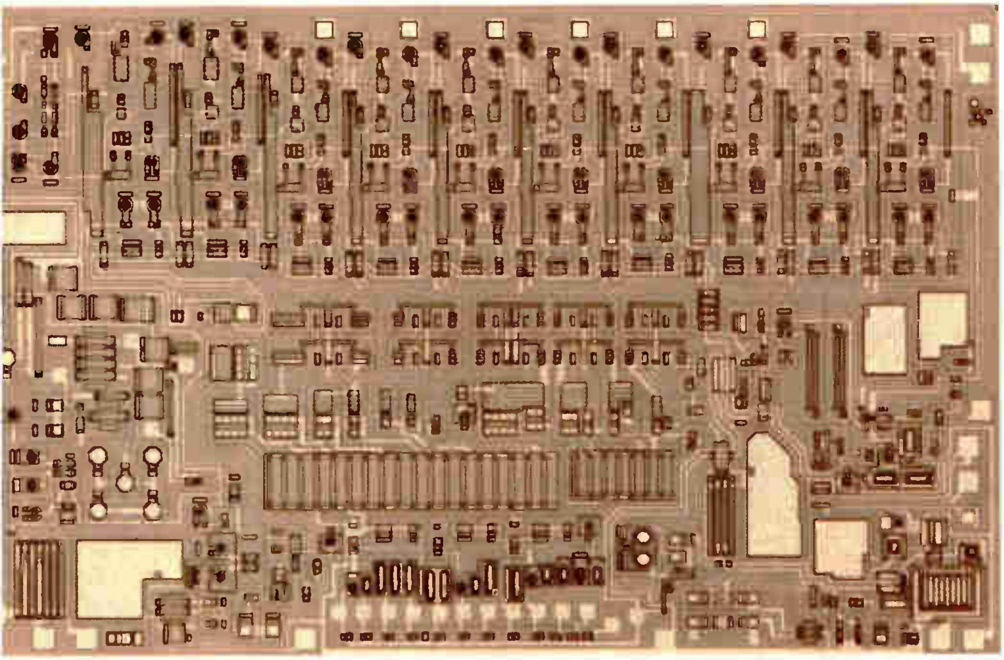
An analog input system is nothing more than an analog data-acquisition system, but one that is microprocessor-compatible. It is generally made up of: an analog multiplexer, an a-d converter, address decoding logic for channel and device selection, control logic, timing circuitry, and buffered latches at the output for storing the converted data. There may also be a sample-and-hold circuit between the multiplexer and the converter and perhaps even an instrumentation amplifier to permit some signal conditioning.

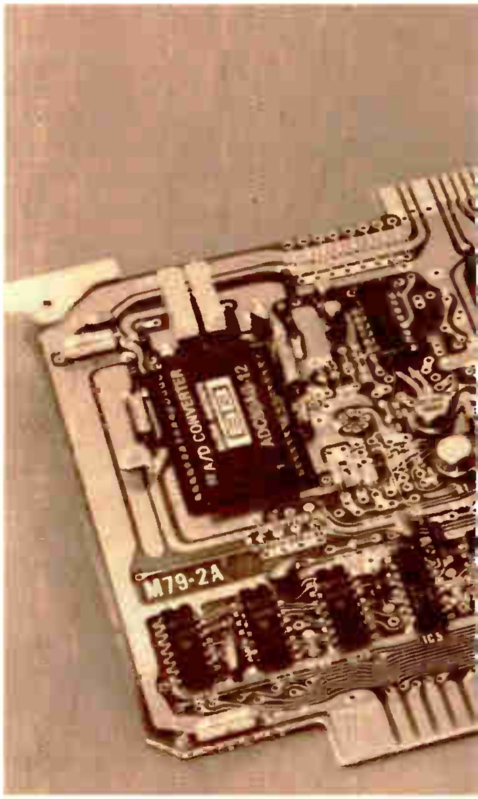
An analog output system also can handle two or more

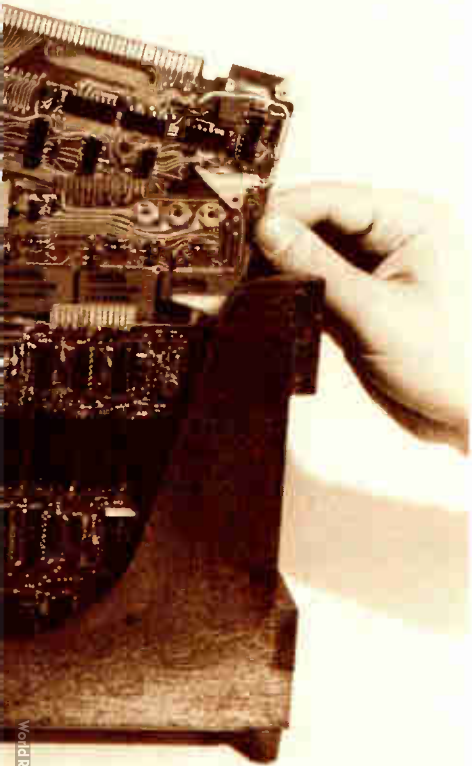
Analog I/O on the move. Anywhere from 30% to 40% of all microprocessor applications will require an interface to the real world of analog data. So manufacturers of analog data-conversion products, whether monolithic chips, hybrid circuits, modular devices, or analog boards, are fast making their devices directly microprocessor-compatible. For example, Signetics is making the first self-contained monolithic 8-bit digital-to-analog converter (bottom left) to be microprocessor-compatible. Meanwhile, Burr-Brown has put the first complete 8-bit analog input/output systems (below) in IC-compatible packages. For the first time, Datel has squeezed an entire microprocessor-compatible 12-bit data-acquisition system (far right, center) into an IC-like package. And Micro Networks will shortly have an 8-bit buffered a-d converter (bottom right corner) that can be programmed over a wide range of inputs. Boards carry the full interface, so they are dedicated to a single microcomputer and slip right into the same card cage, as shown for Datel's units (top center). Boards may provide both input and output analog channels, only input channels, like the Burr-Brown unit (bottom center), or only output channels, like those from Data Translation (top right corner).

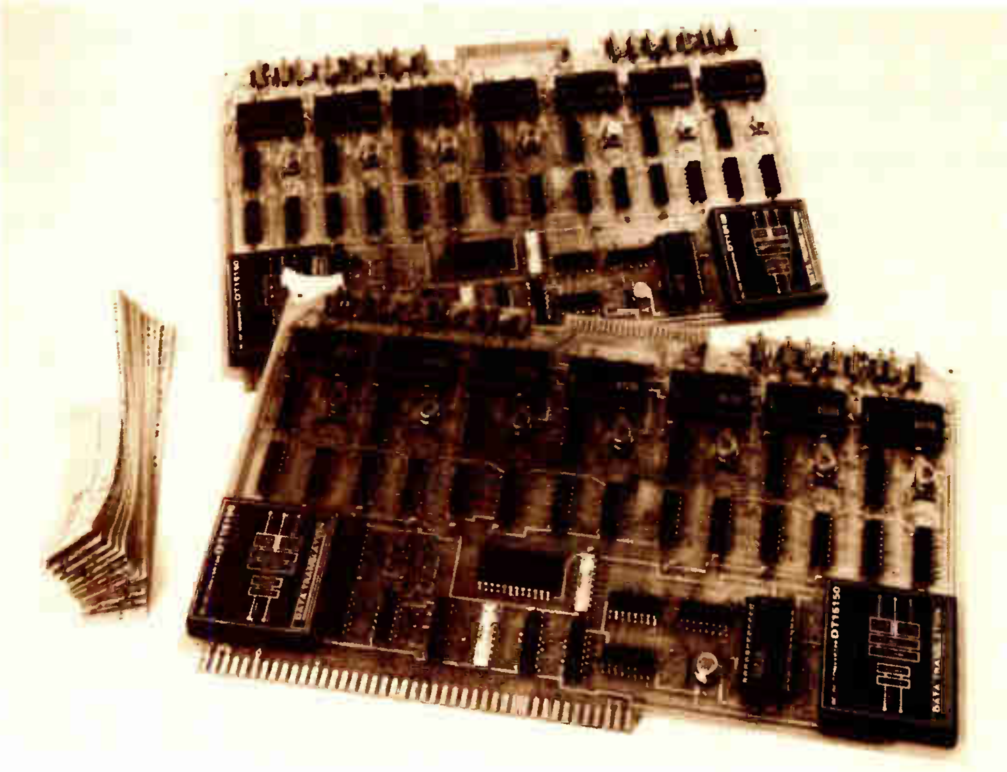


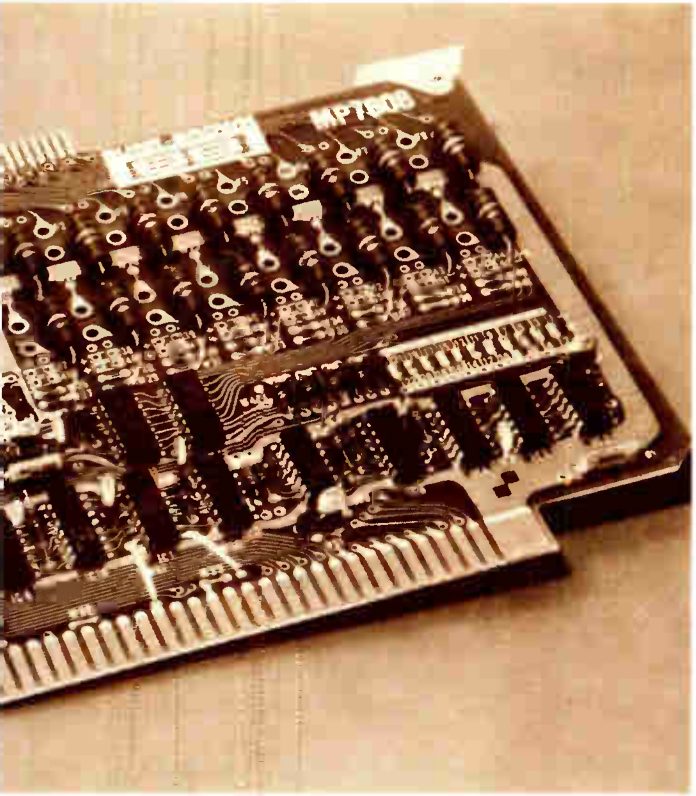


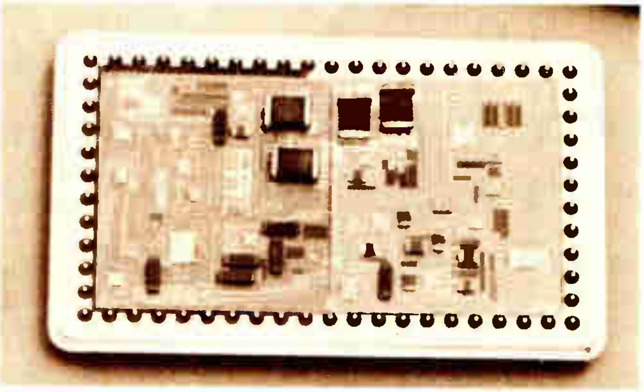


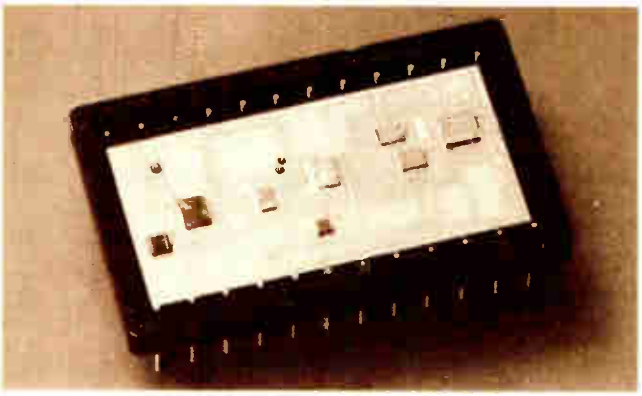












How converters interface with microprocessors

A converter interfaces with a microcomputer like any other peripheral and computer—through a multifaceted interconnection involving both hardware and software. In the case of the converter, the interface deals with three kinds of signals: control, address, and data. All three types of signals are needed to: select the channel to be converted in multichannel systems, initiate the conversion and determine when it is complete, and transfer the data.

Data transfer involves digital signals, but those of the converter must be compatible with those of the microprocessor's data bus. To save gates, all microprocessors have a three-state data bus so that, besides the normal logic low and logic high, the bus has a high-impedance state that looks like an open circuit, permitting a number of channels to share it. For the most efficient operation, therefore, the converter should provide compatible three-state logic for transferring data directly to this bus or accepting data directly from it.

In addition, the data bus may be made up to 4, 8, or 16 binary bits. If the bus word is wider than the converter word, the most significant bits of the bus may simply be ignored. But if the converter word is wider than the bus, the digital data must in effect be multiplexed between converter and microprocessor. This sort of scheme usually requires not only latches for data storage, but also more than one microprocessor cycle, as well as provision for sequencing the operation.

Addressing is merely the process by which the microprocessor selects the converter alone in a single-channel application or the analog channel to be converted in multichannel applications. Typically, a microprocessor has a 16-bit address bus, making over 65,000 unique address codes available. Once the microprocessor has selected the converter by addressing it, the converter must respond by putting data on or taking data off the data bus.

Control signals are the read or write commands from the microprocessor. They indicate whether the addressed location is to accept data or supply it, and they also can verify the validity of the address code and sometimes even the data-bus code.

Besides the various signals required to make the interface, there are different ways to handle data transfer. The two techniques most widely used for converters are accumulator input/output and memory-mapped I/O, with direct memory access running third.

In the first method, data is transferred between the accumulator register of the microprocessor and a register associated with the converter. The technique requires special I/O instructions, although address decoding is easy because separate control signals keep all I/O addresses isolated from memory addresses.

In contrast, a memory-mapped converter looks like just another memory location to the microprocessor. This method keeps programming simple and makes for applications flexibility, since no special I/O instructions are needed, and only memory-reference instructions are required to access data. So despite the fact that full 16-bit addresses may need to be decoded, many of the new microprocessor-compatible converter products are memory-mapped devices.

The third technique for data transfer, direct memory access, is best reserved for high-speed applications. It requires a separate controller that steals part or all of the microprocessor cycle, controlling the bus and transferring data directly to memory. A lot of extra hardware may be involved, so in general the method is further restricted to applications involving large amounts of data.

This data, control, and status information may be exchanged between the microcomputer and its peripherals in several ways: interrupts, polled I/O, or direct memory access. With the last of these, the I/O device takes over and controls the information transfer entirely. In polled I/O, the microprocessor both initiates and controls the transfer by interrogating each peripheral with an I/O instruction.

With interrupts, the peripheral initiates the transfer, but the microprocessor retains control of it. Interrupts may be vectored or nonvectored. For a nonvectored type, the microprocessor steps and then polls all peripherals to find the one that caused the interruption and needs servicing. With a vectored interrupt, on the other hand, the interrupting peripheral sends out the address of its service routine, so the microprocessor need not poll all other peripherals.

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channels, but it tends to use a full d-a converter for each channel of output. A two-channel system has two d-a converters, and so on. Other elements are input data-storage latches, plus logic for address decoding and perhaps control, and possibly even output buffers for driving loads directly.

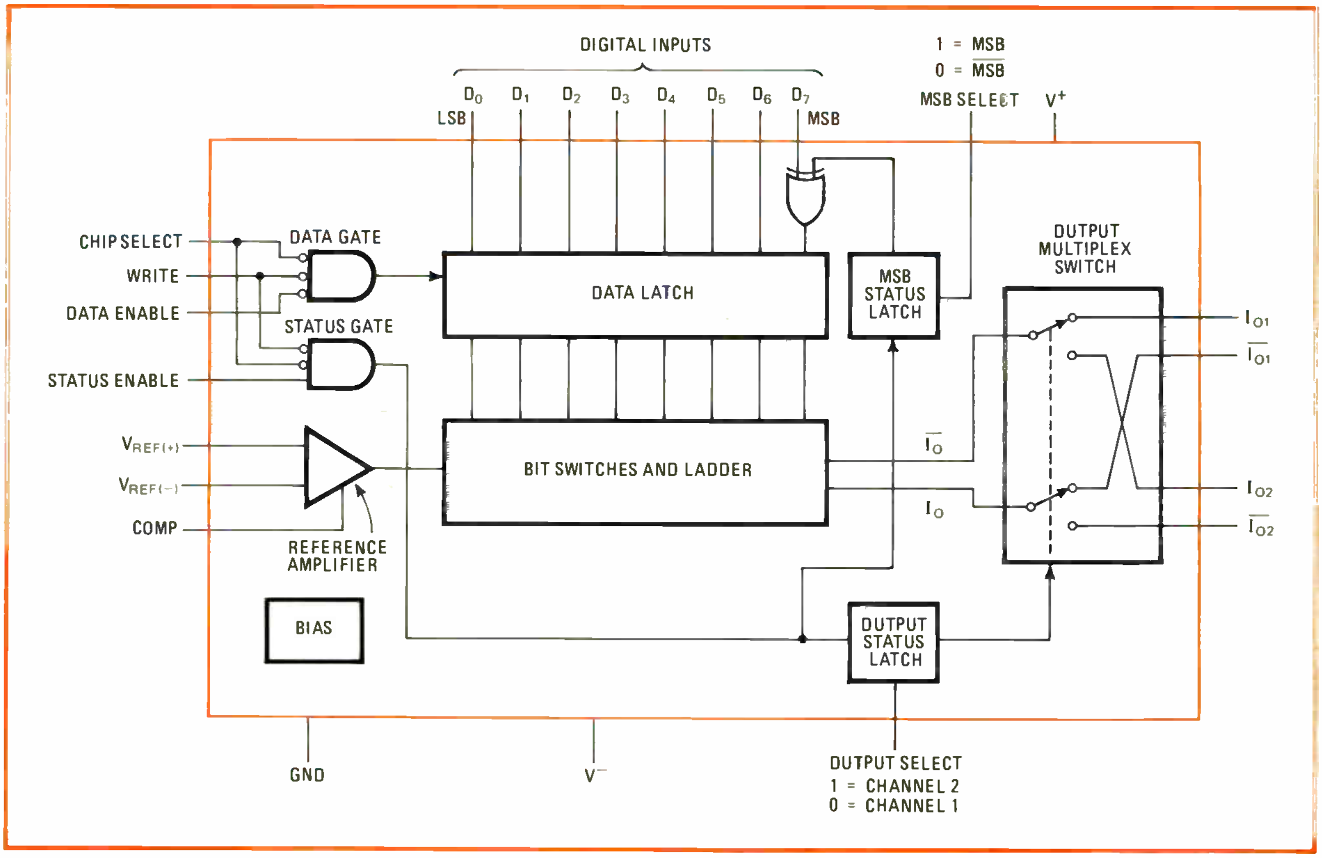
Differentiating the technologies

Even with the terminology sorted out, the user still runs into confusion over various components technologies because of the heavy competition among them for his attention (see "Analog I/O: a budding business," p. 86). For a similar circuit function, he may choose from monolithic chips, hybrid circuits, modular devices, and even complete analog boards. But once the differences between them are known, he should find the choice fairly straightforward.

At present, most conversion products—whether monolithic, hybrid, or modular—are not directly microprocessor-compatible, so they usually require three-state buffers to talk to the microprocessor data bus, as well as one or more so-called interface chips to get the appropriate address and control signals. But some notable exceptions to this rule already exist, and many of the coming generation of devices will be microprocessor-compatible. That said, the differences between the component technologies are mainly in performance and degree of functional complexity.

Monolithic devices are low-cost general-purpose units and have the greatest applications flexibility. By the same token, they also require the most know-how on the part of the user.

In d-a converters, chips tend to serve 8-bit applications, although some 10-bit parts and a couple of 12-bit parts are available. Most of these units are current-output devices, fast to moderate in speed and with settling times ranging from under 100 nanoseconds to 400 ns or so. However, only a sprinkling of devices



1. Choice of output channels. Current-output 8-bit digital-to-analog converter from Advanced Micro Devices has a two-channel multiplexer at its output, so that the user may select different output ranges or loads. The bipolar chip settles in less than 150 nanoseconds.

include a voltage reference and still fewer provide both a reference and an output amplifier—though this situation is changing. Prices currently range around $8 to $20.

As for a-d converters, nearly all the single-chip successive-approximation type need one or more external components, such as a voltage reference, a comparator, and/or a clock. Most are 8-bit devices, the rest are 10 bits, and none reach 12 bits. Their conversion times range from fast to moderate, anywhere from about 20 to 40 microseconds, and prices run from $10 or so to $30.

In contrast, single-chip integrating a-d converters are pretty much self-contained, usually requiring only a few external passive components and sometimes a reference or a clock. They are primarily intended for instrumentation applications, so accuracy is fairly high and so is resolution—10 to 13 bits. Speed is another matter; conversion times are slow to very slow, taking from tens of milliseconds to several hundred milliseconds, although some of the chips include automatic zero correction and full-scale calibration in their conversion cycle. As a rule, prices are low, ranging from about $7 to $25.

For high resolution at high accuracy, the a-d converter of either kind often comes as two or three parts, with its analog and digital circuitry on separate chips. By and large, the successive-approximation units are three-chip sets having a resolution of 8 or 10 bits and moderate speed. In contrast, two-chip integrating converters produce 11 to 16 bits and are slow, taking from 20 ms to over 10 times as long. Considering their high performance, prices for these integrating sets are very reasonable, mostly around $10 to $25 in small quantities.

In general, hybrids offer the user both higher performance and greater functional complexity than a single chip, and they give him it in a single IC-compatible package. Most of the converters are complete, requiring no external components, so they are easier to use than monolithics but do not have quite the flexibility, and they cost more.

Hybrids for convenience

Resolutions for hybrid d-a converters range from 6 to 16 bits. Settling time can be as fast as 0.5 μs for an 8-bit part or 100 μs for a 16-bit part. Price depends on performance, so the range is wide, from about $20 to $150 or more.

Hybrid a-d converters are largely successive-approximation devices, although some 16-bit integrating types are available. For successive-approximation parts, resolutions mostly span 8 to 12 bits, with conversion times of under 1 μs to about 50 μs. Again, cost is sensitive to performance, and price ranges from around the $40 region to under $300.

Furthermore, some of the newer hybrid devices are a complete system in the guise of a single plug-in component. They may perform all the multiple functions of data acquisition and signal conditioning for several channels of input, or they may be entire multichannel analog data output systems. Prices for these system-like devices are high—approximately $100 for 8-bit units and several hundred dollars for 12-bit units. But designing with

Analog I/O: a budding business

The best available guess is that at least one in three microprocessor applications will require an analog interface, to handle the 80% of analog measurements that will run into a computer—almost invariably a microcomputer. So the growth of the analog input/output market clearly depends on how quickly the microprocessor comes into its own. This year it probably totals around $50 million, but experts hesitate to make predictions even for next year.

Manufacturers of the analog I/O components roughly divide the market into three major categories: industrial, instrumentation, and commercial. Industrial, of course, encompasses all types of process control, where hopes for growth are highest. Instrumentation is also a broad area, covering test equipment, medical electronics, environmental control, and even weather monitoring. Commercial applications are mainly in the automotive area now, but could branch out into control systems for the home in the future.

Most industrial applications require resolutions of 12 bits or more, as well as reasonably fast speeds because several channels of data must usually be converted; so they are being served mainly by hybrids, modules, and boards. Instrumentation also usually needs 12 bits or more, though 8 bits is good enough for some tasks, but its speed requirements are generally more relaxed; so all four types of components share in this market. Chips pretty much dominate commercial applications, as they are chiefly 8 bits.

them is easy, and many of the latest parts are directly compatible with most of the popular microprocessors.

At the component level, modules are the ultimate in performance, combining high resolution and high speed, often with a high degree of functional complexity. But unlike monolithics and hybrids, they take up a lot of board space and are fairly expensive. Still, they do offer the user high performance in a convenient low-profile printed-circuit-compatible package having a seated height of 0.4 inch or so. Dimensions for width and length vary from 1 by 1.5 in. on up to about 4.5 by 6 in. As might be expected, converter modules are almost always completely self-contained.

Modules for high performance

Modular d-a converters are available as both current-output and voltage-output devices in resolutions of 6 to 18 bits. Settling times range from 2 to 750 ns for current-output units and from 5 to 250 μs for voltage types. Price depends on performance, of course, and varies from $12 to $1,000 or more.

A-d converter modules come in successive-approximation, integrating, and even high-speed parallel versions, with resolutions of 4 to 16 bits. Conversion times run the gamut with: ultrafast video-like speeds of 40 to 100 ns for parallel types at 4 to 8 bits; superfast to moderate speeds of 1 to 400 μs for 6-to-16-bit successive-approximation devices; and moderate to slow 300-μs to 250-ms speeds for integrating units at 8 to 14 bits. Prices, too, vary widely, from about $30 for a 6-bit unit to more than $1,000 for a 16-bit part.

As for packing the multichannel function of an entire data-acquisition system in a single plug-in package, modules were the first components to do so, easily antedating hybrids. These units are mostly 12-bit systems, less often 8- and 10-bit parts. Their input capacity is either 8 or 16 channels, and their throughput rates are very fast—ranging from 25 to 125 kilohertz. Depending on resolution and speed, they sell for about $200 to $750. A few are even directly microprocessor-compatible.

The next rung up the ladder brings the user to analog boards, which are compatible with the single-board microcomputers now gaining wide market acceptance. These boards are complete analog I/O systems, providing multichannel analog-to-digital and/or digital-to-analog capability. Since they also incorporate the full digital interface, they are always dedicated to a particular microcomputer and require the least engineering of all the microprocessor analog components.

Of the four technologies for analog I/O, monolithic devices are setting the fastest pace in the race to win the most users, as is only to be expected. Semiconductor makers recognize that the future of monolithic data converters is intimately tied to the microprocessors and are scrambling to get in the running with chips that ease the task of interfacing.

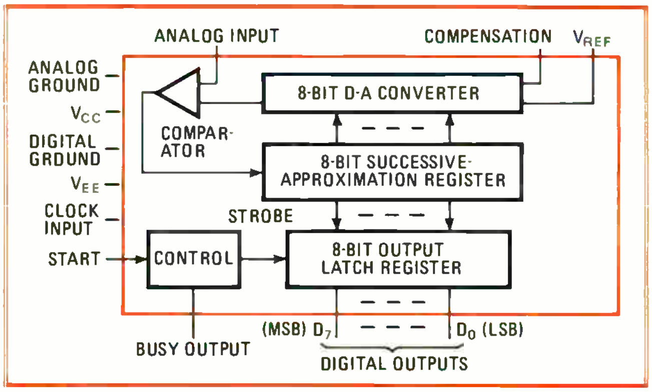
Most often this interface aid takes the form of turning the converter into what looks to the microprocessor like a memory location—in other words, turning it into a memory-mapped device complete with data latches and chip-select plus read/write functions.

This may seem minimal but is not. The real advantage of a chip is that it provides a general-purpose function at low cost. So the manufacturers are reluctant to make chips so functionally complex as to narrow their market. Also, the more complex a chip becomes, the greater the chip area required, and generally the lower the yields.

Bipolar vs C-MOS

As a result, too, most makers are sticking with the two tried-and-true processes for converter products—a standard bipolar linear or complementary-MOS technique. Although there is a smattering of other technologies out there, these two are by far the dominant, and for good reason. Both are fairly mature and well-behaved, so costs can be kept down.

The standard bipolar process yields circuits of such accuracy and stability that even quality analog components like a voltage reference can be included in them. The process also can handle high-speed current switching and provide high-compliance outputs suitable for driving real loads. C-MOS is a denser, low-power technology that is better suited to digital functions. It is slower than the standard bipolar approach, and analog components made with it are merely adequate. Rather than competing with each other, though, these two technologies have found their own niches, with standard bipolar serving the needs of high-speed high-accuracy



2. Superfast. This buffered 8-bit successive-approximation analog-to-digital converter made by TRW LSI Products has an amazingly fast conversion time of 400 nanoseconds. Built with high-speed bipolar technology, the unit holds power drain to 400 milliwatts.

applications and C-MOS serving those applications where greater functional complexity and low cost are primary.

Since data converters are a mix of analog and digital circuitry, just about every other IC technology has been used for them, too, but to a far lesser extent. For a high degree of digital circuit density, as required for, say, a successive-approximation register, some companies have turned to p-channel MOS. A p-MOS chip is most often the digital half of a two-chip a-d converter set. For the analog half of that set, some makers are using mixed processing, which puts bipolar transistors and field-effect transistors on the same chip and may be either a bi-FET or bi-MOS approach. The idea is to combine the high impedance of a FET input with the exceptional linearity of a bipolar output.

About to break on the scene is integrated injection logic. It seems a viable technique for getting the density needed for digital circuitry and the linearity needed for analog all on one chip. A remote possibility is n-channel MOS technology. It is probably the cheapest way to deliver complex functions on a single chip, but there are no commercial devices as yet.

Coming devices, largely C-MOS and bipolar chips, are converging mainly on the 8-bit area. Interfacing should be fairly simple, because 8-bit converters are directly compatible with the 8-bit data buses of 8-bit microprocessors. Besides adding this direct microprocessor compatibility, their manufacturers are also minimizing the number of external components their converters require and reducing supply requirements to a single voltage. Even with these extras, prices are coming down.

A deluge of new chips

A big surprise is the emergence of the first complete microprocessor-compatible data-acquisition systems on a chip.

In a few months, there will be two—from National Semiconductor Corp., Santa Clara, Calif., and Fairchild Semiconductor, Mountain View, Calif. Both are 8-bit devices and are expected to be priced at a fraction of the cost of similar hybrid units.

Coming this month is National's ADC0816, a medium-speed C-MOS chip. Besides a multiplexer for accommodating 16 single-ended channels, the unit has an 8-bit successive-approximation a-d converter, three-state buffered latches, and an internal reference that is derived from the supply voltage. However, it can also operate with an external reference and requires only a single 5-volt supply. Conversion speed is approximately 100 μs per channel. Price depends on linearity, with units accurate to within ±1 least significant bit selling for less than $18 each and those having a linearity of ±½ LSB going for under $20 apiece.

In contrast, the Fairchild chip is an ultra-low-cost bipolar design aimed primarily at automotive applications like engine control and passenger convenience functions. In hundreds, price is under $5, dropping to the $1 range for production quantities. To be dubbed the μA9708, the device is a six-channel analog processor that relies on a microprocessor for its digital intelligence. Including an on-chip sample-and-hold circuit, it employs a pulse-width conversion scheme to provide 10 to 11 bits of linearity and takes about 300 μs to do an 8-bit conversion. Fairchild is supplying samples of the device now and expects it to be in production by year's end.

The firm is also planning a companion analog output system, the μA9706, to be available the first quarter of 1978. It will be an eight-channel, microprocessor-compatible, 6-bit d-a unit employing a digitally controlled, variable-frequency method of conversion. Two of the 6-bit outputs may be cascaded and then weighted to get 12 bits of resolution at 12-bit linearity. Again, price will be rock-bottom, down in the $1-to-$2 range.

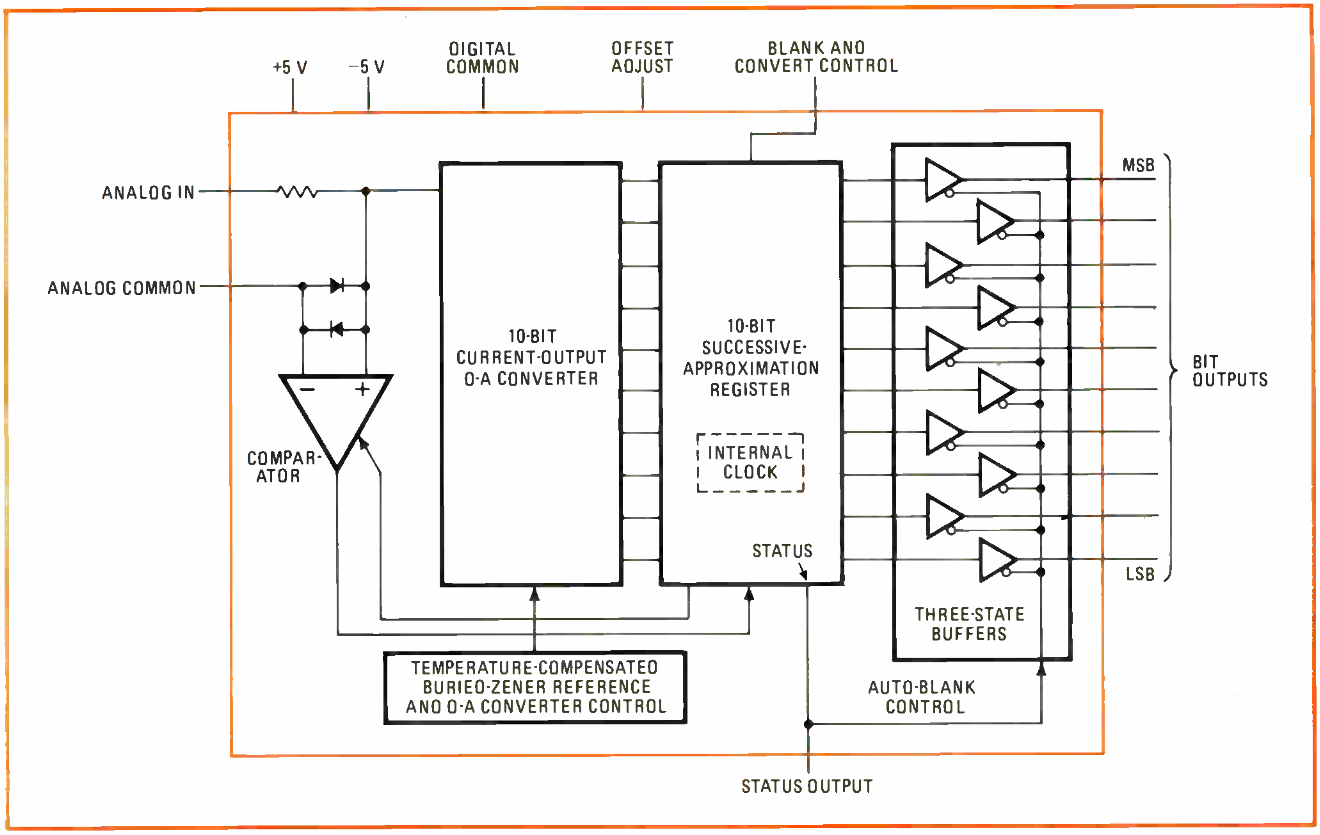
Other variations of these monolithic analog input chips are likely to appear within the next six months. They will probably be C-MOS and have an on-board 8-bit successive-approximation a-d converter. Besides microprocessor compatibility and multichannel input capacity, they may offer an integral sample-and-hold circuit, but may require an external voltage reference. Price, though, is likely to be higher—in the range of $35 to $40.

The 8-bit d-a converter chips

In single-chip converters, there is heavy action in 8-bit d-a units, particularly the self-sufficient ones. Signetics Corp., Sunnyvale, Calif., has just announced the first self-contained 8-bit d-a converter to be microprocessor-compatible. Designated the NE5018, the device is priced low—only about $10. Besides an internal reference and 8-bit data latch, this standard bipolar chip includes an output amplifier and has a commendable settling time of 2 microseconds.

Early next year, Motorola Semiconductor, Phoenix, expects to have its microprocessor-compatible 8-bit d-a converter on the market. Also a standard bipolar chip, the MPUDAC will include an internal reference as well as an output amplifier.

Other companies prefer to retain the flexibility of a current output, leaving it to the user to select the output amplifier that best fits his needs. This is the approach of Advanced Micro Devices Inc., Sunnyvale, Calif., which is readying a pair of microprocessor-compatible 8-bit d-a converters for sampling in the fall. Both are standard bipolar chips with current outputs that settle in under 150 nanoseconds. One device (the AMD6080) will be



3. Self-contained. Fabricated with integrated injection logic, this 10-bit successive-approximation analog-to-digital converter from Analog Devices is the first such unit to be self-contained. It includes a comparator, a clock, an internal reference, and even buffered latches.

able to handle six different binary codes, while the other (the AMD6081) will accommodate eight different codes. Furthermore, the AMD6081 (Fig. 1) has a two-channel multiplexer at its output, enabling the user to select different output ranges or output loads.

Getting remarkable speed out of its bipolar process is TRW LSI Products of Redondo Beach, Calif. The firm has just introduced a pair of 8-bit successive-approximation converters: the TDC-1001J with an extremely fast conversion time of 400 ns, and the TDC-1002J offering a more toned-down time of 1 μs. Both units (Fig. 2) include a comparator and a parallel-output buffer register, but require an external clock and reference. Linearity is within $\pm 1/2$ least significant bit, and power consumption is a fairly conservative 400 milliwatts.

The first company with commercial I^2L devices will be Analog Devices Inc., Norwood, Mass. Next month, the firm is announcing its AD571, the industry's first completely self-contained 10-bit a-d converter (Fig. 3) to be made in monolithic form. It is a successive-approximation design, including a voltage reference, a d-a converter, a clock, comparator, control logic, and output latches for microprocessor hookup. Price will be less than $25. As a followup, Analog Devices will bring out an I^2L 8-bit high-speed d-a converter before next year, aiming it, too, at microprocessor applications. Settling time for this voltage-output device is expected to be 1 to 2 μs and selling price low—from $5 to $8.

At National, the major thrust for the coming year will be in low-cost 8- and 10-bit C-MOS devices for medium-speed applications. The company will shortly have a pair of microprocessor-compatible C-MOS chips for instrument applications. They employ a pulse-width conversion scheme and operate from a single 5-V supply. One is a 3½-digit device, while the other is a 3¾-digit part. Both feature automatic zeroing and polarity selection, as well as overranging.

Two-chip converters

For the most part, single-chip converters are limited to resolutions of 8 and 10 bits. For higher resolutions, as already noted, semiconductor manufacturers often split the converter into one analog and one digital chip, a technique that is particularly effective for a-d converters.

That approach has been used very successfully by Intersil Inc., Cupertino, Calif., which offers a number of integrating a-d converter chip sets. The latest device, to come by the end of the year, is a digital chip for making a 16-bit binary dual-slope a-d converter for microprocessor applications when used with the firm's ICL8052 analog processor. Made with a standard bipolar process, the new ICL7104 will incorporate automatic zero, automatic polarity, and overranging. It can convert a full 16 bits in 300 ms, and is particularly suited to applications involving a universal asynchronous receiver/transmitter (Fig. 4). In quantities of 100, price for the pair of chips is expected to be a very reasonable $15.

In integrating a-d converters, Siliconix Inc., Santa Clara, Calif., makes both single-chip and two-chip charge-balancing designs. It has just dropped the price of its single-chip three-digit LD130 d-a converter, a C-MOS device, to under $4 in quantities of 5,000. The two-chip sets are 3½- and 4½-digit designs, employing p-MOS for the digital circuitry and either standard bipolar or bi-MOS processing for the analog processor.

Another company taking the two-chip approach for the time being is Texas Instruments Inc. of Dallas, which has just introduced an analog bi-MOS chip for building a 8- or 10-bit dual-slope a-d converter. The TL505 is designed for use with the firm's TMS-1000 family of 4-bit microprocessors. It includes an amplifier, comparator, reference, and switches, and will be very low in cost, selling for under $4 in 100-unit lots. By the end of the year, TI will also have a single-chip three-digit integrating a-d converter in I^2L. One version is expected to be microprocessor-compatible.

Not on the market yet is a two-chip design coming some time in the second quarter of 1978 from Harris Semiconductor, Melbourne, Fla. The set, to form a 12-bit successive-approximation a-d converter, will incorporate automatic zeroing, a sample-and-hold function, and interfacing for microprocessor hookup. For the analog portion, Harris will be using a bipolar process and a C-MOS process for the digital circuitry.

Hybrids go to systems level

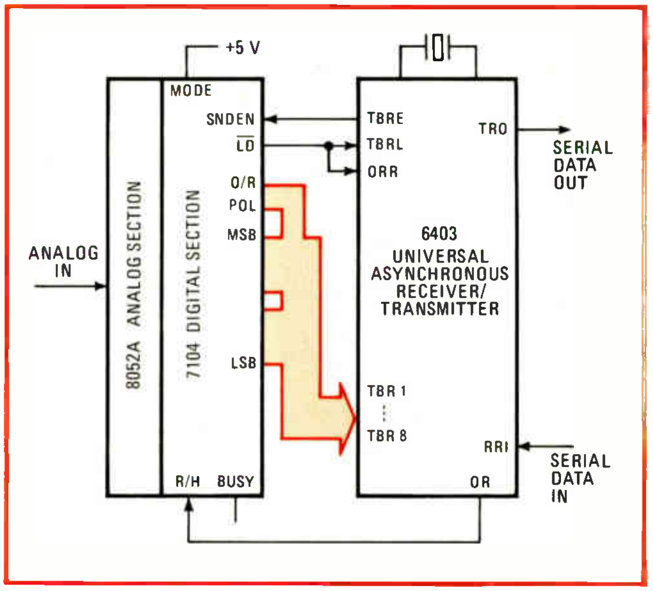
Like monolithics, hybrid circuits are becoming increasingly complex, as manufacturers upgrade their hybrid converters with microprocessor compatibility and on occasion squeeze an entire analog I/O system into an IC-compatible package. It is beginning to become apparent that the limiting factor here is the package, for both thick- and thin-film technologies are well up to providing this higher complexity.

Hybrids usually come in large-cavity (extra-wide) dual in-line packages, the biggest of which has about 20 pins to a side. But 40 pins are not enough for all the interconnections needed by the newer microprocessor-compatible analog I/O devices. To solve the problem, those companies making especially complex devices are double-staking pins along the lengths of the DIP or even putting pins around all four sides.

Although most hybrid converters are self-contained, requiring no external components at all, few of them include the data latches for hooking onto a microprocessor bus. But this situation is changing. Within the next few weeks, for instance, Beckman Instruments Inc., Fullerton, Calif., will have a pair of 12-bit microprocessor-compatible d-a converters implemented in C-MOS. Both contain latches. One device is to include both a reference and an output amplifier, while the other contains only switching and resistor networks. For a viable design, Beckman has gone to a custom C-MOS chip for the logic function.

Other hybrid manufacturers are taking their devices up to systems level. Micro Networks Corp., the first company to put a complete data-acquisition system in a DIP, has just come out with a microprocessor-compatible version of this eight-channel 8-bit device. Soon, the firm will also offer a pin-programmable microprocessor-compatible 8-bit a-d converter that requires only the addition of an external clock. It can be programmed for seven input levels, ranging from ±2.5 to ±10 V.

Because of the increasing demands of circuit complexity, Micro Networks of Worcester, Mass., has found that a single layer of interconnections is no longer enough. So it is developing a multilayer thin-film process—the first in the industry. The first product made with the new process will be a four-channel 8-bit data distribution system, which is already being prototyped and will be in production towards the end of the year. The device will include four latched d-a converters, suitable for microprocessor applications, although there are no plans to include addressing functions in it at this time.

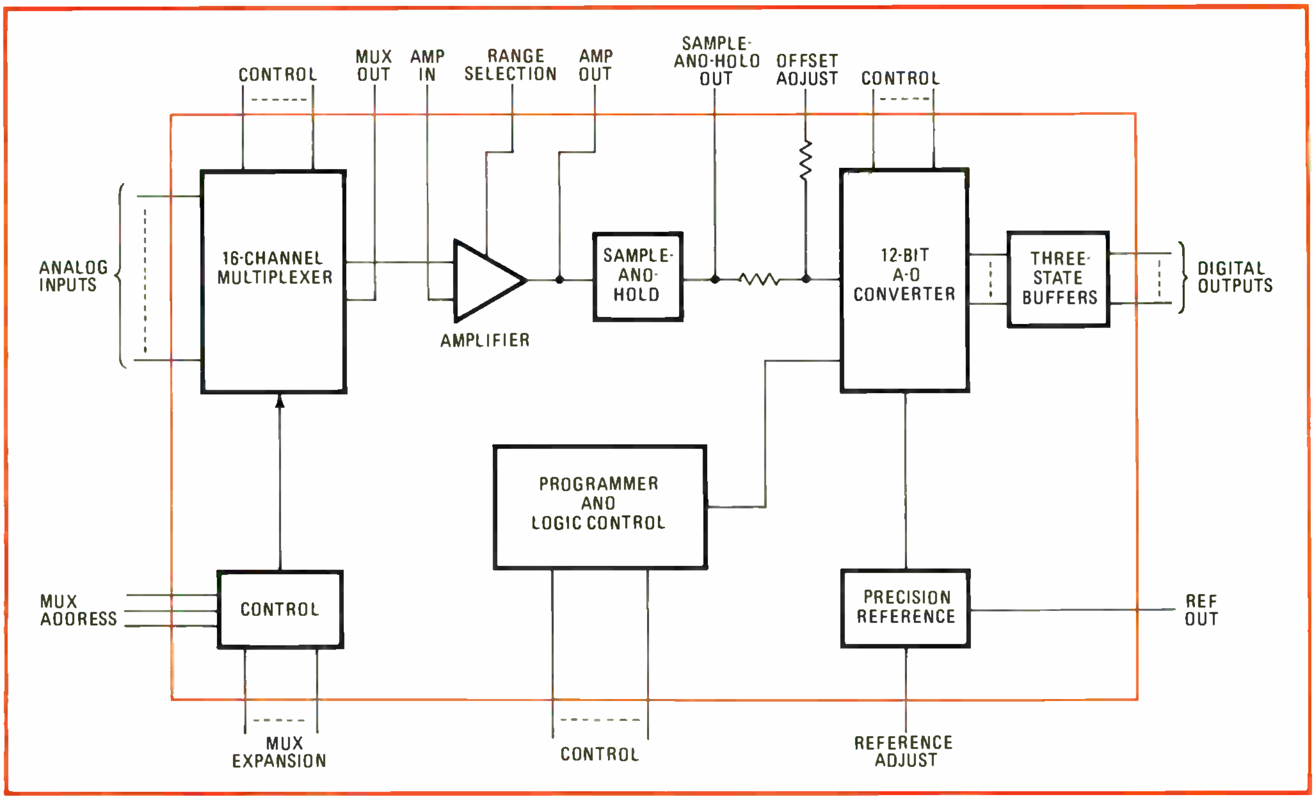


4. High resolution. Providing 16 bits of resolution, Intersil's two-chip dual-slope analog-to-digital converter offers simple microprocessor hookup, especially for applications involving serial data transfer by means of a universal asynchronous receiver/transmitter.

Squeezing I/O systems into DIPs

Another leading hybrid firm, Burr-Brown Research Corp., Tucson, Ariz., is already making complete 8-bit analog I/O systems in DIPs—the first devices of their kind. These thick-film hybrids are directly compatible with most of the popular microprocessor chips. The MP20/21 is an eight-channel 8-bit analog input system, complete with buffers, a multiplexer, an a-d converter, and even a programmable-gain instrumentation amplifier for handling low-level signals. A sample-and-hold circuit, if desired, would have to be external. The MP10/11 is a two-channel 8-bit analog output system that incorporates address decoding and control logic. What's more, early next year, Burr-Brown will offer 12-bit hybrid systems implemented in C-MOS. The analog units will accommodate 16 single-ended or 8 differential channels, while the output units will be two-channel devices. Price is expected to be in the range of $300 to $350.

Not to be left behind, Datel Systems Inc., Canton, Mass., is coming out this month with its analog input system for microprocessors, a complete 16-channel (single-ended-only) 12-bit unit implemented in thin film. It is the first device of its kind in hybrid form and includes an instrumentation amplifier, as well as a sample-and-hold circuit. Another version, capable of eight-channel differential operation, will also be available. Commercial



5. Modular unit. Made by Analogic, this modular 16-channel 12-bit data-acquisition system is one of the few such devices to be directly microprocessor-compatible. Dubbed the MP6812, it incorporates a sample-and-hold circuit and even a programmable-gain amplifier.

units are to sell for under $300 each in small quantities.

In contrast with the flurry of changes among monolithics and hybrids, modules present a stable picture and one that is likely to remain so for the immediate future. That is partly because this approach got the jump on the others. For instance, by now there are several firms making modular data-acquisition systems, most of which are 16-channel 12-bit units.

These modular units usually provide a sample-and-hold circuit, some contain an instrumentation amplifier for signal conditioning, and a very few offer direct microprocessor compatibility (Fig. 5). In comparison with monolithics and hybrids, fewer companies are in the module business, among them Burr-Brown, Analog Devices, Datel, and also four Massachusetts companies: Adac Corp. of Woburn, Analogic Corp. of Wakefield, Data Translation Inc. of Natick, and Dynamic Measurements Corp. of Winchester.

Since modules perform best of all data-conversion products, they are the way to go where space is not at a premium but resolution, accuracy, and speed are. As a result, many of the analog boards now being commercially produced use one or more modular devices.

Analog boards—the easiest of all

For the most part, boards are 12-bit systems and may be bought as full I/O units or as only input or only output units. Since each is designed for a specific microprocessor, it is the same size as the digital boards in the microcomputer system.

Depending on the microcomputer, the analog boards come in a variety of interface configurations. Some provide signal conditioning in the form of an on-board instrumentation amplifier, but no analog filtering. Inputs are commonly high level (10 V nominal) and/or low level (10 millivolts nominal), with some boards able to handle current loops or thermocouple signals directly. On the other hand, analog outputs may be buffered for driving either voltage or current loads directly, or they may be geared to drive a point plotter.

Users tend to favor a certain microprocessor, so they need only to select the analog board or boards best suited to their applications. In fact, the analog interface is developed to such an extent that the user often just has to slide the board into the card cage and write his program to have an operating system.

Input boards provide capacities of up to 64 channels (expandable to over 100 channels with extra multiplexing, of course), while output boards may have up to eight channels. Some boards can operate from a single 5-V supply, others require ±15 V, and still others require all three of these voltages. Both 8- and 12-bit systems are available for the microcomputer boards made by Intel, Motorola, Digital Equipment Corp., National, Zilog, Computer Automation, Process Computer Systems, and Pro-Log.

The number of companies offering analog I/O boards is mushrooming. Some of the microcomputer houses—like Intel, Motorola, and DEC—now have them, and the list of independent suppliers is growing. It now includes such firms as: Adac, Burr-Brown, Analog Devices, Data Translation, and Datel. A few of these companies, Analogic among them, are even making analog boards for minicomputers—but that's another story. □

One-chip bipolar microcontroller approaches bit-slice performance

8X300 combines best of both worlds with 250-nanosecond cycle time and powerful instruction set

by John Nemec, *Signetics Corp., Sunnyvale, Calif.*

□ While refinements in the metal-oxide-semiconductor process have improved the performance of 8-bit MOS microprocessors, the need for really high speed still drives designers to the bipolar bit-slice machines. Advances in bipolar Schottky technology, however, now allow the design of a single-chip microprocessor with the computational ability and the performance advantages that approach those found in bit-slice designs.

The 8X300 microprocessor from Signetics Corp. is the first such device. Not only does it have a cycle time of 250 nanoseconds, but it also has an improved architecture that makes it extremely efficient; hence its throughput is vastly superior to those of MOS devices. The interfacing bus structure, for example, is partitioned into two banks, and in a single instruction cycle the processor can accept data from a port on one bank, operate on it, and deposit the result in a port on the other bank. Since instruction fetching is concurrent with data operations, and both are executed in one 250-ns instruction cycle, the 8X300 is as fast as bipolar bit-slice systems on a microcycle basis.

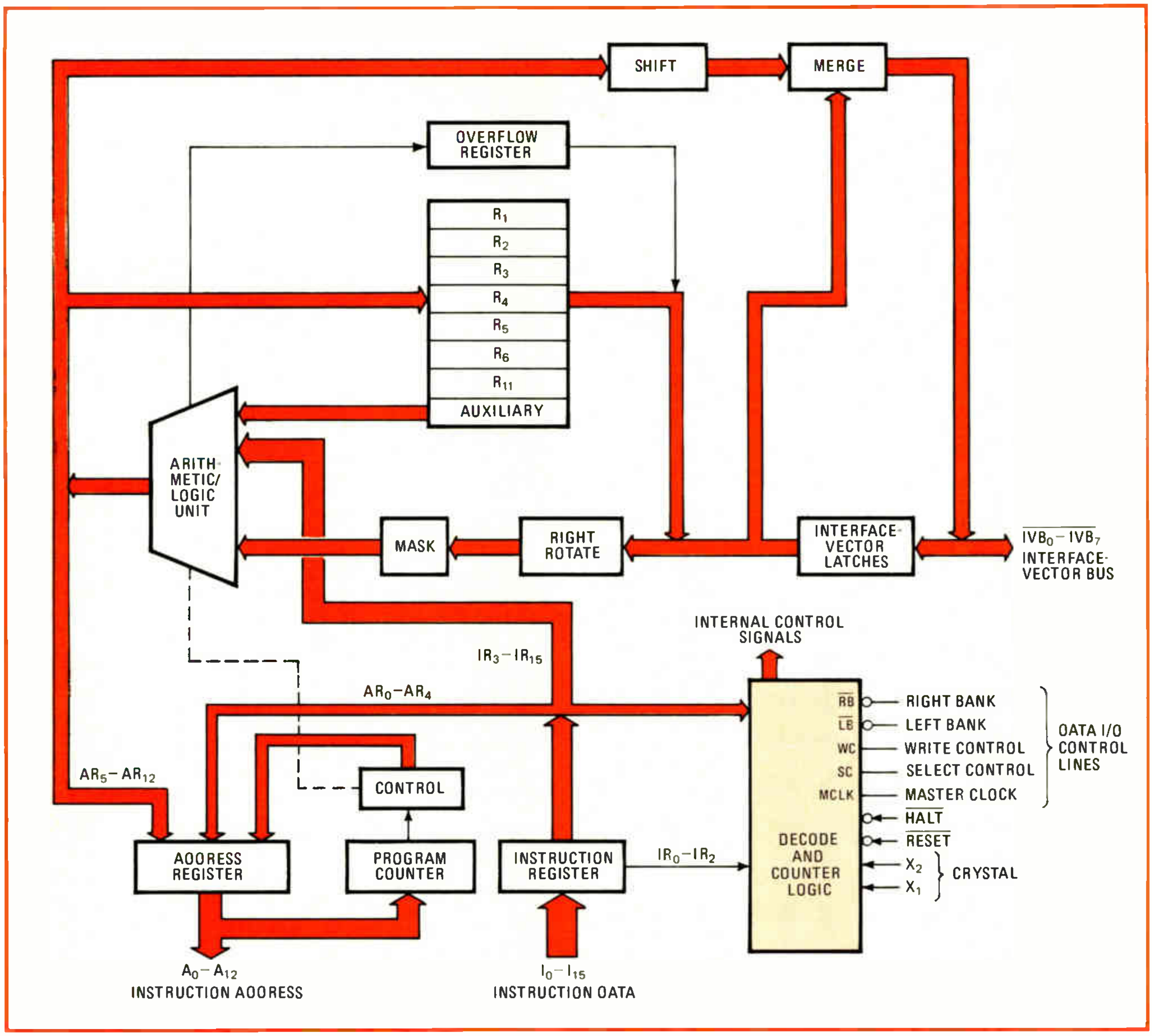
Moreover, the 8X300 is easier to program than bit-slice devices. The powerful instructions have simple mnemonic representations of the functions they perform, such as ADD for the addition function, and these mnemonics can be directly translated into their octal representation. With these conveniences, several hundred lines of program code can readily be written by hand. Consequently, for tasks of less than 500 instructions, no assembler is needed—only a simple conversion is required to generate the actual program-memory content.

Its ease of programming and flexible interfacing structure make the 8X300 a natural as a subsystem and peripheral-device controller—one requiring little additional hardware for such applications. And the speed of the 8X300 allows it to handle control functions that MOS processors cannot, such as direct-memory-access interfacing, for example.

Novel architecture

The architecture of the 8X300 processor is shown in Fig. 1. The chip includes full instruction-decoding logic that interprets the particular class of instructions, such as input/output or arithmetic and logic, and performs the indicated operation. The decoding and control logic supplies all internal signals for the processor, as well as signals on the control lines for directing the data input and output.

The processor also contains its own program counter, which is automatically incremented upon execution of the instruction. The counter may also be left unchanged or loaded with a new value. Control of the current



1. High-performance microcontroller. The Signetics 8X300 processor, a bipolar Schottky device with a 250-ns cycle time, is capable of processing at throughputs rivaling those of bit-slice machines. Fetching of its 16-bit instructions is concurrent with data operations; and with a bus partitioned into right and left banks, the 8X300 can, in a single instruction cycle, accept data, operate on it, and deposit the result.

address is provided by the address register and may be derived completely or partially from the program counter, from the instruction data lines (AR_0 through AR_4), or from the output of the arithmetic/logic unit (lines AR_5 through AR_{12}). Because of this flexible instruction-address scheme, the order of execution may be altered by instructions or under conditions determined from selected data.

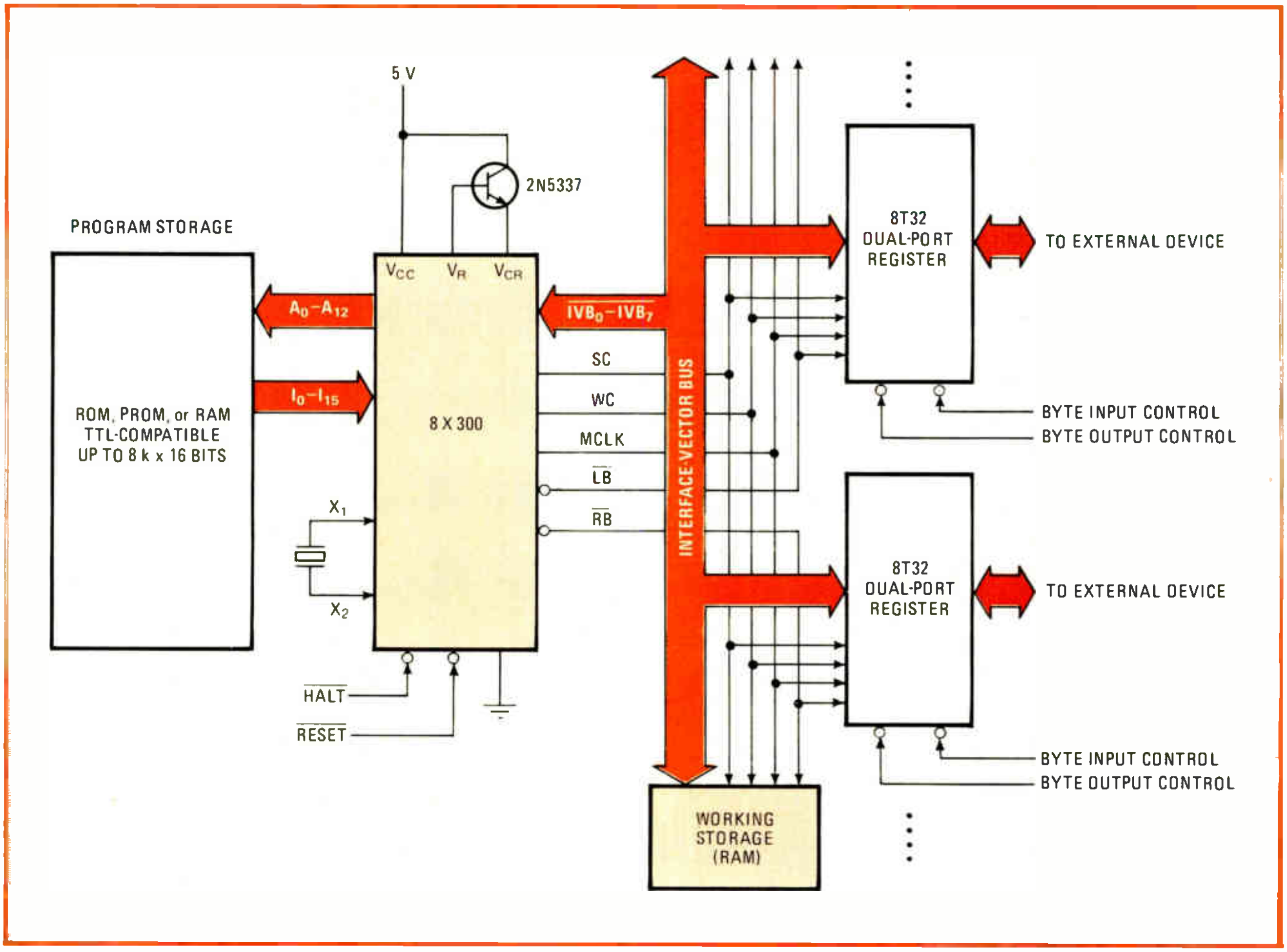
The read/write registers

The processor manipulates 8-bit data bytes. Internal data is stored in eight 8-bit read/write registers—R_1 through R_6, R_{11}, and an auxiliary register. The auxiliary register holds one of the operands used in two-operand instructions, such as ADD or AND, and a single-bit overflow register stores the carry-over bit from additional operations.

Further, the addition of the rotate, mask, shift, and merge functions to the ALU extends the 8X300's operating capability and enhances its efficiency.

Interfacing with external circuitry is through an 8-bit bus called the interface-vector bus and consisting of lines IV_0 through IV_7. The bus carries both address and data information, and the accompanying data-I/O control lines tell the external circuitry which of the two types of information is on the bus. These lines include write- and select-control, right- and left-bank-signal, and master-clock lines.

Since the interface-vector bus carries addresses as well as data, I/O ports on the external circuits must be enabled before data transfer can take place. This is usually accomplished by placing an address on the bus under program control and then activating the select-control line, which indicates that a valid address is on the bus. When presented with an address, each of the possible 512 I/O ports either enables itself upon



2. System design. A typical configuration has memory for program storage and latches for up to 512 directly addressed I/O ports, which are divided among left and right banks. All addresses and data are carried by the interface-vector bus and directed by control lines.

identifying the address as its own or disables itself if the addresses do not match.

The processor can directly address all of the I/O ports without the need for a decoder. The bus, and the interface-vector bytes on it, are bidirectional.

Within the processor, the interface-vector bytes are addressed in a unique fashion. Each byte has an 8-bit field-programmable address. When a given address is selected, the byte is automatically designated, and the 8X300 can then communicate with the I/O device. Moreover, once enabled, the addresses remain so until the processor changes them. This direct-addressing feature is especially convenient if a few ports are to be accessed frequently. However, if the time required for this operation is an imposition on the user, instruction memory can be extended so that the selection of ports is automatic upon instruction fetch.

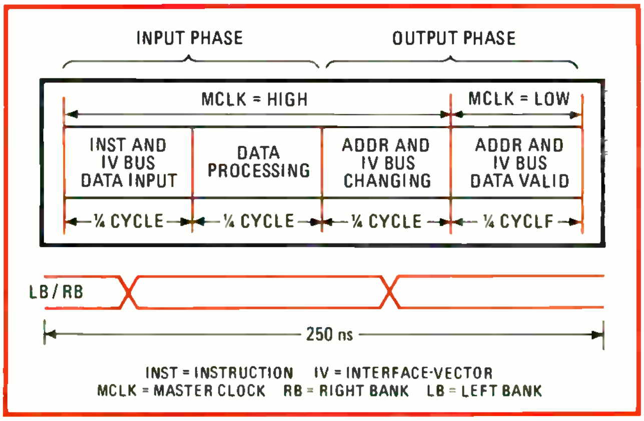
In extending the memory, an extra field is appended to each instruction through an additional bus applied to each I/O port. The address field may be as wide as required to serve all system I/O ports and, if necessary, to serve memory. The address field contains two addresses, since the interface-vector bus is partitioned into right and left banks.

Partitioning of the interface-vector bus into two banks allows the 8X300 to select ports dynamically. The processor uses the left-bank (LB) and right-bank (RB) data-control lines as master enables for the I/O ports, as shown in the typical interconnect scheme of Fig. 2. Any two I/O ports can be active at the same time provided they are on opposite banks, and the ports recognize address, data, and controls only when enabled by the bank signal to which each is connected. Bank partitioning can thus be considered a ninth address bit that is alterable by the processor within an instruction, and it is this additional bit that permits direct addressing of 512, or 2^9, I/O ports.

In a general data operation between two I/O ports, first an address is presented to one bank that enables an I/O port and disables all others on the bank. Next, another address is presented to the opposite bank, effecting a similar selection there. Then the operation between the two takes place.

Instruction cycle

Each 8X300 operation is executed in one instruction cycle, which is subdivided into four quarter cycles as shown in Fig. 3. The instruction address for an operation is presented at the output of the processor during the third quarter of the previous instruction cycle. If the system memory is fast enough, the instruction returns to the processor during the first quarter of the cycle in



3. Instruction cycle. Two I/O ports may be dynamically selected in a single cycle if they are on opposite banks. Complementary LB and RB control signals change state during first and third quarter-cycles to accept data from one port and deposit it in the other.

which it is to be executed. The decoded instruction then directs the operation of the processor throughout the cycle.

In terms of processing data, the instruction cycle may be viewed as having two halves, an input and an output phase. During the first half of the instruction cycle, data is brought into the processor and stored in an interface-vector latch. Storage is completed during the first quarter cycle, and in the next quarter cycle the data is processed through the ALU. In the second half cycle, the data is presented to the bus and finally clocked into the designated I/O port.

Bank selection during the input and output phases is independent. Thus data may be received from the right bank, processed, and then deposited in the left bank or vice versa, or may even be sent to and from the same bank. Bank selection during instruction cycles is specified by the instruction.

Much of the strength of the 8X300 architecture lies in the powerful instruction set that controls the processor. The instruction words, each 16 bits in length, are made up of several fields that include the operational code, the source and destination fields, and the length field.

Instruction fields

The contents of each field can be represented by a set of octal digits, to simplify the task of coding. These digits have a direct relation to the specific operations that the data undergoes in its travel along the 8X300's internal data paths. The op code for addition, for example, is 01. In an operation between two I/O ports, the first of the source field's two digits specifies the bank and the second prescribes the number of bits to be rotated to the right. Similarly, the first digit of the destination field again specifies a bank, while the second digit prescribes the number of bits to be shifted. The length field specifies the number of bits to be accepted for operation in the ALU.

The capabilities of the 8X300 are such that it can, with few additional devices, perform all the functions required of an intelligent terminal. Whereas a typical system of this kind is constructed from many small- or medium-scale-integrated circuits for the control portion of the terminal—cathode-ray-tube display, dot-matrix graphics, keyboard data entry, and host or mass-storage interface—and a microprocessor for the intelligence portion—data manipulation and number crunching—the 8X300 performs most of both the control and intelligence functions. The result is a system with fewer parts and far more capabilities for the money.

Intelligent terminal

The 8X300-based intelligent terminal depicted in Fig. 4 consists of four major sections. First is the interface section, which implements the standard RS-232C interface with the host or main-data storage. The Signetics 2651 programmable communications interface performs the serial-parallel data interconversion for byte processing by the 8X300 and for display-refresh memory. The interface section includes a keyboard that is scanned by the processor for operator inputs.

The second major section comprises the video circuitry that generates all pixel, character, and line timing, as well as the composite video signal. This circuitry also supplies signals to the refresh-memory address counter for proper timing of character codes and attributes—blinking, reverse video, and so on. Synchronization, blanking, video, and attribute signals are then summed in the video mixer to produce the signal for driving standard monitors.

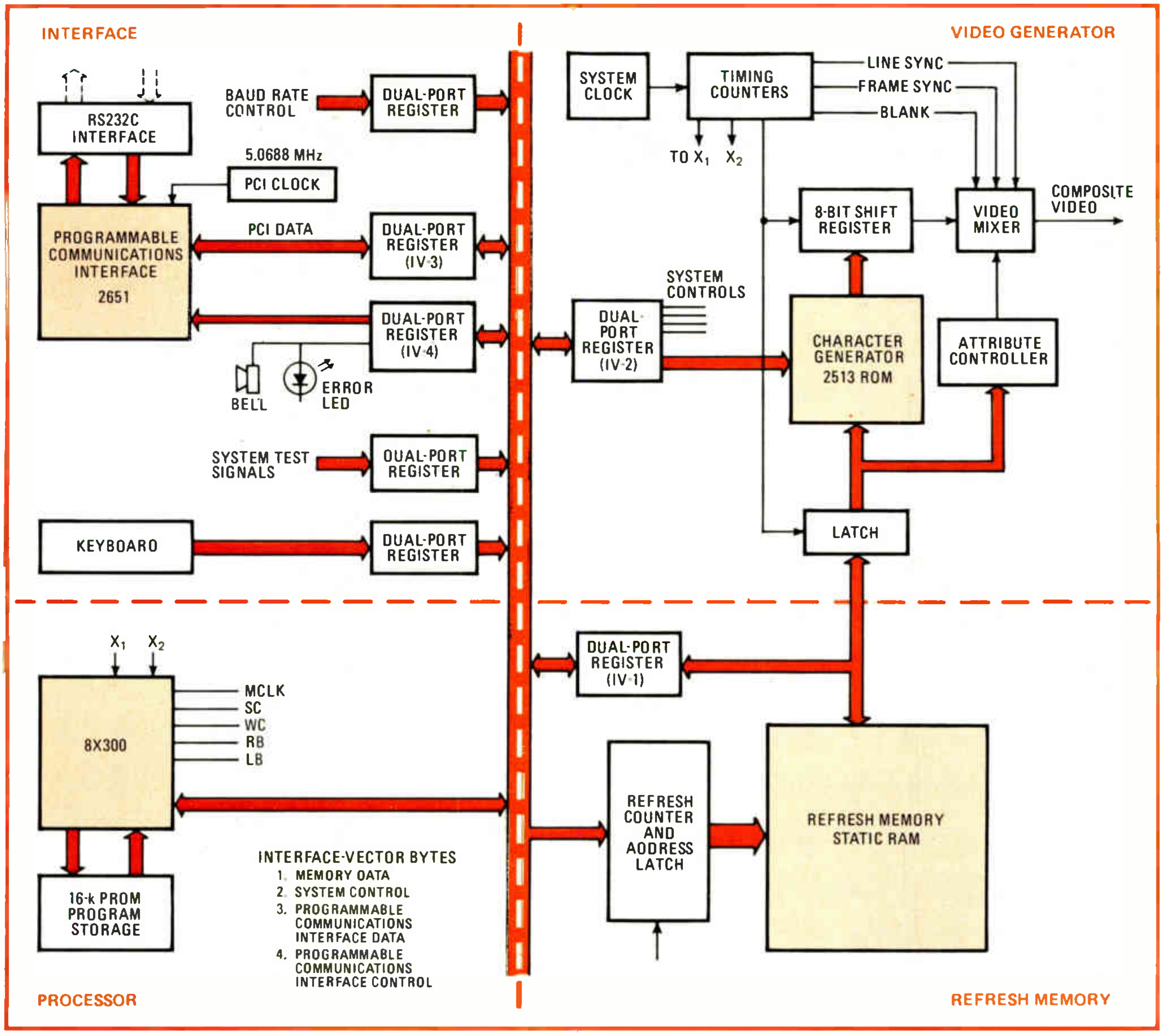
The third section, the refresh memory, stores the characters to be displayed on the screen. Its characters are addressed under control of the video-generator circuitry. The circuitry also provides for timing and control to facilitate interleaved access to the memory by the 8X300 processor. Interleaving permits the processor to examine or modify the refresh memory without disturbing the on-screen display or the video-refresh process.

The processor's role

The final section is the processor, the terminal's intelligence center. It performs both the executive control—managing the other three sections—and the data-processing function required by the terminal.

Since the 8X300 controls the refresh memory and video-generator sections and thus provides the timing for each frame, all frame-related features, such as scrolling and command-scanning, can be easily implemented. But most important, the processor also performs all the data manipulations—the intelligence within the terminal. The processor may accept input data from the host or the keyboard and can then present the data in proper format by means of the CRT display. Information may be entered or modified by the user and then returned to the host after the essential data items have been extracted from the refresh-memory file. This process, tailored to the user's needs, may be accomplished fully by the 8X300 microprocessor in firmware.

The basic control program, including keyboard scan, RS-232C interface service, edit, scroll, cursor, and so forth, requires only 502 words of program storage. Thus the entire terminal can be coded with two 4,096-bit programmable read-only memories. The balance of parts for the entire terminal hardware include the 2651



4. Intelligent terminal. The 8X300 builds an intelligent terminal that, with a total of about only 40 devices, is low in cost while high in capabilities. Included in the terminal are RS-232C interfacing, keyboard scanning, character generation with attributes, and fully interleaved refresh memory. The processor manages the other three sections and adds intelligence in data handling and number crunching.

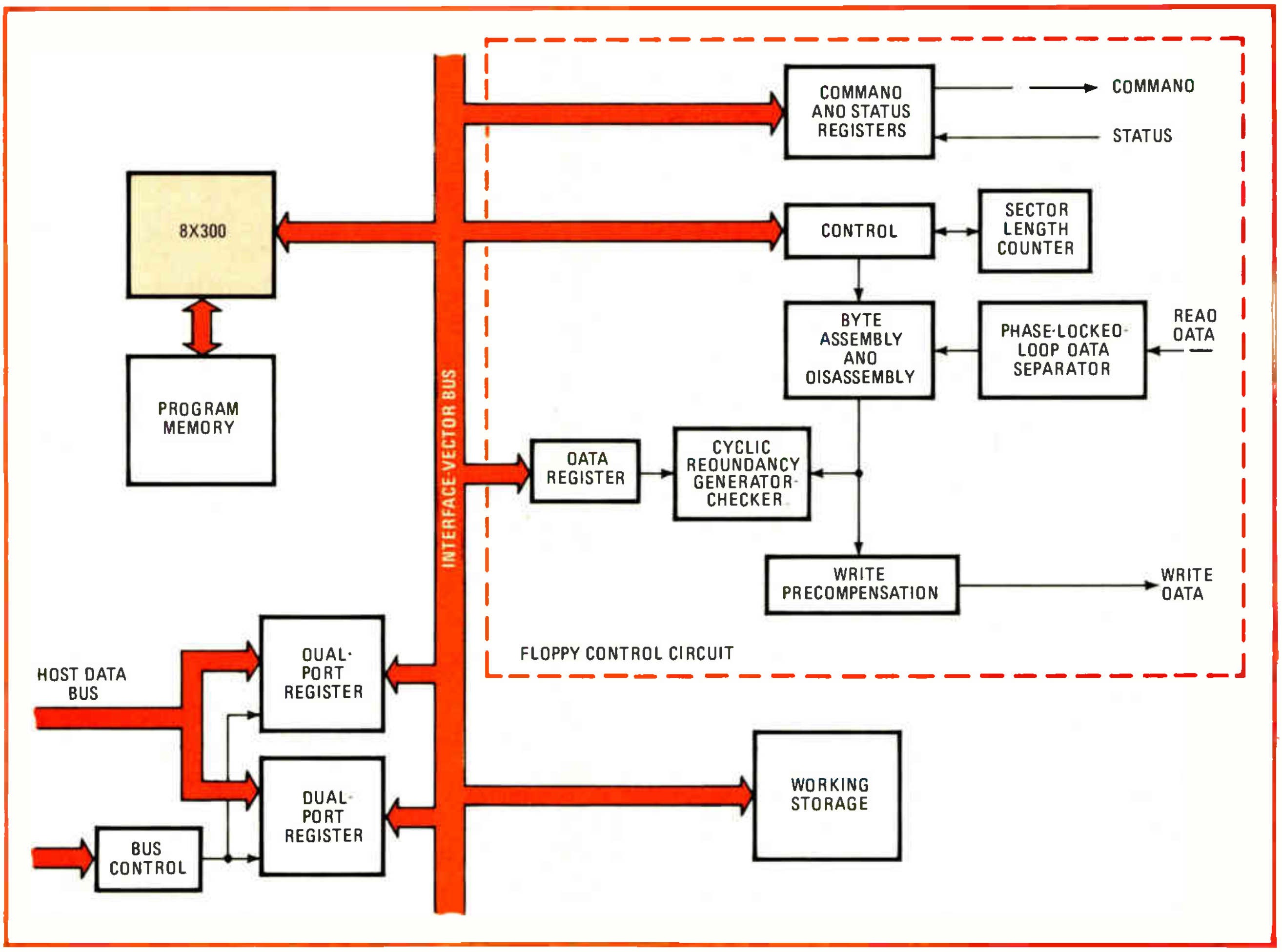
programmable interface chip, the random-access memory for display refresh, a field-programmable logic array, and several low-power Schottky components, in addition to the 8X300. The use of about only 40 medium- and large-scale-integrated parts to construct the complete system contrasts with the over 110 small- and medium-scale-integrated components needed at present to build dumb terminals.

Floppy controller

The 8X300 can be used in a very practical floppy-disk controller circuit that has few parts and offers highly reliable control and data transfer and complete interfacing with the host processor. The processor's high speed enables it to handle any density—single, dual, and quad formats. With only minor firmware changes, a single hardware configuration can accommodate all popular disk drives and a variety of host processors. What is more, it can do so within a single operating system—all that is needed is to switch from one set of firmware to another.

The floppy-disk controller, shown in Fig. 5, has basically two major functional parts, plus minor support functions. The two major sections are the processor and the control circuit.

The 8X300 communicates with the surrounding circuits through the interface-vector bus and controls the disk drives through command and status registers. Operating efficiency is high because selected control and status bits share the same bidirectional I/O register, allowing both polling (status monitoring) and command to take place in as short a time as 250 ns. The processor's high speed allows simultaneous control of several disk drives for operations such as overlap seeks, where one drive is accessing while another reads or writes data. The 8X300's limits are reached only during tight-loop data



5. Floppy-disk controller. High performance of the 8X300 allows it to effectively control a floppy-disk drive. The processor not only handles track and sector addressing but actually oversees data transfer. It also provides interfacing with the working store or directly with the host.

transfers that have to be extremely fast, but since these periods are very short, they present no significant system delays.

The 8X300 builds reliability into the disk operations by overseeing the actual data transfer, in addition to positioning the read/write head. The intelligence of the processor can be used to reread data after it has been written or even to mask out bad tracks that fail to read correctly after, say, 10 rewrites.

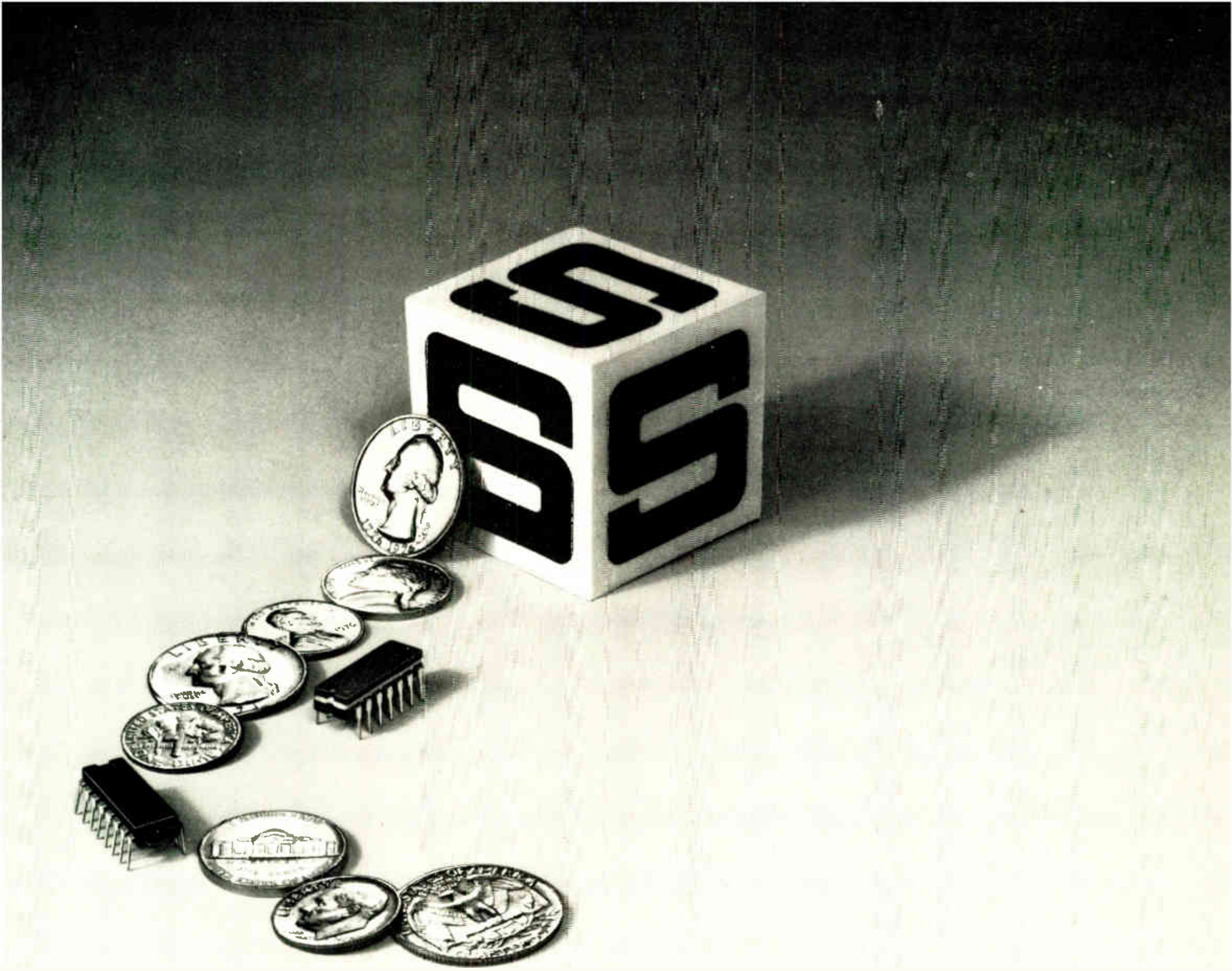
Efficient operation

Registers within the 8X300 monitor the track and sector addresses, making seeks and sector accesses highly efficient. In setting up the data transfers, the 8X300 monitors both interleaved data on the disk and the system clock for address-mark detection; it then examines and moves data a byte at a time once the controller circuit has been synchronized with the byte boundaries. Under control of the processor, disk data may be transferred to working storage (which can interface directly with the processor bus) for subsequent transfer to the host or, if it can be accommodated, transferred immediately to the host.

Very little external logic is needed for direct-memory-access interfacing between the 8X300 and the host. Transfer of data, commands, and status takes place through eight bidirectional I/O ports that are compatible with transistor-transistor logic and are supplemented with additional logic for direct connection to the host. The protocol is established in processor microprogramming, which may be conveniently altered for a variety of host types. Total program size for disk control and interfacing the 8X300 with the host processor is less than 800 instructions.

The other major section, the control circuit, has the hardware, which does a better job of recovering data from the disk than microprocessor software could. Functions include phase-locked-loop data separation, cyclic redundancy generating and checking, data-byte assembly and disassembly, and precompensation for widening the write pulses applied to the disk. These circuit functions, under control of the 8X300, can easily be instructed to operate for either single or dual recording densities, and the system can be expanded to handle most types of quad-density encoding.

Counting the control circuit as two LSI devices, the entire floppy-disk controller can be built from about 12 components. The system is complete in that it not only controls the access of disk data, but also provides the interface between any host and any off-the-shelf floppy-disk drive, and monitors and checks data transfer for ultimate reliability. □



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All sides of CMOS technology

Circle 97 on reader service card

Monolithic timers form transducer-to-recorder interface

by T. George Barnett
Laindon, Essex, England

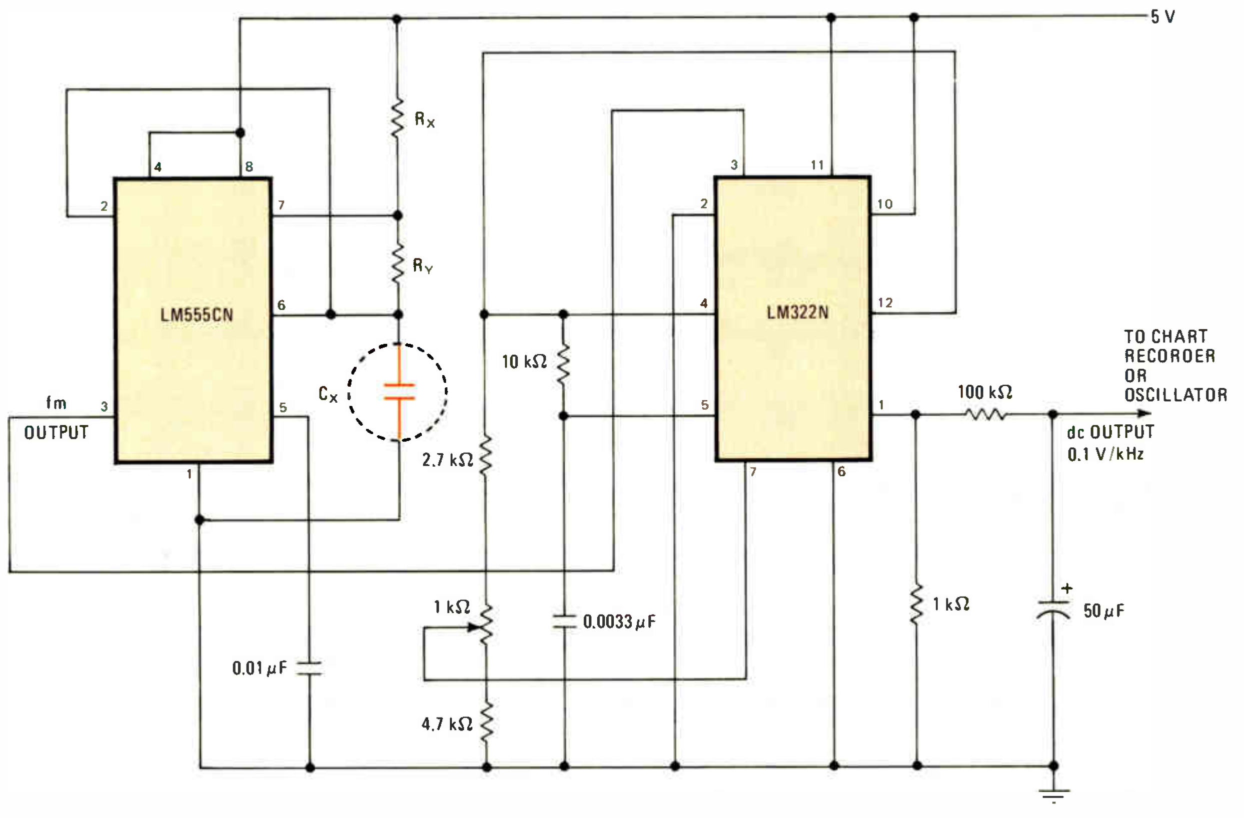
Capacitive transducers often require an expensive capacitance bridge to transform sensed capacitance variations into a voltage for presentation on a chart recorder or oscilloscope. A circuit using two monolithic timers can provide both a capacitance-to-voltage interface and a simple and accurate method for measuring the transducer capacitances.

As shown in the figure, the transducer serves as a capacitive frequency-determining element for the 555 timer. This makes it possible to measure transducer capacitances indirectly, while isolating the transducer from the scope or chart recorder to minimize the loading effect. The LM555CN timing device is connected in the astable mode, its free-running frequency set by R_x, R_y, and C_x. The transducer, typically in the range of 0.001 to 100 microfarads, is element C_x in the timing network.

As the transducer capacitance varies in response to the physical parameter being measured, the output frequency of the 555 varies linearly. The ratio of R_x to R_y sets the duty cycle, which depends on the frequency range desired.

The output of the 555 is presented to the LM322N timer. This circuit, wired as a monostable multivibrator, and combined with the one-pole resistance capacitance filter, forms a frequency-to-voltage converter. The dc output voltage varies linearly with the input frequency, and has a slope of 0.1 volt per kilohertz. The linearity is within 0.2% over the output voltage range of 0 to 1 v.

A 1-kilohm potentiometer connected to pin 7 of the 322 adjusts the output pulse width, serving to calibrate the system to a specified voltage at 10 kilohertz or some other frequency. To ensure linearity, the collector of the output transistor, pin 12, is fed to pin 4 (V_{REF}), so that the amplitude of the pulse at pin 1, the emitter of the output transistor, is constant. The period of the one-shot should be much less than the period of the astable multivibrator for best results. □



Transducer-to-recorder interface. Two timers determine transducer capacitance, perform capacitance-to-voltage conversion for chart recorder, while isolating transducer from output-circuit loading. Transducer placed in timing network of 555 astable multivibrator determines its frequency. LM322 one-shot, which should have a much shorter period than the multivibrator, transforms frequency into voltage.

Resistor-controlled selector simplifies CB channel synthesis

by Peter Saul
Ferranti Electronic Components Division, Lancashire, England

This selector, which can derive up to 256 channels for citizens' band or amateur-radio applications, combines the convenience of single-control tuning with the versatility of digital frequency synthesis. A potentiometer replaces the binary-coded-decimal thumbwheel or rotary switches normally used to tune a band about any frequency initially set by a synthesizer external to the circuit. There are no special layout requirements.

Although some excellent circuits have been developed using a slotted disk and optosensors, there are mechanical problems involved in making the disk and sensor mountings, and the systems are generally too complex and costly. In addition, these systems do not return to the set frequency after a power-down. This circuit overcomes those drawbacks.

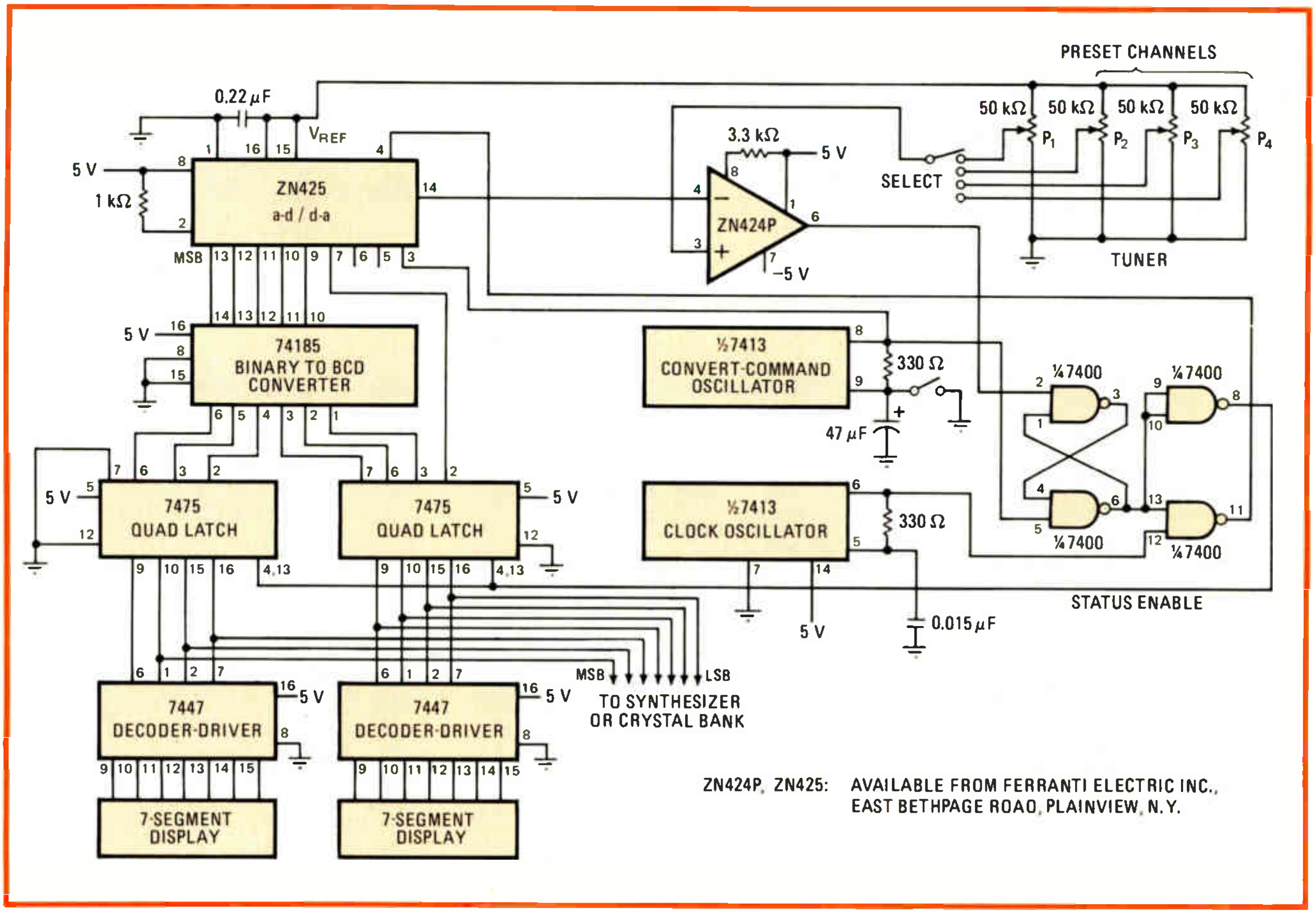
The system uses a potentiometer with 10 turns or more, an analog-to-digital converter, and straightforward logic designs as shown in the figure. A good choice for the analog-to-digital converter is the Ferranti ZN425E, which has an on-chip counter.

A voltage derived by P_1 (in the tuner circuit) from the on-chip voltage, V_{REF}, is applied to the noninverting input of the ZN424P low-noise, high-gain amplifier. The voltage must be converted to its BCD equivalent by the a-d converter.

The conversion begins as the ZN425 starts counting in binary after the initialization from the convert-command oscillator. The counter is advanced by the clock oscillator, which is gated through the 7400 array. As the counter advances, a linear ramp voltage is generated at its output at pin 14. This signal is introduced to the noninverting port of the ZN424. When the ramp voltage exceeds the voltage set by P_1, the output of the op amp falls, resetting the flip-flop in the 7400 and terminating the count. This process is repeated 70 times per second.

The 7475 latches capture the data and drive the 7447 decoder and drivers so that the channel number, from 0 to 63, may be displayed. The 7-bit word also drives the synthesizer. For 256 channels, two additional 74185 converters are needed, as are an additional 7475, 7447, and seven-segment display. The actual frequency of the channel is determined by the design of the oscillator in the synthesizer.

The circuit returns to its initially set channel after power-off or power failure, because the same comparison voltage appears at the noninverting input of the ZN424P. Temperature and voltage stability are good,



Single-control synthesis. Voltage derived from V_{REF} by 10-turn potentiometers is converted to BCD equivalent for driving synthesizer. Up to 64 channels are generated by 74185 and ZN425. Additional BCD converters, latches, and displays are needed for a 256-channel synthesizer.

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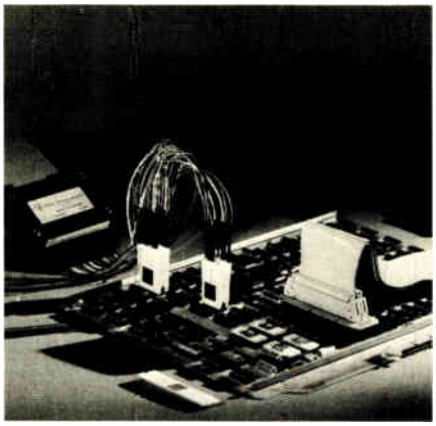

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provided good-quality potentiometers are used. Under extreme combinations of temperature and voltage changes, a one-channel shift has been observed, but that is not a serious problem. In addition, it is extremely difficult to set the frequency between channels. Power drain from the circuit is 350 milliamperes, but it may be reduced considerably if low-power transistor-transistor logic replaces the standard devices. ☐

Double-ended clamp circuit has ideal characteristics

by Keith Wilson
Herga Design and Development Ltd., London, England

The quad operational amplifier and the analog multiplexer in this dual-threshold clamp circuit give it ideal characteristics—in particular, razor-sharp clamping. Two op amps in the array serve as comparators, determining the relationship of the input signal amplitude to the high and low reference levels, and the multiplexer passes one of the three signals, depending on the op amps' decision. The absence of feedback networks simplifies design and optimizes performance and ensures that component values and layout will not be critical.

The ideal characteristics of the clamper are made possible mainly by the use of op amps. They permit independent adjustment of upper and lower clamp points and simplify the solution of any temperature-compensation problems. In addition, the op amps will detect millivolt-level differences between the input signal and the set thresholds, so that the multiplexer will accept signals within the thresholds and pass them undisturbed to the output but will block signals exceeding the thresholds.

As shown in the figure, an input signal is introduced to the noninverting ports of two op amps making up one half of the LM348 device. The high and low reference levels are applied to the inverting input ports. The op amps, operating as comparators, run at open-loop gain and are powered from a single-ended supply. Both drive the CD4052 differential four-channel multiplexer.

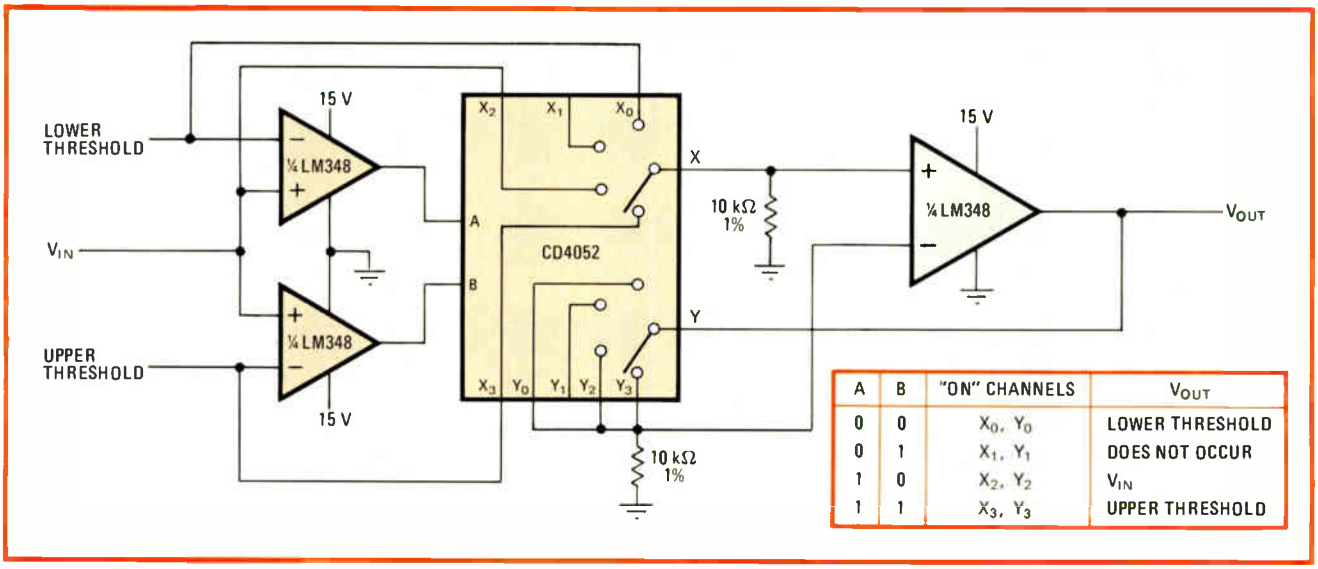
Each comparator may be in one of two states at any given time. Therefore, in combination, both comparators may assume one of four possible states. The control signals from the comparators are applied to the A and B inputs of the multiplexer, which routes the input signal, the upper threshold voltage, or the lower threshold voltage to the output amplifier. Thus a hard clamping action takes place. Between the limits of the clamping levels, circuit response is linear, as can be determined from the truth table at the bottom of the figure.

Changes in the channel resistance of the multiplexer switches are caused by supply voltage and temperature variations, but are due chiefly to the amplitude variations of the input signal. The purpose of the output amplifier circuit is to compensate for the amplitude distortion introduced by the multiplexer switches.

Without compensation, the signal encounters a voltage divider composed of the switch resistance and the 10-kilohm resistor at the input to the output amplifier (added to improve switch linearity). By using another 10-kΩ resistor and the remaining switch in the 4052, the gain of the op amp can be made to increase proportionately to switch resistance.

Supply voltage changes amounting to several volts cause negligible change at the output of the op amp. Temperature variations create errors amounting to only a few millivolts. ☐

Designer's casebook is a regular feature in Electronics. We invite readers to submit original and unpublished circuit ideas and solutions to design problems. Explain briefly but thoroughly the circuit's operating principle and purpose. We'll pay $50 for each item published.



A	B	"ON" CHANNELS	V_{OUT}
0	0	X_0, Y_0	LOWER THRESHOLD
0	1	X_1, Y_1	DOES NOT OCCUR
1	0	X_2, Y_2	V_{IN}
1	1	X_3, Y_3	UPPER THRESHOLD

Dual-threshold clamper State of comparators driving analog multiplexer ports A and B determines which of three inputs appears at V. Circuit response is linear between threshold limits. Truth table describes circuit function.

TV receiver puts two pictures on screen at same time

Picture within a picture comes from second signal stored in bucket-brigade-device integrated circuits; control IC permits single electron gun to produce the two

by Manfred Ullrich, *Intermetall GmbH, Freiburg, West Germany*
and Max Hegendörfer, *Grundig AG, Fürth, West Germany*

☐ Viewers who want to watch a football game while keeping an eye on another television program will welcome new sets that provide a soundless inset monitor picture along with the standard picture. As well as a second program, the source for the inset can be a signal from a remote camera, a video tape recorder, or the like.

Providing two complete pictures simultaneously poses some tricky technical problems. To begin with, there must be some way of telescoping a standard-size picture to the size of the small inset. Also required is some way for the beam from a single electron gun to produce two out-of-phase pictures simultaneously. Complicating the design is the requirement that the horizontal and vertical sweep for the inset must be shorter than that for the large one—roughly five times shorter in the case of a 26-inch-diagonal screen.

What these requirements point to is a means of temporarily storing in an analog memory the inset's video signals and reading them out in the proper sequence when needed. In a nutshell, that is the key to the Intermetall/Grundig approach to the picture-in-a-picture problem. The design uses two analog memo-

1. Picture in a picture. Grundig's 26-in.-diagonal color TV set is able to display simultaneously with the main picture a small, 4.5-in.-by-3-in. black-and-white inset from another channel, thanks to circuitry on a special small chassis built into the large set.

ries—one for each video field—and a control circuit. Intermetall designed and builds the two types of chips for Grundig.

This year's Radio and Television Exhibition in West Berlin marks the debut of the new feature. On the screen of a 26-in.-diagonal color set (Fig. 1), the monochrome inset is about 4.5 in. wide by 3 in. tall. It is deemed too small to obstruct the main program, yet is large enough to distinguish faces, channel numbers, titles, and the like. The picture resolution is 3 megahertz, with 58 lines per field, 64 picture elements per line.

Two signals in

In the signal flow depicted in Fig. 2, the incoming antenna signal enters the receiver through a 3-decibel splitter, which prevents the signals in the two tuners from interfering with each other. The output from tuner 2, the one for the inset picture, goes to the separate video intermediate-frequency amplifier and its demodulator. At the output of this amplifier is the inset's composite video signal.

Both the frame and line pulses for the small picture come from the synchronization separator. These pulses go to the controlling integrated circuit, which produces all the control signals for the two memories. The inset picture's composite video signal is applied to these two memories for processing.

The video outputs from the two memories are combined in a video summer, which has filters to eliminate any spurious clock pulses. The signal then goes to a crispening circuit to restore the loss of picture sharpness that resulted from the digital quantizing process in the memories. This circuit also increases the system's high-frequency response.

All the circuitry from tuner 2 through the crispening circuit is included on a small chassis that fits inside the TV set's regular chassis. The inset signal next goes to a video combiner that blends it into the large picture in accordance with signals from the control IC.

BBDs fill the bill

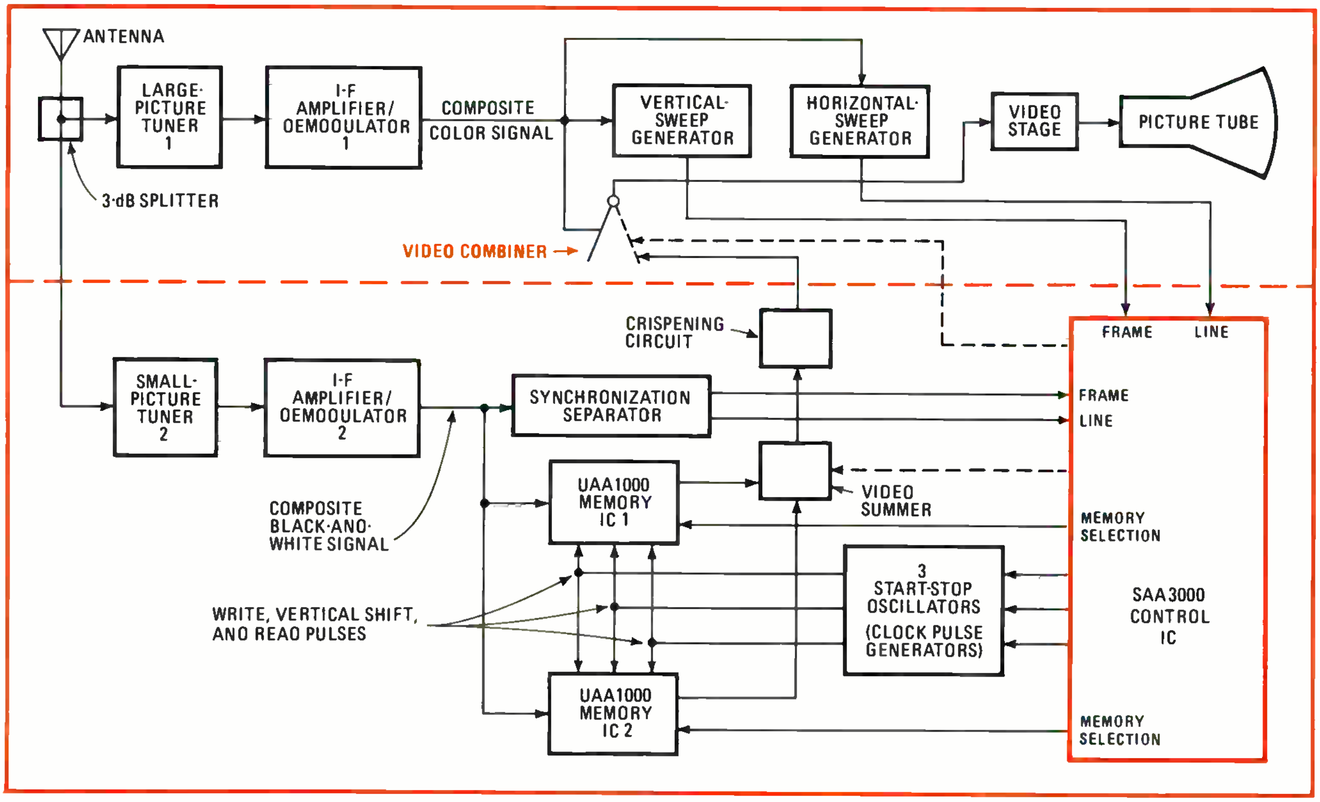
For signal storage, the most suitable type of memory is the bucket-brigade device, a metal-oxide-semiconductor delay line consisting of capacitors interspersed with field-effect transistors. It is both inexpensive and simple to manufacture.

However, the conventional BBD line, in which several hundred integrated capacitor-transistor delay elements are in series, proved to be too short to store all the information required for the inset picture. But more elements in the line would attenuate the signals too much. Therefore, it was necessary to develop a BBD memory in which the capacitor-transistor combinations are in a matrix. With this arrangement, the line of elements is short, and the signal losses reasonable.

Optical shortcuts help

A small monochrome picture need not have the same information content as the large color picture in order to yield sufficient detail and sharpness. In fact, by using a few optical shortcuts that reduce the information content, it is possible to simplify the design a great deal while reducing the inset picture to the proper size.

Only every fourth scan line is stored in the memory



2. Small-picture processing. The inset portion of the screen has its own tuner, i-f amplifier, and sync separator that process the video signal. The information is put into the memory ICs by the control IC. Signals from the memories go through a summer and a crispening circuit.

and processed, which allows reducing the picture format to a quarter its original height. An equal horizontal reduction is achieved by writing the lines into the memory at 1.5 MHz and reading them out four times faster. Another shortcut is omitting the horizontal and vertical blanking intervals, as well as several lines along the picture's upper and lower edges. Finally, the inset picture is cut a bit along its right- and left-hand edges.

Each analog memory, an n-channel aluminum-gate device that is designated the UAA 1000, packs some 4,000 FETs and about the same number of capacitors onto a 12-square-millimeter chip. It comes in a 16-pin plastic package with a minimum storage time of 3.8 milliseconds and a maximum storage time of 35 ms.

The controller, SAA3000, is a p-channel silicon-gate device integrating about 1,000 FETs onto a chip that is also 12 mm^2. It comes in an 18-pin plastic package. The three devices—two memories and the controller—are mounted on a printed-circuit board that also contains a few peripheral devices.

The use of two memories facilitates the storage and readout of the video signals. While one memory is releasing the information contained in the first video field, the other memory is storing the second field in preparation for releasing it.

The write-in process is always in phase with the signal from the transmitter of the small picture. Readout is always in phase with the signal from the main-picture transmitter. This in-phase condition keeps the inset's location on the screen stable.

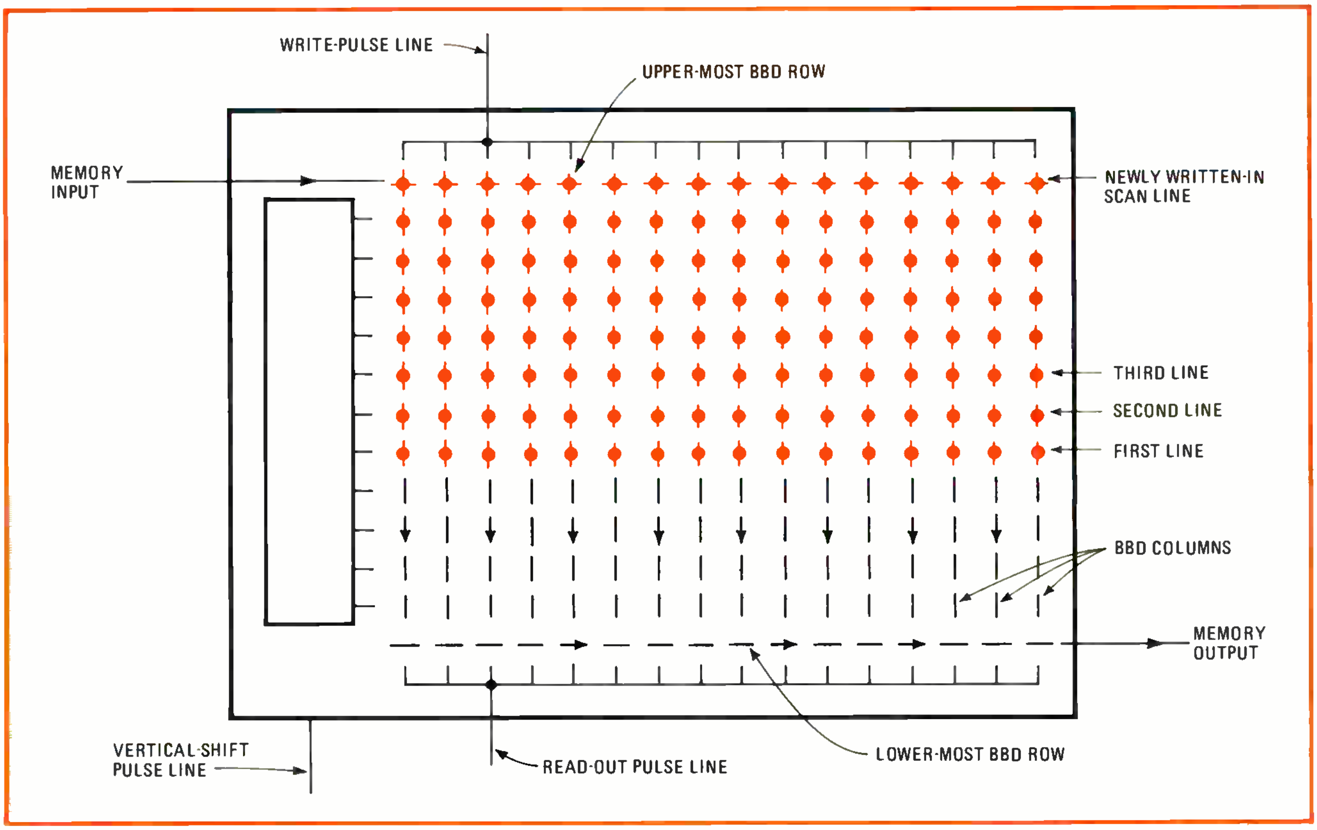
To write into the BBD memory, the write pulses from the control IC serially put the information in the first scan line into the memory's uppermost row (Fig. 3). Next, the vertical-shift pulses shift the information one row down. The now-empty upper row of the matrix is ready to accept the next scan line's information. Then the two rows are shifted down one row, again vacating the top row for the next line. Every fourth scan line is stacked in this fashion until the memory is full.

Stacking the memory

Information readout proceeds in similar fashion, but from the bottom of the stack. It starts when the beam from the electron gun is at the beginning of the large-picture line that will contain the first line of the small picture. At the instant the beam reaches the spot that corresponds to the left edge of the inset, the readout pulses begin to shift the information in the first line—the bottom row—in serial fashion out of the memory. It is this information, rather than the color picture's video signals, that goes on the screen to form the black-and-white inset.

At the beginning of the next line of the large picture, the vertical-shift pulses again bring the information down by one position. At the right instant, the pulses shift the information for the next line out of the memory, and the process continues until the memory is empty, completing the small picture.

The primary function of the control circuit is to generate the signals for the various switching and control



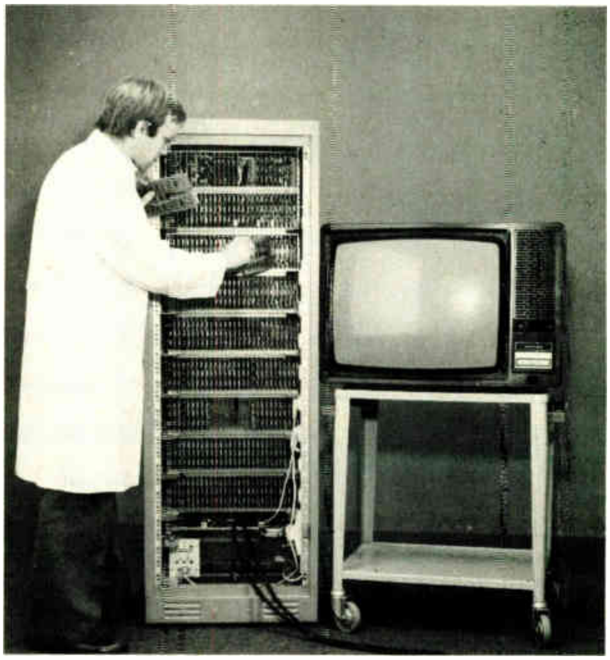
3. Loading and unloading. Triggered by signals from a control IC, each BBD analog memory is filled one scan line at a time. A vertical-shift pulse from the control IC causes the BBD to drop the first line vertically, vacating the top row for the next scan. The procedure continues until the memory is filled. Readout reverses the procedure from the bottom. System contains two memories so one is storing while other is reading.

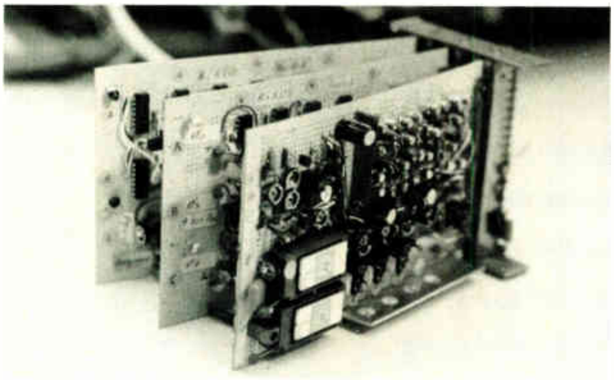
Working out the picture in a picture

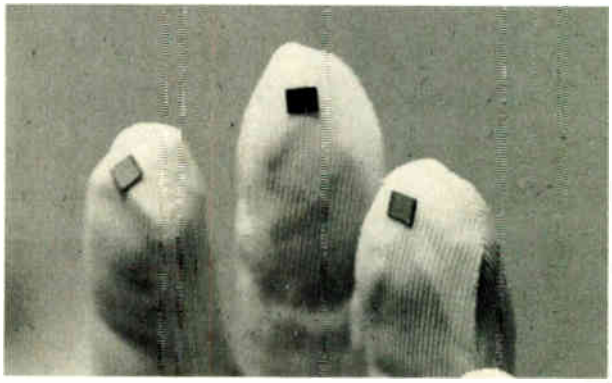
To find out how viewers would react to the optical short-cuts designed into the picture in a picture and to get an idea of how the bucket-brigade-device analog memory should be organized, Intermetall built a simulation setup of transistor-transistor-logic components. This simulator (right) with all its digital TTL memory, converter, and control circuitry filled a man-sized cabinet with nine 19-inch racks containing about 5,000 circuits. It consumed no less than 170 amperes.

The metal-oxide-semiconductor memories that were developed next helped shrink the apparatus down to just three printed-circuit cards (below left) containing the two BBD devices and only 30 TTL control circuits. This version consumed less than 1.5 A. After the 30 TTL devices were replaced by a single MOS component, the essential hardware for the picture in a picture consisted of only three integrated circuits—two analog memories and the control device.

The three chips contained in plastic packages measure 12 square millimeters each (below right). The n-channel aluminum-gate analog memory packs 4,000 field-effect transistors and about the same number of capacitors. The p-channel, silicon-gate control chip integrates about 1,000 FETs. Work on integrating circuitry external to the three ICs is continuing.







steps needed to produce the inset. It puts out the write pulse, the readout pulse, and the vertical-shift pulse. It insures that the two memory circuits are set alternately for write-in and readout. It also must cope with the different and constantly changing phases for the inset and large-picture controls.

Control IC directs traffic

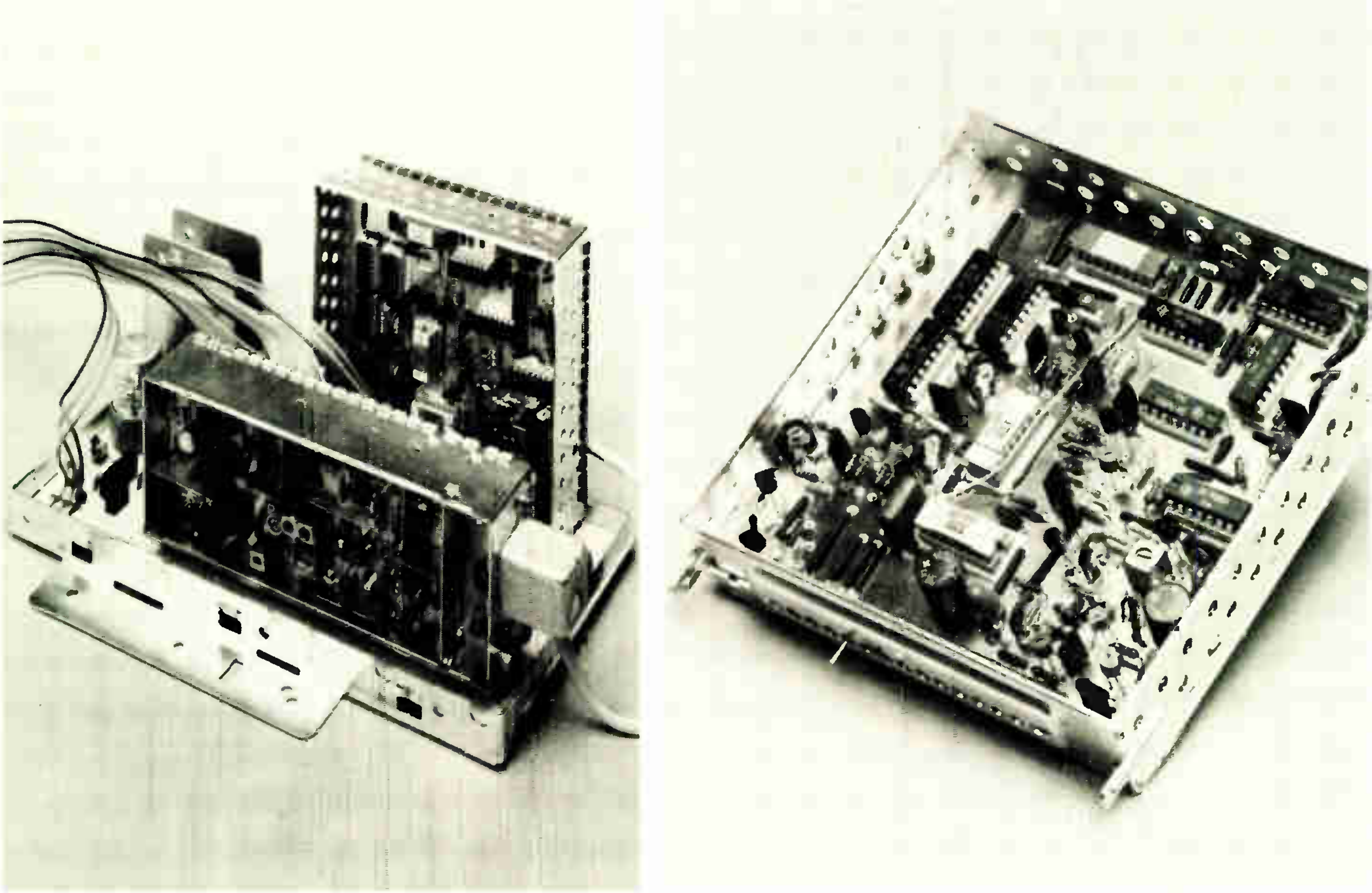
The inputs to the control circuit are the video and line signals from the two transmitters for the channels being received. Usually, the line frequencies of two TV stations differ from each other by no more than 0.01 hertz. But the circuitry works even when the frequency difference is several hundred hertz, which can be the case if one of the two signals is from a video-tape player.

To display the signal that is appearing as the inset calls for an additional tuner, video i-f amplifier, and a sync separator. Since a bandwidth of only 0.75 MHz and simple transmission characteristics will do, both the tuner and the i-f amplifier can be of simple design. The small bandwidth requirement—0.75 MHz vs 3 MHz—comes from the readout rate's being four times faster than the write-in rate.

Pulses with a short rise time and a peak-to-peak amplitude of about 20 volts are needed to transport the video information into the two analog memories. However, the generators—actually start-stop oscillators—and drivers required for these pulses cannot be integrated because of their excessive power dissipation. Therefore, they are external to the two memory ICs.

Chassis in a chassis

To facilitate service and at the same time maintain the set's modular structure, the picture-in-a-picture circuitry is mounted in a small auxiliary chassis (Fig. 4a). It fits into the main chassis and connects by plug-in cables. The small-picture chassis contains a stabilized power supply that produces all essential operating voltages, making it independent of the main chassis. It also incorporates the inset's tuner, i-f amplifier, and sync separator, as well as the module containing the analog memory ICs, the control chip, and the peripheral pulse-driver circuitry



4. Chassis in a chassis. The inset picture comes from a separate small chassis (a), containing its own power supply, a tuner, i-f amplifier, and sync separator, plus the plug-in module (b) that contains the two memories, controller, and peripherals.

(Fig. 4b). The picture-in-a-picture chassis is shielded to prevent stray radiation from the drivers. Large-picture reception also is possible with the inset module of Fig. 4b removed from the set.

Selecting two channels

The picture-in-a-picture circuitry is being introduced in Grundig's top-of-the-line models. These sets have electronic tuners with memory that can hold as many as 16 channel numbers. Direct recall of the stored channel numbers is by 16 of the set's 26-command infrared remote-control unit. A key on the hand-held transmitter (Fig. 5) selects these channels. There are eight additional memory positions for channel numbers for the inset picture.

There are two keys on the remote-control transmitter, one for the large picture only and the other for the combination. The same two keys are used to switch sequentially through the programs shown in the small picture.

A three-digit light-emitting-diode display shows both channels selected. When the set is turned on, the large picture is automatically set to the first channel, but with no small picture shown on the screen. The viewer then may select a channel for the small picture. If the eight memory positions for the inset picture are not all used, the channel-switching sequence may be made shorter, which speeds up channel-access time. □

5. Double selector. Grundig's IR remote-control transmitter can select as many as 16 large picture and eight inset picture channels. The viewer may select only the large picture or may shift back and forth between the large and small pictures.

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Circle 107 on reader service card

Expanded test inputs increase 4004 processor capability

by Robert F. Starr
Shell Oil Company, New Orleans, La.

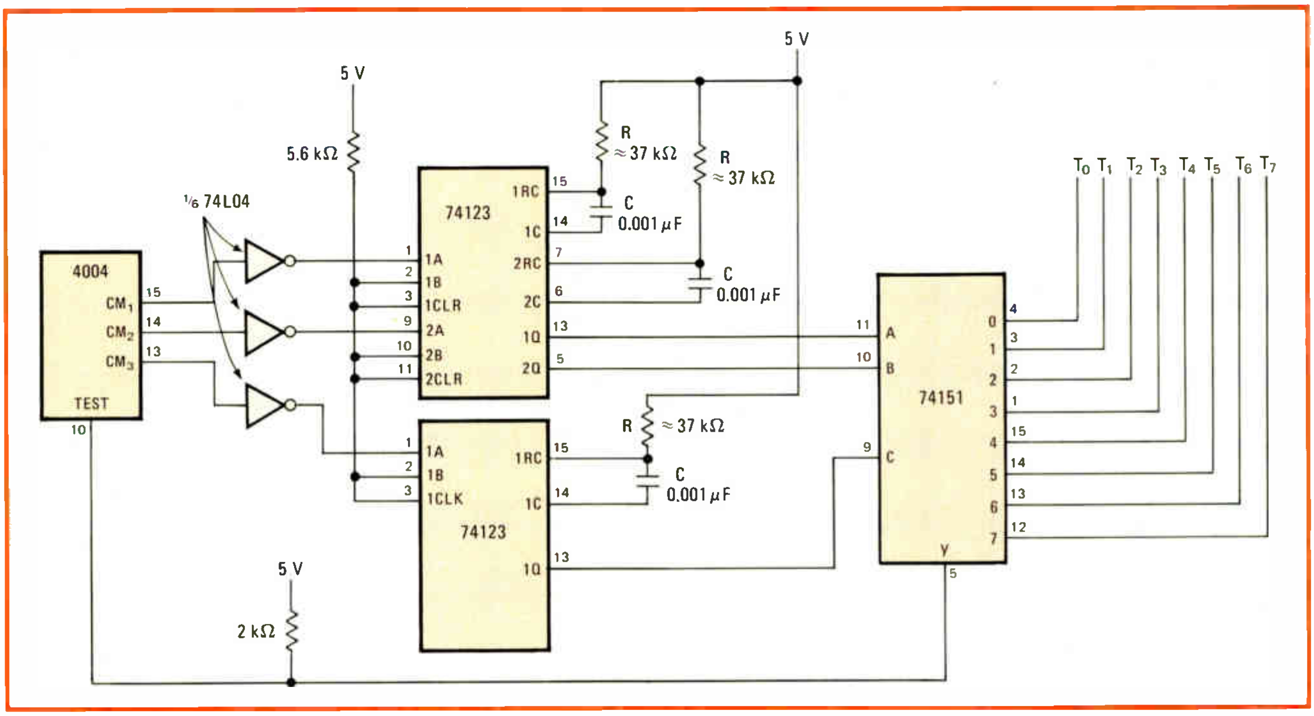
Although it was the first commercial microprocessor, the 4004 is still useful in many control and data-acquisition systems, especially those using binary-coded-decimal data, for which its 4-bit word is a convenient match. To increase its usefulness, a simple and inexpensive multiplexing circuit can furnish the equivalent of an interrupt feature by gating up to seven extra inputs to the 4004's test port.

The desired test signal can be selected by means of the 4004's three CM output lines. As generally used, the designate-command-line instruction (DCL) sets the binary code at the CM outputs to select one of eight random-access memories. But here the instruction selects lines T_0 through T_7.

The CM signals trigger their respective 74123 monostable multivibrators. The multivibrators drive the 74151 multiplexer, which routes the desired input line to the test port.

The duration of the signal generated by the one-shots is slightly greater than one instruction cycle (10.8 microseconds) to ensure that they may be retriggered. Thus, true logic signals will be generated on the multiplexer's select lines, making operation more stable. In some cases, it may be necessary to insert a no-operation instruction after the DCL command to allow the outputs of the one-shot to settle before the software attempts to check the status of the test line.

The circuit can be built for a few dollars. For the added flexibility it provides, it is well worth it. □



Expanded test capacity. Multiplexed test lines increase usefulness of 4-bit 4004 microprocessor. Selection of test lines $T_0 - T_7$ is accomplished by software. One-shots are retriggerable, transform processor's pulse output to true logic signal for selecting multiplexer lines.

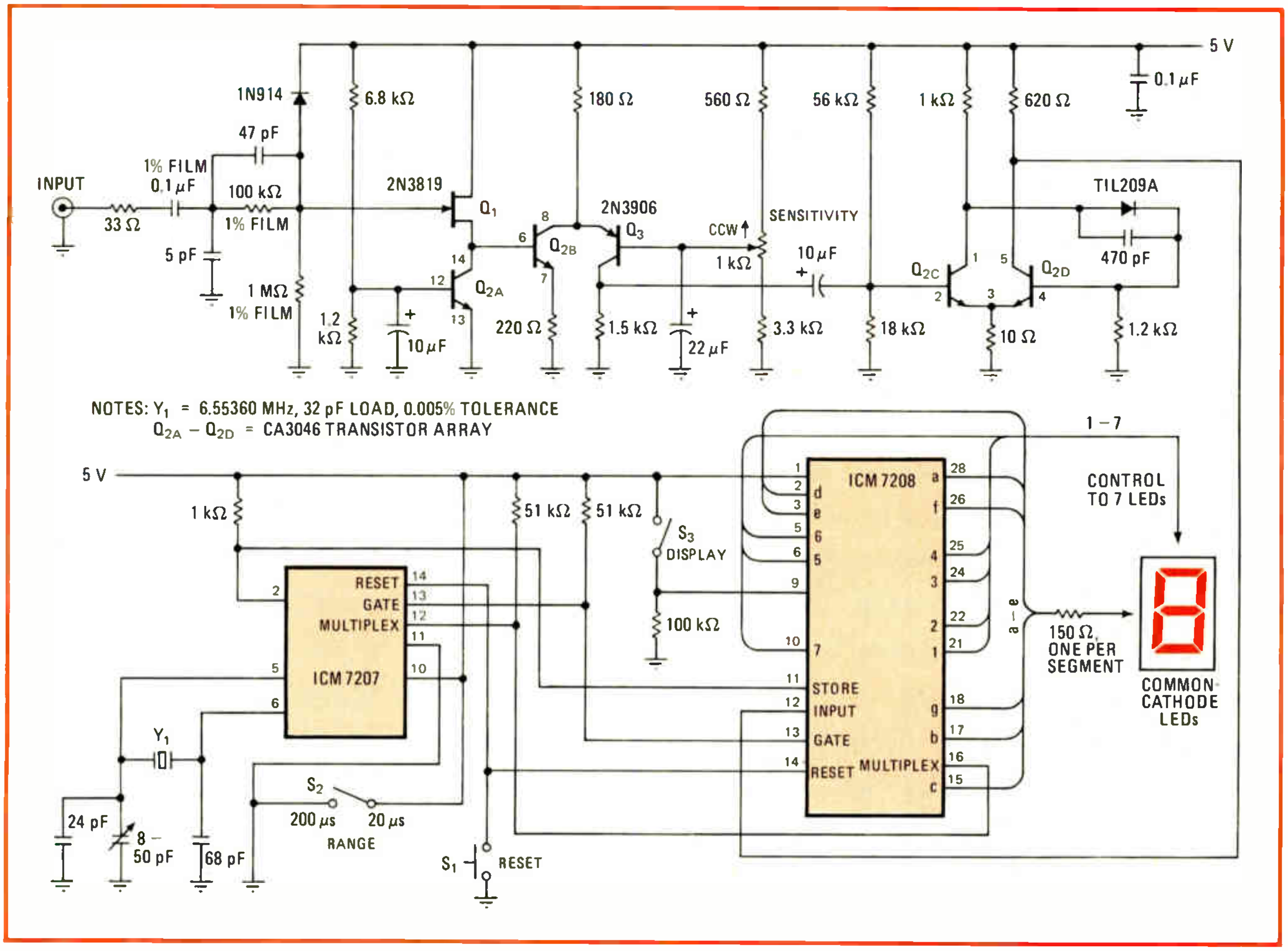
Wideband preamp and LSI pair form high-quality counter

by James A. Mears
Dallas, Texas

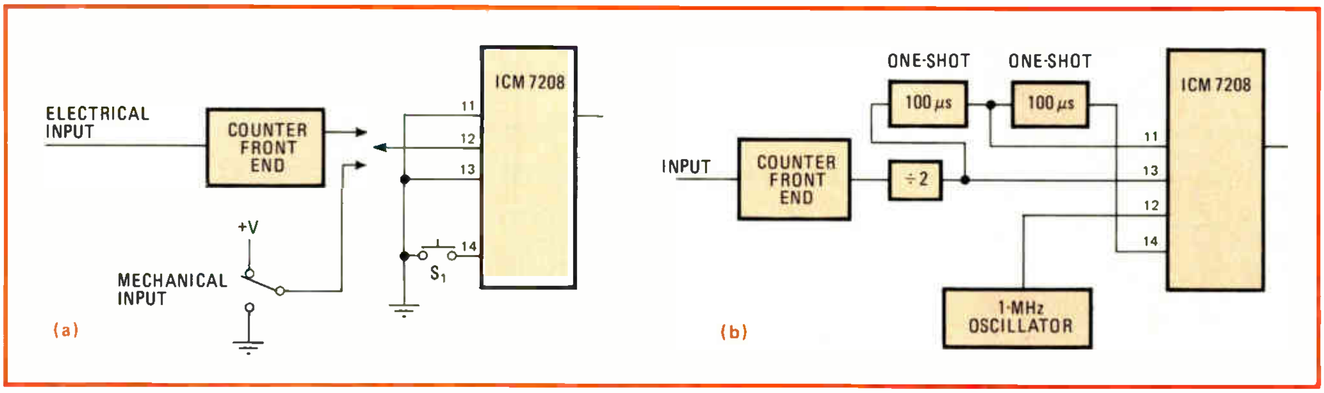
A carefully designed preamplifier, when combined with two new large-scale-integrated circuits, forms a high-performance, low-cost frequency counter with a typical response of 5 megahertz. Among this counter's many desirable qualities are a high input impedance throughout the frequency-measuring range, a frequency response that can be extended to 30 MHz, a single voltage supply and, if the displays are powered separately, a low power drain that allows battery operation.

As the figure shows, the input signal is applied to the 2N3819 field-effect transistor through a frequency-compensated attenuator. The combination of the FET and attenuator produces an input impedance of 1 megohm from 0 to 30 MHz. The input circuit is protected from overdrive by the 1N914 diode. Q_1 is a current-biased source follower, providing high input impedance, low output impedance, and high stability even at low power-supply voltages.

The amplified signal is applied to the cascode amplifier composed of Q_{2b} and Q_3. The operating (bias) point is Q_3 is adjustable over a 1-volt range, so that the triggering voltage may be properly set even with noise present on the input signal. The signal is then introduced to the Schmitt trigger composed of Q_{2c} and Q_{2d}. The circuit has a fixed hysteresis determined by the TIL209A light-emitting diode (the LED acts as a low-voltage zener), which makes triggering precise even with slowly varying waveforms. This output signal, which will



1. Frequency counter. A well-designed front end and two LSI circuits permit realization of a high-performance, low-cost frequency counter. The counter's frequency response is 5 MHz, but can be expanded to 30 MHz. Total cost is $50, half that of competitive units.



2. Easily adaptable. A slight modification to the input circuit makes it absolutely versatile. The circuit can be configured to monitor the number of electrical or mechanical events (a) or as a period counter (b) for measuring input cycle duration or the time between events.

be counted by the Intersil ICM7208, has a duty cycle of approximately 50%.

The ICM7208 contains a seven-decade counter, a display multiplexer, a seven-segment decoder, and digit and segment drivers. Additional circuits within the 7208 serve to blank the display, reset the counter inhibit input, and switch the display on and off. The device can count to 5 MHz, and the circuit draws only 1 milliampere or so at 5 V. A companion device, the ICM7207, supplies a crystal-controlled time base and other signals for multiplexing the display and controlling the sampling interval of the 7208.

The output frequency of the crystal-controlled oscillator is reduced to 1.6 kilohertz by the 7207 in order to multiplex the seven-segment LED display. The 7207 is also configured to produced a gate signal of 20 or 200 microseconds for the 7208 counter. This count window is switch-selectable. Leading-zero blanking and an on/off switch for the display are provided for energy conservation.

The circuit may be simply reconfigured as a period of event counter, as shown in Fig. 2. Additional divider stages at the counter's input and control-signal channels may be used to expand the range of the counter to 30 MHz.

This counter compares favorably with other designs. Its sensitivity at 0.1 MHz is 50 millivolts, decreasing to 200 mV at 30 MHz. The current drain is 21 milliamperes at 5 V, neglecting the LED displays. Total cost for this circuit is less than $50; a transistor-transistor-logic frequency counter would cost twice as much and might dissipate as much as 40 times the power. Commercially available units cost $200 to $300. ☐

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

Bias-current network improves sample-and-hold response

by H. F. Nissink
Physics Department, University of Tasmania, Hobart, Australia

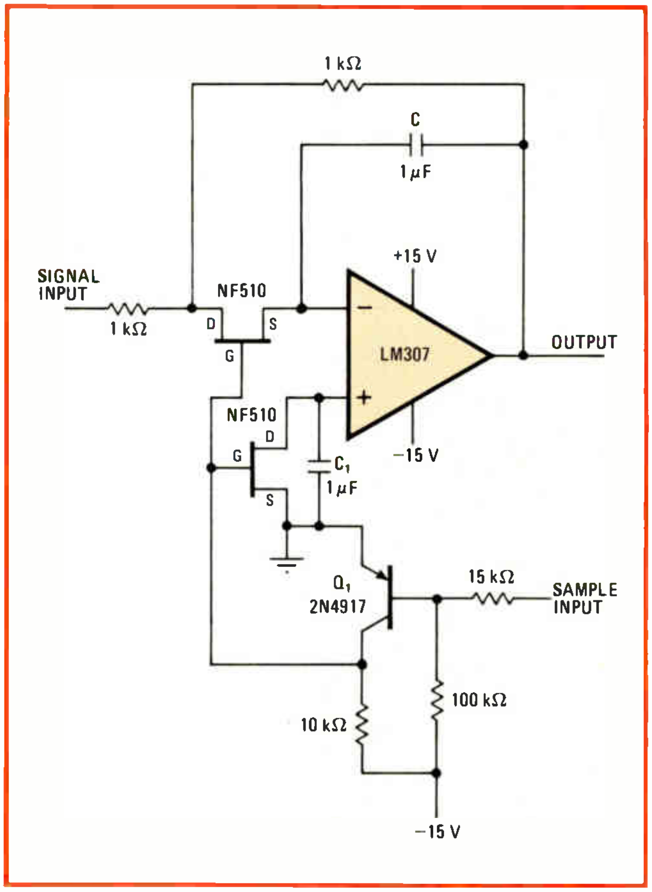
A compensating bias-current network greatly enhances the voltage-holding quality of a sample-and-hold circuit. Connected to the noninverting port of the operational amplifier, the network detects and restores the charge lost by the hold capacitor.

As shown in the figure, an input signal is sampled at the NF510 transmission gate by a pulse from switching transistor Q_1. The sampled voltage appears across C almost instantaneously and should be stored indefinitely. However, there is a small loss of charge with time because of voltage drift at the op-amp output. The drift is due to the op amp's minute bias current, which flows into the inverting input. This current lowers the output voltage and thus the voltage across C.

However, because the bias currents flowing at both inputs of the op amp are approximately equal in magnitude (although opposite in polarity) over a wide range of input voltages, circuitry added to the inputs can compensate for the bias-current flow. Specifically, if C_1 is made equal to C, each port will look out onto an identical circuit. Thus small changes in the bias current at the inverting port, which removes charge from C, will be countered by like changes in the current at the noninverting port, which charges C_1, and the op amp's input offset voltage will be minimized.

Of course, because of the inherent properties of the op amp, the magnitude of the input currents cannot continue to increase for a constant output voltage. A condition will therefore eventually occur in which the current at the inverting port will exceed the current at the noninverting port, and the output voltage will fall.

The circuit has a hold time—arbitrarily defined as the time in which the output voltage decays by 100 millivolts—of approximately 4 minutes with the values shown and about 10 minutes if both capacitors are doubled in value. The decay is independent of the magnitude or polarity of the input voltage. ☐



Charge restorer. Sample-and-hold response is improved if charge lost by hold capacitor C is replaced. Voltage change across capacitor due to op amp's inverting-port bias current is cancelled by compensating network. Droop rate, only 100 millivolts per 10-minute period, may be improved if capacitors C and C_1 are matched.

Standard coming for phase-angle meters

Anyone shopping for a phase-angle meter should be aware that the National Bureau of Standards at present has no standard to which phase-angle measurements can be referred. But the NBS is working on one. Now in its laboratory in Gaithersburg, Md., is **a phase standard that covers frequencies of up to 50 kilohertz, producing two sinusoidal signals with a phase difference accurate to within 0.01°.** Built around Fairchild Semiconductor's 9405 bit-slice microprocessor family, the instrument creates the phase difference digitally and then calculates the sinusoidal waveshapes with known phase difference. But it probably won't be ready for use in calibration for another 6 to 12 months.

Stringing together program cards for the SR-52

Here's another trick from Frederic N. Fish III of Tempe, Ariz., for Texas Instruments' SR-52 calculator—the card reader may be activated under program control without halting program execution. Pressing 2nd READ during the learn mode enters code 96 into program memory. When this code is reached during program execution, the card reader is activated, the new program is entered from one side of the card, and program execution in the new program begins at the step that contained the read code in the previous program. **This means that you can even string cards together (using small pieces of clear tape on the top surface) to make programs of indefinite length.** Be sure to pay careful attention to which side of the card is being read, and you may have to provide some manual assistance to orient the cards properly.

Die swaging cuts cost of electronic hardware

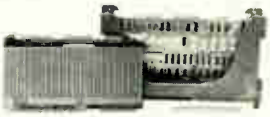
Automatic screw machines usually turn out those small close-tolerance metal parts that are essential elements of a number of electronic components and interconnections—the pins for printed circuits and sockets, reeds for reed switches, connector parts, tips for patchcord sockets and plugs, as well as header pins and wire-wrap pins. But a little-known metal-working process called automatic die swaging could make them for as little as one tenth the price, producing as many as 600 parts a minute or even more. For instance, **pc pins costing $22 per 1,000 on an automatic screw machine could be made for about $2 per 1,000 with automatic swaging.** Die swaging involves hammering a part into form by means of a series of contouring die cavities—so metal is moved, rather than removed, to shape the part. Round wire yields solid parts, while strip metal yields tubular components. At present, only three companies do this work: Auto-Swage Products of Shelton, Conn., Bead Chain Manufacturing of Bridgeport, Conn., and Ball Chain Manufacturing of Mount Vernon, N. Y.

It's news to try to checkmate a computer

If you're a chess enthusiast and eager either to play against a computer or write chess programs for it, you'll be interested in a newsletter just started by Douglas Penrod of Santa Barbara, Calif. Patterned after the papers put out by many computer hobbyist clubs, the Computer Chess Newsletter depends heavily on reader contributions. Editor Penrod welcomes tutorial-type articles that probe **the philosophy and implementation of chess programming, news reports, book reviews, information on available programs, and records of titillating games played against a computer or between computers.** For a sample issue, send 75 cents to Penrod at: 1445 La Cima Rd., Santa Barbara, Calif. 93101.

Lucinda Mattera

NEW GARRY SBC 80/10 UNIVERSAL MICRO-PROCESSOR WIRE-WRAP INTERFACE BOARD



Garry Manufacturing Company now has available their new SBC 80/10 Universal Microprocessor Interface Board designed to plug directly into the Intel SBC 604 Modular Cardcage/Backplane bus system with power interface connections for ±5 and ±12 volts dc.

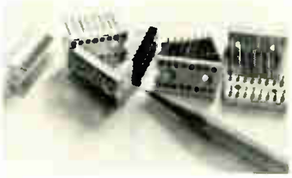
The Garry SBC 80/10 Universal Wire-Wrap board provides 38 columns of 44 low-profile socket terminals per column, with alternate rows of committed ground and voltage wire-wrap terminations. The P/N EP 272-38-15 interface board will accommodate up to 95 16-position I.C. chips or an equivalent mix of 14, 16, 18, 22, 24, 28 or 40-position I.C. chips.

For complete information concerning the SBC 80/10 and other Universal Microprocessor/Minicomputer Wire-Wrap Interface boards, please contact Garry Manufacturing Company, 1010 Jersey Avenue, New Brunswick, NJ 08902. 201-545-2424.

Use Reader Service Card number.

NEW SERIES OF SOCKETS FOR PACKAGING 8, 14, 16, AND 18 CONTACT DIPs

Has approved MIL-Spec 5-83734



A new series of packaging sockets that accommodate 8, 14, 16, and 18 contact DIPs, as well as round-lead ICs with 0.016 to 0.020 inch diameter wires is now available from Garry Manufacturing Company of New Brunswick, NJ. The new sockets have an ultra-low profile, for the most compact packaging of components.

The insulating bodies of these parts are of SE-O Grade Valox: the individual socket terminals are in two precision-machined pieces. The inner contact is gold-plated beryllium copper. The outer contact is brass, available in a variety of platings, including gold and tin. Both printed-circuit bifurcated and wire-wrappable terminations (pins) are offered; the ends are closed to eliminate danger of solder or flux wicking.

The new DIP sockets are available off-the-shelf.

For complete information contact Garry Manufacturing Company, 1010 Jersey Avenue, New Brunswick, NJ 08902. 201-545-2424.

Use Reader Service Card number.

MULTI-UNIVERSAL HIGH-DENSITY WIRE-WRAPPABLE PACKAGING PANELS

A new line of Multi-Universal High-Density wire-wrappable packaging panels, particularly suitable for use in microprocessor and digital-circuit applications, is now available from the maker, Garry Manufacturing Co., of New Brunswick, NJ.

These universal panels will accommodate:

.100-inch spacing (SIP) Single-in-line packages
.300-inch spacing (DIP) Dual-in-line packages
.400-inch spacing (4K Ram) Memory packages
.500-inch spacing (UART)
.600-inch spacing (LSI) Large Scale Integrated Circuits

Designated the MU Series, the new packaging panels are available with 18 columns of 55 terminals per column, as plug-in modules P/N EP 80-18/55-15 or they can be manufactured to a customer's individual "slot" requirements. These panels are available in two to four weeks.

For complete information contact Garry Manufacturing Company, 1010 Jersey Avenue, New Brunswick, NJ 08902. 201-545-2424.

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12-bit data system goes hybrid

Using thin-film technology, Datel is first to put a self-contained 12-bit acquisition system in an IC-like package

by Lawrence Curran, Boston bureau manager

Much smaller than equivalent modular products yet about the same in performance, a multichannel data-acquisition system developed by Datel Systems Inc. is the first of its kind in hybrid form. It comes in a package that is compatible with integrated circuits.

The thin-film device has two versions: the HDAS-16, offering single-ended input channels, and the HDAS-8, with eight differential input channels [*Electronics*, Aug. 18, p. 35]. Both are complete 12-bit data-acquisition systems in 62-pin metal packages measuring 2.3 by 1.4 by 0.24 inches, and both offer a combined acquisition and conversion time of 20 microseconds for a throughput rate of 50 kilohertz.

Eugene Zuch, product marketing manager at Datel, says that is probably the fastest speed of any unit that includes a built-in instrumentation amplifier. This amplifier provides gains that are programmable from 1 to 1,000 by means of a single resistor—a feature that Datel engineers say will make the units useful in low-level signal interfacing applications with bridge circuits, transducers, strain gauges, thermocouples, and so on. With these products, Zuch sees Datel challenging modular data-acquisition systems on price, performance, and especially size. At the same time, he says, "these hybrid products represent a clear emphasis on staying well ahead of what the monolithic houses can do."

At gains of 1 to 10, root-mean-square input noise is less than 0.1 least significant bit and throughput is 50 kHz; at a gain of 100, root-mean-square input noise is less than 0.16 LSB and throughput is 20 kHz. Throughput drops to 2.4 kHz, with rms noise less than 0.5 LSB, at a gain of 1,000. The slower throughputs are attributable to the longer settling times of the instrumentation amplifier at higher gains.

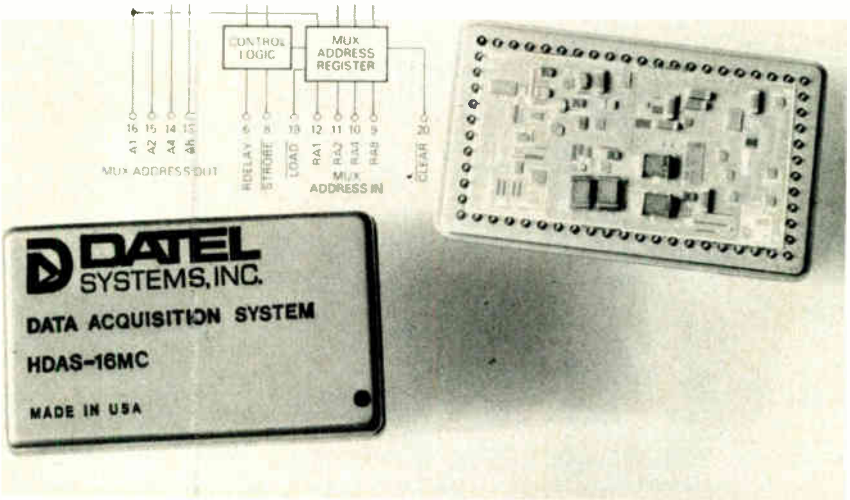
Apart from the amplifier, the data-acquisition system includes a complementary-metal-oxide-semiconductor multiplexer, a 10-volt buffered reference, a sample-and-hold circuit, the 12-bit analog-to-digital converter, a multiplex address register, and digital control logic. These circuits are grouped in two interconnecting substrates.

The 10-v reference can be used also for external circuitry—to drive a bridge circuit, say, or provide power to a transducer or operational amplifier. The sample-and-hold circuit includes its own MOS capacitor, "which means that the user doesn't need an external capacitor to improve the droop and linearity of his system," Zuch points out.

Besides noise and throughputs, other important specifications of the HDAS hybrids are: input resistance of 100 megohoms, maximum input bias current of 200 picoamperes, and input offset drift of 10 microvolts per °C times the gain. Maximum error at a 50-kHz throughput is ±1 least significant bit after calibration, which is done using external gain and offset-adjustment trimming potentiometers.

Power requirements for the hybrid devices are ±15 v dc and +5 v dc at a total consumption of 2.8 watts. Models HDAS-16MC and HDAS-8MC operate from 0 to +70° C, and are priced at $295. The range from −25° to +85° C is covered by the HDAS-16MR and HDAS-8MR, selling for $395, and the range from −55° to +100° C calls for the HDAS-6MM and HDAS-8MM, priced at $695. Delivery time is eight weeks. The units will be shown in Datel's Wescon booth 29.

Datel Systems Inc., 1020 Turnpike St., Canton, Mass., 02021. Phone Eugene Zuch at (617) 828-8000 [338]

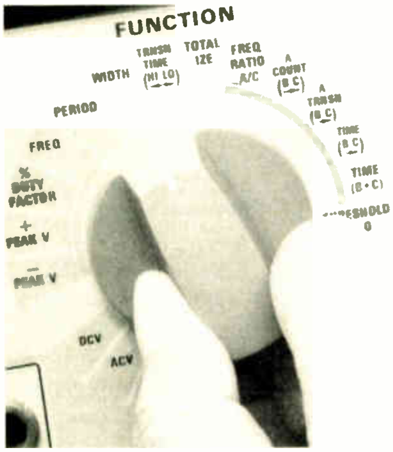


Digital tester gets it all together

Field-service instrument for computer mainframes and peripherals combines versatile multimeter with counter/timer and logic indicator

by Stephen E. Scrupski, Instrumentation Editor

Already a leader in high-quality portable service oscilloscopes, Tektronix is aiming to meet other needs of the service technician with its model 851 digital tester, a combined digital multimeter, counter, and logic-state indicator. Measuring voltage, resistance, time, temperature, and logic states, and performing gated counting, the 851 is intended not only for servicing digital logic, but for maintenance of the electromechanical portions of the digital peripherals, such as disk and tape drives and printers.



According to Ted Janus, marketing program manager for the 851, the instrument allows the on-site service technician to restore service about 90% to 95% of the time, the remaining problems being referred back to product specialists. He points out, too, that many on-site repairs involve alignment, adjustment, and electromechanical troubleshooting as well as electronic maintenance and repair—hence the combined digital and analog functions in the 851.

The instrument measures the following:

- Voltage: five ranges of dc volts from 2 volts to 500 volts full scale; four ranges of ac volts from 2 volts to 350 volts full scale.
- Resistance: seven ranges from 200 ohms to 50 megohms full scale.
- Temperature: −55° to 150°C.
- Peak volts: 30 v.
- Frequency: four ranges from 100 kilohertz to 35 megahertz full scale.
- Time: five ranges from 1 millisecond to 10 seconds full scale.
- Counting: 99,999 counts.

Logic-state indicators can be used to probe for signal activity, and to track down faulty devices, the unit counts digital transitions in a method resembling signature analysis. For this purpose, the schematic must first have been annotated with the number of transitions that should occur at each test point, and the equipment must be driven with a standard input signal. The technician then checks the number of transitions at each test point and traces any error back through the circuit until he finds a faulty component.

The 851 can even measure transition times between two logic levels, doing so from high to low or vice versa at the flip of a slope switch. Both the high and low thresholds are adjustable from −30 v to 30 v, and the control has a preset position for transistor-transistor-logic levels.

The 851's self-test feature allows the user to plug the probes into a receptacle, step through the functions with the front panel switch, and check that the display shows the reading correct for each properly operating function. The unit also checks line voltage directly from the socket into which it is plugged, so no probing of the lines is required.

Price of the 851 is $1,995.

Tektronix Inc., P. O. Box 500, Beaverton, Ore. 97007 [339]

Goodbye to TV sync controls

Inexpensive IC combines with precision ceramic resonator to make vertical and horizontal hold controls unnecessary

by Bernard Cole, San Francisco bureau manager

By combining a linear integrated-injection-logic circuit with a precision ceramic resonator, engineers at National Semiconductor Corp. may well have sounded the knell for horizontal and vertical hold controls on television sets, as well as for factory adjustments of these functions. The circuit, designated the LM1880, derives both horizontal and vertical oscillator signals from the same on-chip oscillator—a 503.5-kilohertz circuit controlled by the ceramic resonator.

Because the resonator is a highly accurate component, the horizontal-scan frequency derived from it is guaranteed to be within 184 hertz of the desired 15.734-kHz horizontal-scan rate. Since the oscillator is a voltage-controlled unit that forms part of a phase-locked loop with a pull-in range of 600 Hz, the lockup is assured when the sync signal transmitted by the television station is received. The TV's vertical frequency is produced with similar precision, so it can be easily injection-locked over the frequency range from 57.63 to 61.22 Hz—again making lockup a certainty. Thus the TV manufacturer has no need to provide adjustments of the oscillator's free-running frequency, either as a factory preset or as a customer control.

In most existing TV sets the vertical and horizontal oscillators are not only less accurate, they are also independent of each other. Typically, their frequencies are set by LC or RC circuits. More modern sets use a phase-locked loop to control the horizontal frequency, but the oscillator still requires at least a factory preset adjustment.

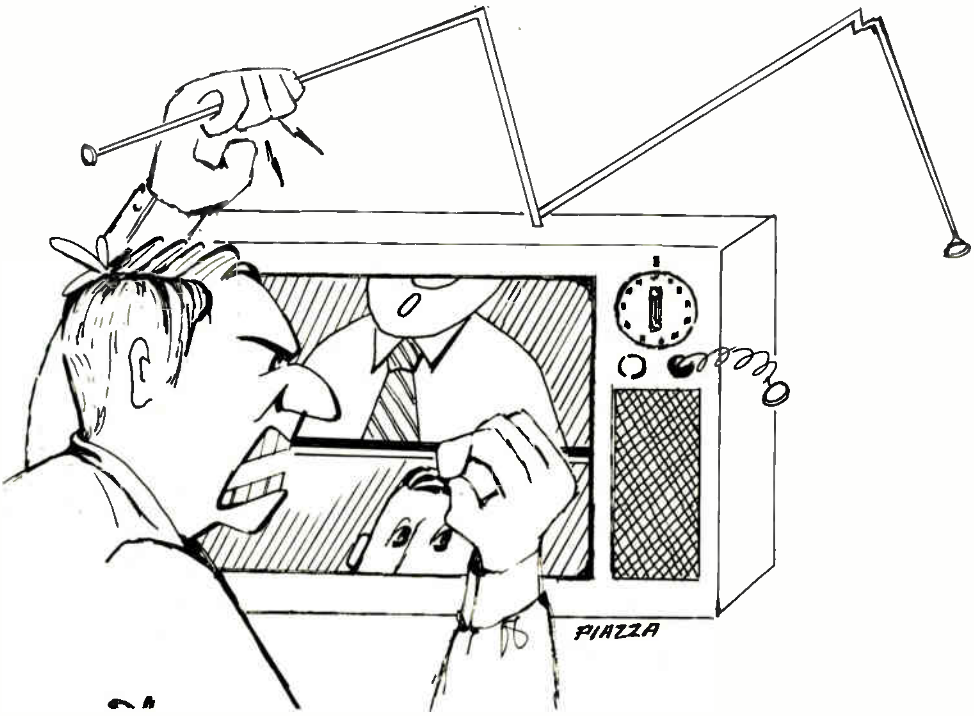
The heart of the LM1880 is a precision voltage-controlled oscillator that works with a model EX-1028 ceramic resonator made by MuRata Corp. of America, Rockmart, Ga. Resonator frequency is 503.5 kHz ±2 kHz. The circuit divides the VCO signal by 32 to produce a predriver output locked to the negative sync input by means of an on-chip phase detector.

The vertical output ramp is injection-locked by a sync pulse controlled by a selective gate. Connected to a 546-element counter, the gate opens after the 514th count and waits for a sync pulse. If none arrives by the 546th count, an automatic reset occurs and a vertical output pulse is generated.

The analog portions of the chip, which make up about 40% of the total, include the VCO and the phase detector and are fabricated using a standard linear process. The rest of the chip—principally the countdown circuitry—is implemented in I^2L. The device also includes a voltage regulator to provide a stable 8.75 volts and circuitry to generate a pulse centered on the chroma burst.

Available now in sample quantities, the LM1880 replaces four to six discrete devices, a phase-locked-loop integrated circuit, two potentiometers, and various passive components, according to product marketing manager Charles Smaltz. Smaltz expects the circuit to sell for less than $1 in large quantities.

National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, Calif. 95051 [340]



Instruments

3½-digit meter resolves 10 μV

DMM with $295 price tag can measure resistance down to 10 milliohms

Calling it the most sophisticated instrument in its class, Ballantine Laboratories Inc. will introduce at Wescon its $295 model 3028B, a 3½-digit multimeter. The meter is root-mean-square-responding on its ac ranges, and on its lowest voltage range of 20 millivolts full scale, it has a resolution of 10 microvolts.

"It's a 3½-digit meter that thinks like a 4½-digit instrument," says Fred Katzmann, Ballantine Labs' president, citing its 10 μV resolution. Katzmann says many things went into obtaining the better resolution—better stability in the reference-voltage source and power supply, careful ground layouts, and the use of a metallized plastic case, which, Katzmann says, "keeps the effects of noise down, so the last digit doesn't ramble on the lowest range."

As an ohmmeter, it can detect resistance down to 10 milliohms, which is useful for such measurements as printed-circuit-board traces, transformer coil windings, and contact resistance. The ohmmeter circuit has high- and low-voltage modes for making measurements in circuits containing semiconductor devices and for performing diode checks, plus a front-panel zero adjust to compensate for lead resistance.

The meter is fully protected against continuous overloads up to 1,200 volts on any ac or dc voltage range and up to 285 v dc plus ac rms on any ohms range. Overload is signaled by a flashing display, and recovery is automatic when the overload is removed. All current ranges are protected by a fast-acting circuit breaker that is resettable by a push button on the front panel. The meter has a one-year calibration cycle and a mean time between failures in excess of 18,000 hours.

Push-button controls permit measurements covering 35 ranges: ac/dc voltages from 10 μv to 1,200 v in 6 ranges; ac/dc current from 10 nanoamperes to 2 amperes in 6 ranges; resistance from 10 milliohms to 20 megohms in 11 ranges. Automatic polarity indication with a plus or minus sign is standard for all dc functions.

In its ac voltage and current modes, the DMM provides rms response for waveforms that have up to 10% distortion and crest factors of 1.2 to 1.6, covering frequencies from 15 hertz to 110 kilohertz, and is usable to frequencies higher than 200 kHz.

The Model 3028B DMM weighs 2

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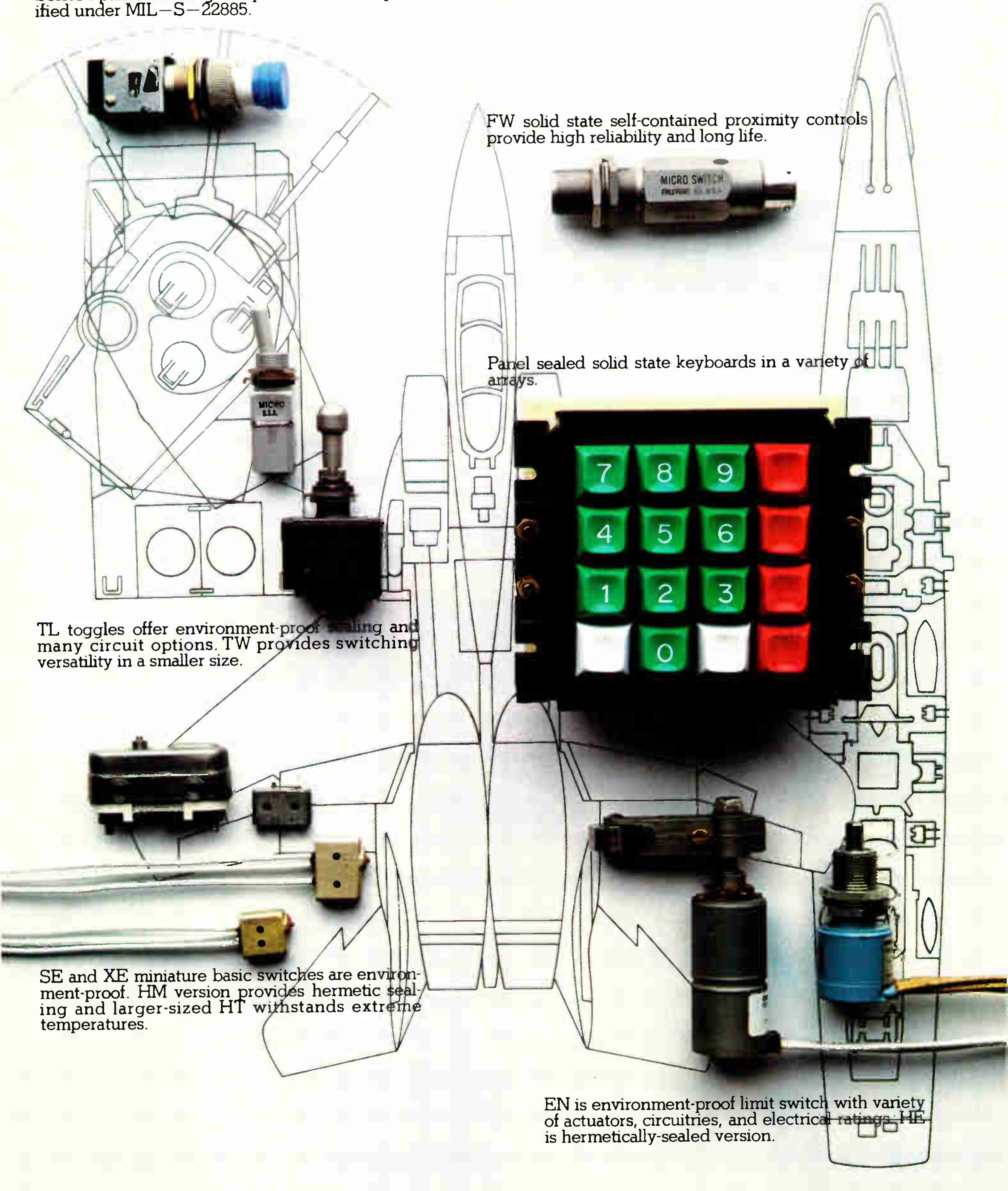


pounds, 7 ounces (with batteries 4lb., 1 oz.), and measures 8⅛ by 2⅜ by 8¹¹⁄₁₆ inches.

Ballantine Laboratories Inc., P. O. Box 97, Boonton, N. J. 07005. Phone (201) 355-0900 [351]

$29 panel meter resolves 3½ digits

Only $29 each in hundreds ($35 each for one to nine), the model DM-3100L is a compact digital panel meter with differential inputs and autozeroing. The 3½-digit (2,000-count) instrument covers the range from −1.999 volts dc to 1.999 v dc with a maximum error of 0.2% of reading + 1 count at 25°C. Maximum temperature drift of gain is 0.01%/°C. The meter has an input impedance in excess of 100 megohms and can tolerate a continuous overvoltage of ±150 v and an intermittent overvoltage of up to 300 v. Commom-mode rejection ratio is 80 decibels from dc to 60 hertz with a 1-kilohm source imbalance. The instrument uses half-inch light-emit-

ting-diode displays.

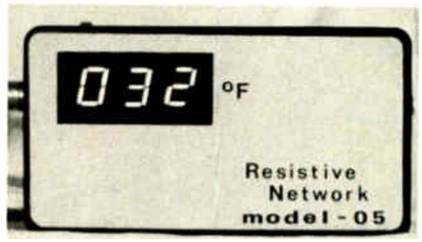
Datel Systems Inc., 1020 Turnpike St., Canton, Mass. 02021. Phone Gene Murphy at (617) 828-8000, Ext. 141 [354]

Digital thermometer sells for $98

Digital thermometers for industrial use generally sell for $200 or more. But the first product from a new company sells for $98, complete with probe and five AA batteries.

Robert Mulcahy, a partner in Resistive Network Inc., says the model - 05 is intended for such jobs as finding hot spots in circuits and measuring the boiling point of solvents in degreasing operations. It is accurate to within 2°F over its range of −67°F to 185°F.

The thermometer provides relatively fast readings, with a time constant of less than 3 seconds in stirred oil. The display, which is updated every 0.2 second, is a 0.43-inch light-emitting-diode type that



can be read easily at 20 feet. Dimensions of the unit are 4.4 by 2.4 by 1.2 in. It comes with a standard 6-in. probe and 4 feet of cable terminated in a phonograph plug. For remote measurement, an audio patch cord may be added to a maximum over-all length of 100 feet.

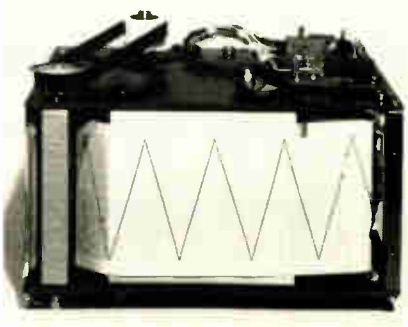
Other models are available with ranges up to 212°F and accuracies to within 1°F.

Resistive Network Inc., 294 Broadway, Cambridge, Mass. 02139. Phone Robert Mulcahy at (617) 547-4711 [353]

Chart recorder ignores battery-voltage changes

A battery-powered chart recorder designed to be built into portable instrumentation is not affected by changes in battery voltage from a peak of 13.9 volts to a low of 10.5 v (almost depleted). Weighing only 4 pounds, the 102 XLA DCH is a single-channel instrument having a position-feedback galvanometer with a maximum over-all error of 0.5% of full scale. Chart movement is held to within 2% of the set speed.

Aimed principally at medical-elec-



tronic applications, the recorder meets the frequency-response specifications of the American Heart Association. It has a 50-millimeter-wide channel across which it writes with a heated stylus. The 102 XLA DCH measures 4 by 6 by 6.25 inches and sells for $425. Delivery time is 30 days.

Astro-Med, Atlan-Tol Industrial Park, West Warwick, R. I. 02893. Phone (401) 828-4000 [355]

10-MHz logic-state analyzer offers powerful triggering

It is hard to program many logic analyzers so that they can get inside nested loops. But the triggering controls on the model 1610A logic-state analyzer deal with this and other problems by allowing the user to specify a sequence of up to seven 32-bit words as a trigger condition. Furthermore, each word in the sequence may be repeated up to 65,536 times. The delay feature of many other analyzers is thus seen to be a degenerate two-word sequence in which the first word is the trigger word and the second word is a don't-care repeated N times.

Capable of capturing 10-mega-

hertz data, the 1610A can be programmed in binary, octal, decimal, and hexadecimal formats. It stores 64 32-bit words of which 20 can be seen at one time. Two control keys allow the user to roll the display to see all of the words.

Other features of the analyzer are a trace-compare mode in which one full trace is stored for comparison with a later one, timing capability in which the time between events is measured and displayed, and a threshold-adjustment scheme that divides the 32-bit data input into four 8-bit groups, each of which can be set to a different threshold. The 1610A sells for $9,500 and has a delivery time of six weeks.

Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif. 94304 [356]

TOPICS

Instruments

United Systems Corp., Dayton, Ohio, has reduced the price of its DigiTec 8320 time interval counter to $4,500. The unit has a single-shot resolution of 1 nanosecond and can resolve 1 picosecond in its time-interval averaging mode. . . .**Dana Laboratories Inc., Irvine, Calif.,** has added four options to its model 9000 microprocessing counter/timer: selective gate control, synchronous window combined with selective gate control, pulse-parameter measurement capability, and remote programming. . . .**Analog Devices Inc., Norwood, Mass.,** has cut the prices of its 4¾-digit panel meters by 10% to 20% while reducing many other second-generation DPM prices. Some 4¾-digit units are now only 2% to 3% more expensive than their 3½-digit equivalents. . . . **Pbl Electro-Optics Inc., New London, N.H.,** has introduced its model RP-800 fiber-optic reflectance photometer for the monitoring and measurement of relative reflectance and relative spectral reflectance. The $795 instrument uses a bifurcated light guide to take light to and from the sample whose reflectance is being measured.

New products

Semiconductors

Chip performs error checks

10-MHz device uses on-board ROM to implement most common error-checking codes

An important factor in using communications-oriented peripheral devices or systems is the technique available to check the data stream for errors. While many of these peripheral devices can handle one or more protocols, they need external circuitry to change cyclic-redundancy-check error codes.

Fairchild Camera and Instrument Corp. has developed a multipurpose CRC generator/checker integrated circuit that is capable of implementing most of the common error-checking codes, including synchronous-data-link control, 6-bit bisynchronous, 8-bit bisynchronous, and such specialized schemes as the airline reservation system code. The IC accomplishes the implementation by a mask alteration of an on-chip read-only memory.

Designated the 9411, the low-power Schottky device operates at speeds up to 10 megahertz and is designed for use in disk storage systems, digital cassette and cartridge systems, and general data communications systems.

The 9411 is a programmable device that operates on serial data streams and provides a means of detecting transmission errors. According to Krishna Rallapalli, advanced products manager at Fairchild, it is designed to accommodate eight 16-bit polynomial codes, and a 3-bit control input selects one of the eight. The ROM decodes the selected polynomial to establish the appropriate interconnections on an on-chip 16-bit register with a gating network. Use of a ROM instead of hard-wired decoding permits the device to offer any other generator polynomials by means of a simple change of mask, Rallapalli points out.

The 9411 can be easily programmed to generate such numbers as maximum-length pseudorandom numbers using irreducible generator polynomials, Rallapalli says. It handles any polynomial up to the 16th order. An error-detector circuit monitors the register for all zero conditions and automatic right-justification is incorporated for polynomials of any order less than 16.

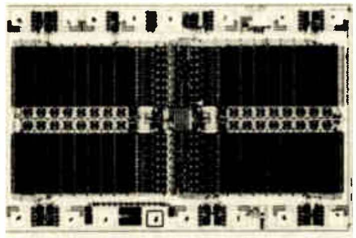
Cyclic checks are used with many tape cassettes and cartridge systems, Rallapalli points out. Most of these units can read data in both the forward and reverse directions. However, if the same check circuitry is used to validate data in both directions, invalid error indications occur. To preclude this, the 9411 includes codes for reverse checking, one for the SDLC code and another for the 8-bit bisync code.

The 9411 is priced at $9 each in quantities of a hundred and is available from stock.

Fairchild Camera and Instrument Corp., 464 Ellis St., Mountain View, Calif. 94042 [411]

1,024-bit V-MOS RAM has 45-nanosecond access time

The S4015-3 1,024-by-1-bit static random-access memory is the first commercial RAM product of AMI's new V-groove metal-oxide-semiconductor technology. As such it will undoubtedly be subjected to extremely close scrutiny—even by users who are waiting for its 4,096-bit successor to come along. Speed-competitive with the bipolar Fairchild 93415/25 and the n-MOS Intel 2115/25 RAMs, the 45-nanosecond memory has a decided price edge: it is 36% cheaper than the Fairchild



part and is priced more than 10% below the Intel memory.

Key to the price-performance attractiveness of the S4015-3 in particular and V-MOS devices in general is their high circuit density, which allows a much larger number of dice per wafer than other MOS configurations. In terms of chip size, the Fairchild bipolar unit is 61% larger than the AMI part, while the Intel memory is 87% larger.

Before this year is out AMI expects to add at least four more products to its V-MOS line: a 30-ns version of the present RAM, two 4,096-bit static RAMs, and a 65,536-bit read-only memory. The present product sells for $6.20 each in hundreds.

American Microsystems Inc., 3800 Homestead Rd., Santa Clara, Calif. 95051. Phone Tom Edel at (408) 246-0330 [413]

Monolithic v-f-v converter goes up to 1 megahertz

The A-8404 is a monolithic voltage-to-frequency and frequency-to-voltage converter with a maximum frequency of 1 megahertz. Requiring only six external passive components, the device converts voltages from 0 to 10 V into a pulse train with a repetition rate proportional to the voltage. Subject to the 10-V and 1-MHz maxima, transfer functions can be tailored by selecting the passive components suitably. The A-8404 operates from a single supply voltage in the range of 5 to 18 V dc. It has a maximum nonlinearity of 0.4% at 1 MHz and offers the equivalent of 8-bit accuracy. Housed in a 14-pin ceramic dual in-line package, it sells for $12 in small quantities.

Intech/Function Modules Inc., 282 Brokaw Rd., Santa Clara, Calif. 95050. Phone (408) 244-0500 [417]

MOS device performs SDLC and other protocols

Designed to simplify the interfacing of digital systems with synchronous data-communications channels, the SMC COM 5025 is a program-

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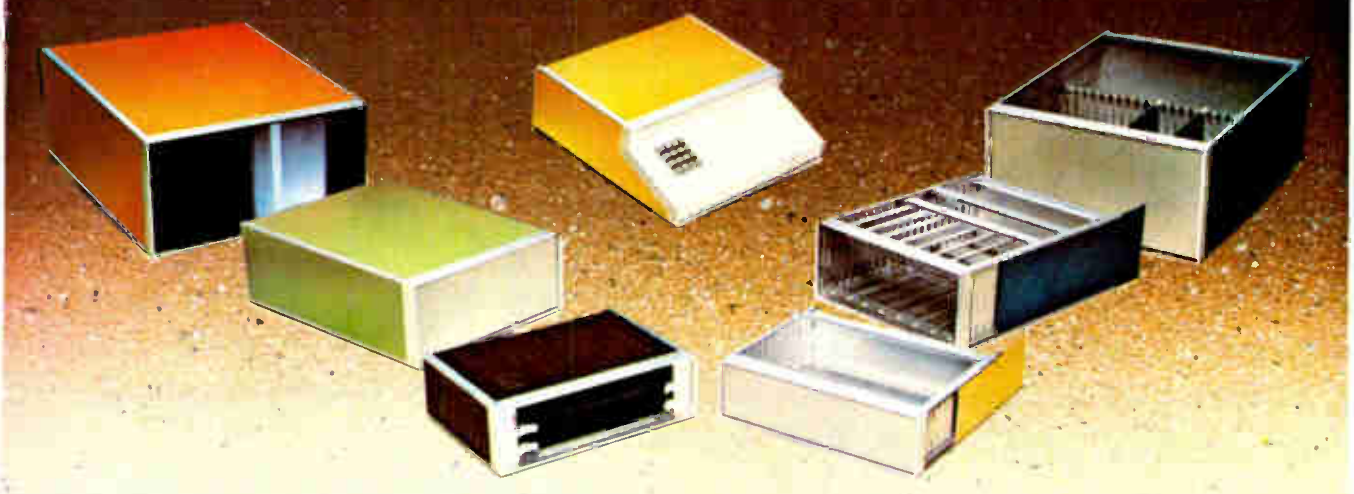

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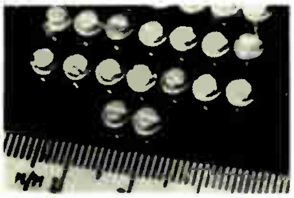
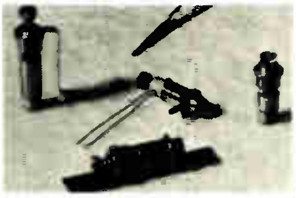


MINIATURE CERAMIC TRIMMERS TYPE CD5: This new range of miniature ceramic disc trimmers has been designed to meet the requirements of mechanical and electrical reliability when the available space is minimal. 5mm in diameter and 4.4mm maximum height they are designed for applications such as electronic clocks and watches but, in addition, available for other conventional uses. **Ranges 0.9 to 25pF.**



MINIATURE UHF TRIMMER CAPACITORS TYPE PTU/TUT: This range of trimmers was first developed for the UK III satellite. The ability of the capacitors to operate over a wide frequency range enables them to be used even into the microwave region with complete confidence. (Actual self resonance frequency at C max type PTU/1.2 is 4GHz.) **Capacitance range 0.2pF to 3pF.** Printed circuit chassis, and strip line styles available.

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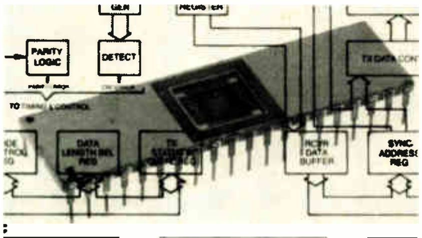


mable, multiprotocol controller that implements all major protocols including bit-oriented types such as SDLC, HDLC, and ADCCP and byte-oriented types like Bisync and DDCMP. The universal synchronous receiver/transmitter is a 40-pin monolithic device built with the COPLAMOS n-channel silicon-gate process. It operates at speeds up to 2 megabauds.

For bit-oriented protocols, the COM 5025 provides bit stuffing and stripping, automatic frame character detection and generation, and residue handling. For byte-oriented protocols, the unit features automatic detection and generation of sync characters. Options include error checking, variable-length data, and an idle mode to transmit flag or sync characters or to mark the line. The cost of a COM 5025 device with a typical set of options is $61.40 in quantities of 500 to 999.

Standard Microsystems Corp., 35 Marcus Blvd., Hauppauge, N. Y. 11787. Phone (516) 273-3100 [418]

8-bit a-d converter runs at 2.5 megahertz

Capable of completing an 8-bit analog-to-digital conversion in only 400 nanoseconds, the TDC-1001J is a monolithic bipolar device with an input range of 0 to −0.5 volt. The unit requires an external clock signal, a voltage reference, and a compensating capacitor. It needs nine clock periods per conversion at a typical clock rate of 22.5 megahertz. All output bits are available one clock period after a status line indicates "ready to convert." There are no missing codes. Accurate to within half a least significant bit, the TDC-1001J sells for $175 in lots of

100 to 999 units. A similar unit with a 1-microsecond conversion time—the TDC-1002J—sells for $75 in the same quantities. Both have a delivery time of 60 days or less, depending on quality.

TRW LSI Products (E2/9085), One Space Park, Redondo Beach, Calif. 90278. Phone William Koral at (213) 535-1831 [414]

TI adds low-power and low-noise bi-FET op amps

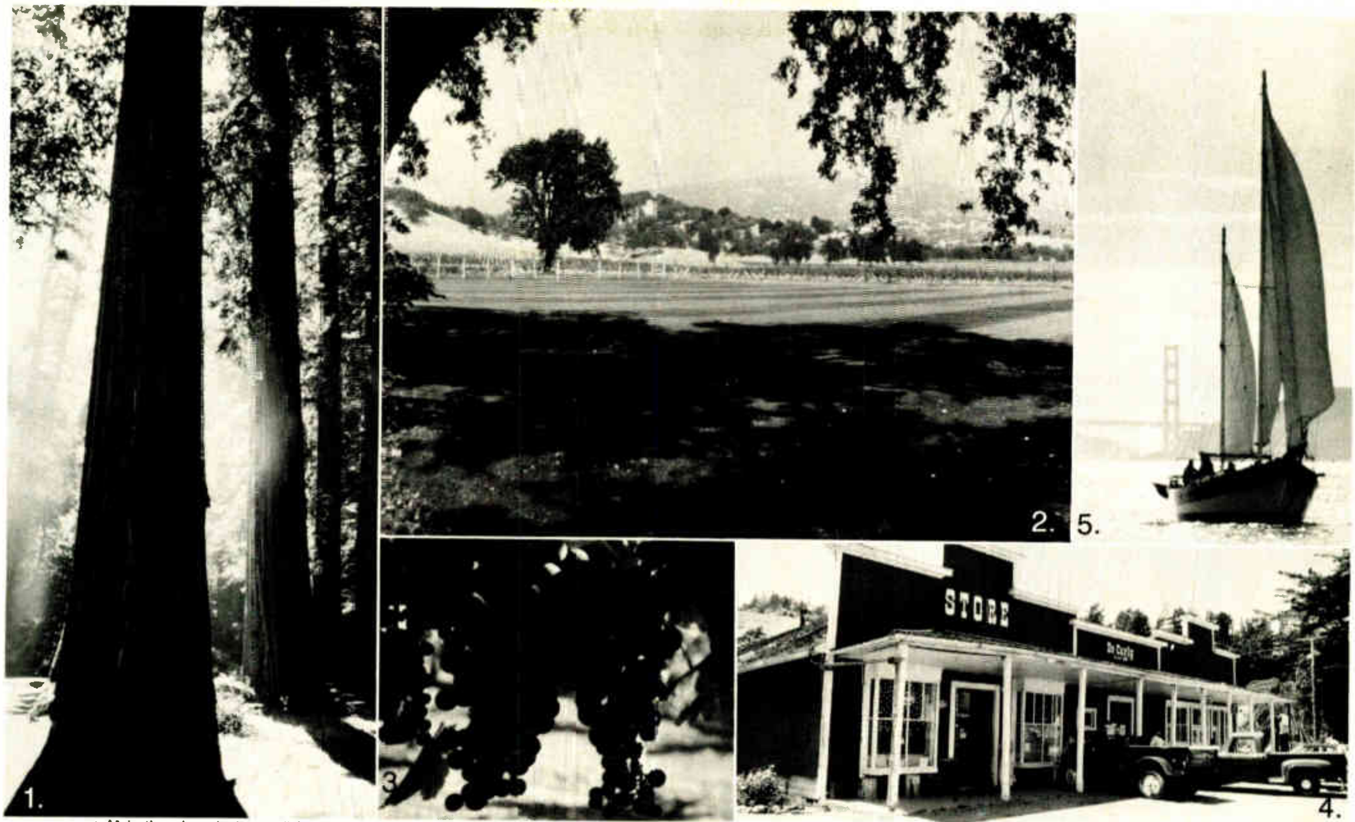
Texas Instruments has expanded its line of bi-FET op amps by adding two new series: the low-power TL061 and low-noise TL071. The three units in the TL061 series draw a maximum of 0.2 milliampere per amplifier; they feature a slew rate of 3.5 volts per microsecond. The four members of the TL071 family have a noise level of 18 nV per foot Hz.

Texas Instruments Inc., Inquiry Answering Service, P. O. Box 5012, M/S 308 (Attn: TL061 and TL071), Dallas, Texas 75222 [415]

TOPICS

Semiconductors

Supertex Inc., Sunnyvale, Calif., is offering a family of p-channel and n-channel enhancement-mode V-groove power metal-oxide-semiconductor field-effect transistors. The n-channel devices have ratings from 45 volts at 1 ampere to 60 V at 2 A; the p-channel units have the same voltage ratings but typically only half the current. In thousands, prices range from 59 cents for n-channel dice to $3.63 for a p-channel unit in a TO-3 can. . . .Meanwhile, **Siliconix Inc., Santa Clara, Calif.,** has upgraded its Mospower line of V-MOS devices. The new 2N6657 and 2N6660, which are meant to replace the VMP 1 and VMP 2, respectively, contain an on-chip gate-protection zener and are therefore totally monolithic. The earlier units had a separate zener chip mounted in the package with the V-MOS chip. In addition the new transistors have lower input currents and lower on-state resistances than their predecessors: 100 nanoamperes vs 500 ns, and 2.5 ohms maximum vs 3.0 ohms maximum. . . .**Texas Instruments Inc., Dallas, Texas,** has developed a new type of monolithic analog-to-digital converter. Called the TL505, the unit is meant to be used with microprocessors similar to TI's TMS1000 series. Analog elements in the TL505 include an op amp, a comparator, a voltage reference, analog switches, and switch drivers. Logic for the dual-slope conversion is performed by the associated microprocessor, or it can be implemented with discrete components. The converter is $3.90 each in hundreds.



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Packaging & production

Thermal unit tests die bonds

Tester measures transient thermal response to check transistor-substrate bonds

A die attachment evaluator from a California firm, Sage Enterprises Inc., uses the transient thermal response of a chip to check the quality of the bond between an npn bipolar transistor die and the substrate to which it is attached.

According to Bernard Siegal of Sage Enterprises, voids in the bond between the semiconductor chip and the device package header are often difficult to detect by the traditional technique, thermal resistance testing, but are readily sensed by the transient-thermal-response technique of the DAE 200.

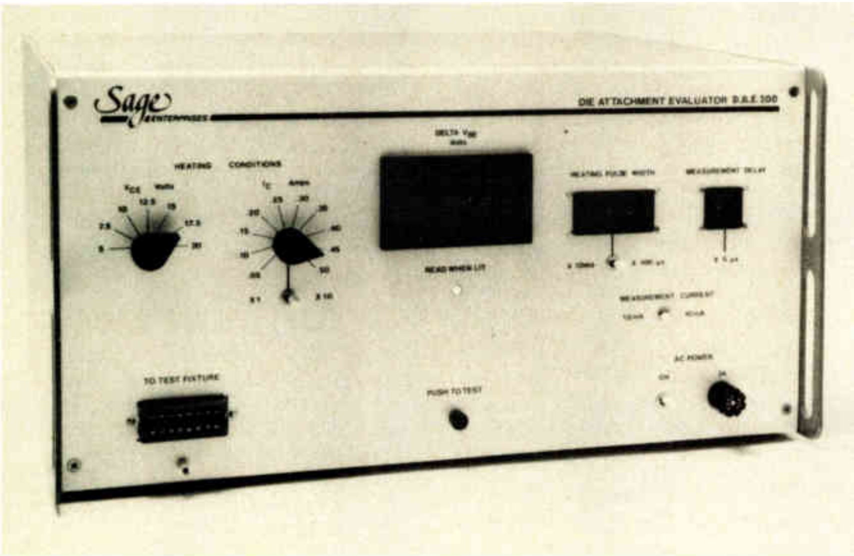
With the new method, the device under test is heated by a single pulse of power that is made slightly wider than the thermal time constant of the semiconductor chip. Since this constant is usually several orders of magnitude less than that of the package, a pulse of the proper width will heat only the chip and the chip-to-package interface. Thus the chip's temperature rise will be determined mainly by the chip size and the die-attach voids, not by the package as a whole. Because of the consistency of the temperature constant from chip to chip of a given device type, this method is useful for comparing different die-attachment procedures, the company points out.

To sense chip temperature, the DAE 200 uses the forward voltage temperature characteristics of a pn junction under constant current conditions. After heating the device with a single-shot power pulse, the instrument computes and displays the change in the base-emitter voltage, which is directly proportional to the junction temperature rise.

By comparing readings on different devices, says Siegal, it is possible with the DAE 200 to screen out potentially defective and unreliable units in a very quick and nondestructive manner.

Available 60 to 90 days after receipt of order, the DAE 200 is priced at $5,150 each.

Sage Enterprises Inc., 1080 Linda Vista Ave., Mountain View, Calif. 94040 [391]



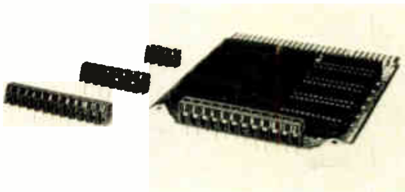
Dry plasma etcher includes optical monitor

A new dry plasma etcher with a preheated chamber and an automated, sequential, de-scum and etching cycle also features a novel photocell detector for monitoring the etching process and determining when it is completed. The optical subsystem lets the operator determine when the reaction is complete regardless of changes in plasma conditions, starting temperature, layer thickness, layer composition, batch size, and wafer spacing. In this way the model 421 avoids under-etching or over-etching and keeps rework to a minimum. The unit can etch silicon nitride, polysilicon, tantalum, tantalum nitride, tungsten, titanium-tungsten barrier metal, and molybdenum. It has a capacity of 50 4-inch wafers.

Tegal Corp., 860 Wharf St., Richmond, Calif. 94804. Phone (415) 232-1757 [395]

Solderless terminal strips mount on pc boards

The TS series of terminal strips for printed-circuit boards uses screw-activated clamps to provide solderless termination of wire leads. Available with 4, 8, or 12 positions, the strips are made of polyamide with silver-plated brass contacts. Wire sizes from 14 to 30 AWG can be accommodated.



O. K. Machine and Tool Corp., 3455 Conner St., Bronx, N. Y. 10475. Phone (212) 994-6600 [397]

Front-loading receptacles ease test-probe insertion

Four new front-loading receptacles designed to function with all Ostby and Barton snap-in unpluggable test probes make it easy to change and replace the probes in a wide variety of situations. Included in the new group are solder-cup, crimp-type,

wrapped-wire, and male-pin models. The solder-cup and crimp-type units are available in press-fit and cemented-in versions.

Ostby and Barton Co., 487 Jefferson Blvd., Warwick, R. I. 02886. Phone (401) 739-7310 [396]

Tiny connectors are less than 1/16 inch thick

Four connectors, with two, three, four, and six contacts, consist of a male plug and a female receptacle both less than 1/16 inch thick. The plugs and receptacles are respectively 1/8 in. and 1/4 in. high, while lengths range from 1/8 in. to 3/8 in. The connectors are already finding wide application in medical equipment, hearing aids, transducers, and high-density assemblies. They are made of gold-plated brass pins and sockets mounted in a high-temperature thermoplastic body. Prices range from $1.25 each in singles down to 25 cents each in thousands. Delivery is from stock to two weeks.

Microtech Inc., 1420 Conchester Highway, Boothwyn, Pa. 19061. Phone Howard W. Peterson at (215) 459-3566 [393]

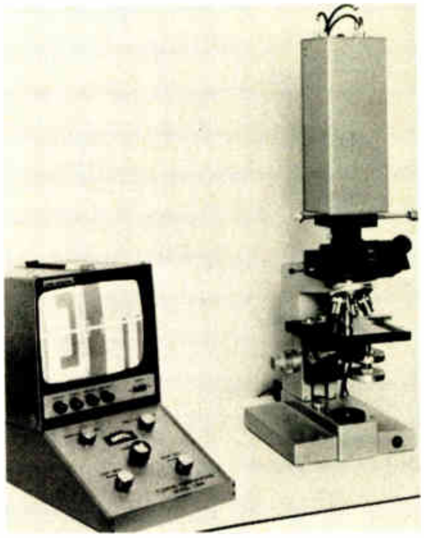
Computerized system tests analog and digital circuits

Capable of performing both static and dynamic functional tests on analog, digital, and mixed circuitry, the GR 1796 computer-controlled test system can check and troubleshoot printed-circuit boards, subassemblies, and complete assemblies. The system employs a high-speed controller with dedicated memory for each driver-sensor pin to provide the megahertz rates needed to test dynamic logic. Among the special features of the new system is a digital input/output electronics package that can switch rapidly from drive to sense while synchronizing itself with the unit under test. The digital I/O unit operates through a universal scanner that allows both digital and analog driving and measuring capability at each I/O pin. The GR 1796 is fully compatible with GenRad's CAPS VIII diagnostic software.

GenRad Inc., 300 Baker Ave., Concord, Mass. 01742. Phone R. T. Szpila at (617) 369-8770, Ext. 117 [394]

Unit measures line and gap widths on IC photomasks

Claimed to be more accurate and repeatable than filar and image-shearing devices, the model LWM MicroRuler measures line widths and gap widths on photomasks used in the manufacture of integrated circuits. It is accurate to within 1 microinch and has a resolution of 0.1 μin. To use the MicroRuler, the operator places two cursors on a cathode-ray-tube display over the edges of the line or gap to be measured. Precise placement is not



critical, as the machine will automatically find the exact position of the line or gap edge and will then measure and display the width directly on the CRT screen. The model LWM sells for $25,000.

Florod Corp., 3341 West El Segundo Blvd., Hawthorne, Calif. 90250. Phone Marty Compton at (213) 679-8201 [398]

Sputtering unit also heats, evaporates, and etches

The IVI 5500 Model 4619 sputtering deposition facility is capable of sequentially or simultaneously depositing material from up to five sources. It also has provision for preheating substrates, for sputter etching them, and for sequential evaporation of materials that are not readily sputtered.

The model 3619 can handle large quantities of 2-, 3-, 4-, and 5-inch wafers—of both round and square shape. Its working height is about 3 feet, making it extremely easy to load and unload.

International Vacuum Inc., Oak Street, Pembroke, Mass. 02359. Phone (617) 826-3195 [399]

TOPICS

Packaging

A P Products Inc., Painesville, Ohio, is now molding its Great Jumpers socket terminations with a plastic that meets Underwriters Laboratories standard 94V-0 for flammability. There is no change in price. . . . **Elfab Corp., Dallas, Texas,** has introduced a new type of backpanel for low-voltage or high-current applications. Called the PWR-Pac System, the panels consist of as many as eight planes of circuitry with insulated solid-copper sheets between them. They are recommended for use in logic circuitry where voltage control is critical. . . . **Stevens Products Inc., East Orange, N.J.,** is now able to produce pilot-run quantities of coil bobbins that operate at temperatures up to 180°C.

Subassemblies

4-decade d-a unit sells for $99

Thin-film hybrid converter designed as feedback element

Users of high-resolution, tracking analog-to-digital converters will be interested in the low price of the four-decade binary-coded-decimal digital-to-analog converter now being introduced by Hybrid Systems Inc., Bedford, Mass. This thin-film hybrid unit is designed for use with tracking a-d converters as a feedback element in such applications as weight-balancing systems, precision-thumbwheel-switch encoding to control power supplies, and voltage-tuned oscillators.

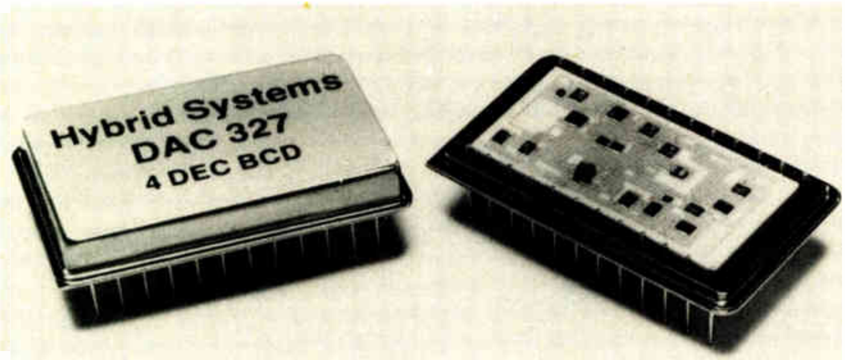
The model DAC327-4-BCD, with a price of $99 in quantities of 1 to 9, is $50 less than competitive units with similar performance, says Wayne Peacock, Hybrid Systems' president. It includes an internal reference, gain-trimmed output amplifier, switches, and thin-film nichrome resistor ladders. The only thing it lacks that is included in higher-priced d-a converters is resistor-programmable voltage outputs.

Says Peacock, "We designed and built the DAC327 to be a four-decade unit, instead of using the fallout from more expensive 14- and 16-bit binary designs." The DAC accepts an overrange input that increases its resolution from 1 part in 9,999 to 1 part in 15,999. Operating from standard ±15-volt analog supplies and a +5-v digital supply, the device produces a short-circuit-protected output of +11.999 v at 5 milliamperes for a complementary digital input of 11,999. If the user wishes, he can increase the positive analog supply to 19.0 v and apply a complementary BCD input up to 15,999 to obtain a 15.999-v output range.

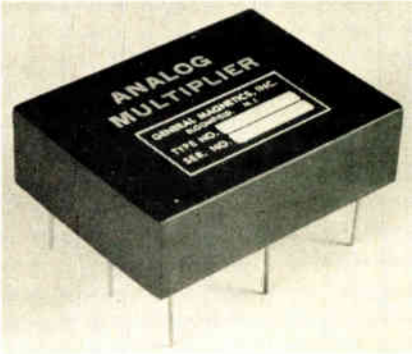
At 25°C, nonlinearity is less than 0.01% of full scale, and differential nonlinearity is less than 1 least significant bit. Gain is factory-calibrated to within 0.1% of full scale, initial offset is no more than ±10 millivolts, and pins are provided to allow external adjustment of both offset and gain by the user.

Settling time to within 0.01% of full scale is 8 microseconds for a change of 1 LSB and 30 μs for a full-scale change. The converter, which is housed in a 24-pin metal dual in-line package, is available from stock to three weeks.

Hybrid Systems Inc., Crosby Drive, Bedford Research Park, Bedford, Mass. 01730 Phone Larry Lauenger at (617) 275-1570 [381]



Analog multipliers hold error to ±2 mV



An analog multiplier's accuracy is generally given as a percentage of its full-scale output, which means that the actual voltage error at its output depends on the signal level. Not so for the new MCM 1509 series of modular analog multipliers from General Magnetics. Designed for low-frequency operation over the range of dc to 100 hertz, they are accurate to within ±0.5% of the theoretical value expected or to within ±2 millivolts, whichever is greater, and they maintain this level of performance over their entire operating temperature range.

No external circuitry is required, and signal inputs are completely isolated. The transfer function is the standard XY/10, with full-scale inputs and outputs of ±10 v. Input resistance at both X and Y terminals is 20 kilohms, while output impedance is on the order of 1 ohm. The units operate from a standard supply voltage of ±15 v dc, with an overall current drain of 25 milliamperes.

There are four temperature ranges from which to choose: +25 ±20°C, 0 to 70°C, −25 to +85°C, and −55 to +125°C. The latter two versions have a maximum offset voltage of ±4 mv, and accuracies of ±1% are available. Intended for printed-circuit-board mounting, the modules come in hermetically sealed metal cans measuring 2.5 by 1.8 by 0.6 inches.

In quantities of 1 to 24, prices start at $175 each.

General Magnetics Inc., 135 Bloomfield Ave., Bloomfield, N.J. 07003 [382]

Instrumentation amplifier offers true isolation

In the past, if a designer needed a high degree of input/output isolation in combination with a true three-wire-input instrumentation amplifier

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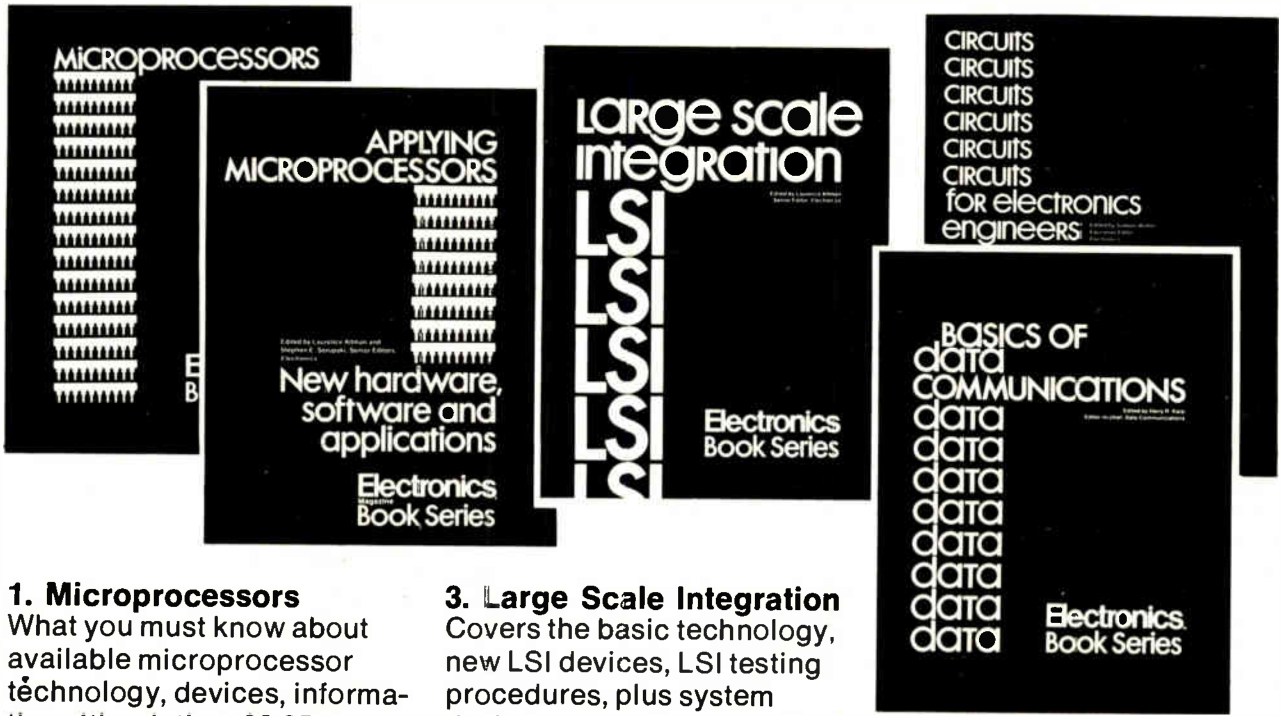

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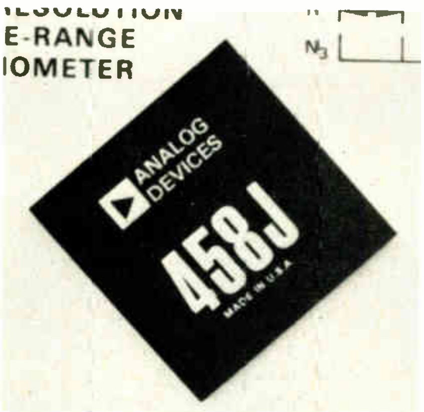
he had to cascade an instrumentation amplifier and an isolation amplifier. Now the model 3456B isolated instrumentation amplifier combines these two functions in one module. The unit, which includes an isolated power supply, has a differential input plus a separate input common. Other isolation amplifiers have either committed noninverting inputs or op-amp inputs.

Key specifications of the 3456B include a maximum gain nonlinearity of 0.02% at a gain of 100, a minimum common-mode rejection ratio of 110 decibels at a gain of 100, and an input offset voltage drift of less than 1 microvolt/°C at a gain of 1,000. The amplifier gain can be programmed from 1 to 1,000 with a single resistor. The 3456B sells for $165 in small quantities. A similar unit, the 3456A, which has an input offset voltage drift of 2.2 μV/°C at a gain of 1,000 sells for $145. Small quantities are available immediately; larger quantities have a delivery time of four to six weeks.

Burr-Brown, International Airport Industrial Park, Tucson, Ariz. 85734. Phone Naresh Shah at (602) 294-1431 [383]

1-megahertz v-f converter drifts less than 15 ppm/°C

Two families of low-drift voltage-to-frequency conversion modules include units with maximum frequencies of 100 kilohertz and 1 megahertz. The 460 family, with 1-MHz full-scale output, features a maximum nonlinearity of 0.015% over the six decades from 1 hertz to 1 MHz. It includes the model 460L, which has a maximum gain drift of 15 ppm/°C. In small quantities,



prices for 460-series units range from $135 for the L unit to $90 for the J, with its drift of 50 ppm/°C.

The 458 family covers the five decades from 1 Hz to 100 kHz with a maximum nonlinearity of 0.01%. Its highest-performing member—the 458L—has a maximum gain drift of 5 ppm/°C and a small-quantity price of $99. The 458J drifts a maximum of 20 ppm/°C and sells for $72.

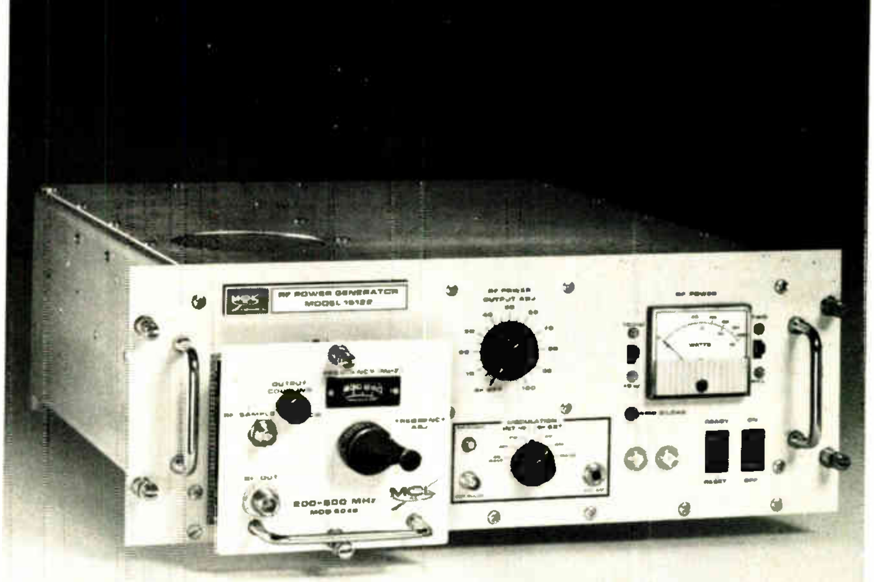
Analog Devices Inc., Route 1 Industrial Park, P.O. Box 280, Norwood, Mass. 02062 [384]

TOPICS

Subassemblies

Analogic Corp., Wakefield, Mass., has increased the versatility of its AN5400 data-acquisition and distribution system by redesigning its power input so that it can operate from 110, 120, and 240 V ac lines at frequencies of 47 to 400 Hz. The original system could only operate from 120-V 60-Hz lines. . . . **Adtech Power Inc., Anaheim, Calif.,** has announced a family of series-regulated power supplies with efficiencies of 53% to 56%. Conventional linear supplies have efficiencies of 32% to 43%. Units in the Energy Miser family sell for less than 10% more than conventional units. . . . **Datel Systems Inc., Canton, Mass.,** has introduced a universal hybrid active filter, the FLT-U2, that uses three operational amplifiers to obtain a second-order transfer function. The units, which have a 3-megahertz gain-bandwidth product, also contain a fourth, uncommitted op amp.

65 watts, 10 MHz-2.5 GHz



New MCL power generators feature flexibility, high output, minimum distortion.

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Microprocessors

Chip controls peripherals

LSI circuit can interface with floppy-disk memories or communications devices

Capable of operating in either the synchronous or asynchronous mode, a two-channel serial input/output controller developed by Zilog can be used to control floppy-disk memories or communications peripherals. The controller—designated the S10 and contained on a chip measuring 200 mils square—was designed initially to work with the Zilog Z-80 microcomputer system. But "it interfaces easily with almost any 8-bit microcomputer," says Roger Badertscher, director of the components department at Zilog.

In planning the peripheral device, several architectures were considered, including programmable logic arrays as used in several other devices on the market, according to Ross Freeman, head of the design team. But such techniques did not provide the logic density necessary for dual channels, Freeman says.

Zilog engineers opted for a primarily random-logic approach implemented with straightforward n-channel silicon-gate depletion-load metal-oxide-semiconductor processing. The chip contains the equivalent of about 10,000 devices, although it is designed according to relatively loose layout rules (5 micrometers). This complexity enabled Freeman and his associates to build a serial-data-interface controller with a data rate 10 to 15 times that of any similar device now on the market, according to Badertscher. In a system with a 2-to-2.5-megahertz clock rate, the data rate of the S10 is 500 kilobits; in a 4-MHz system, it is 800 kilobits.

Each channel of the 40-pin, 5-volt device has four control lines that may be used for modem control. The two input lines in each channel may be programmed to serve as either transmitter or receiver enables or general-purpose inputs. Each channel also has five control registers to select the various operating modes and options, two status registers, and two programmable sync-character registers.

Use of the asynchronous mode allows the transmission and reception of 5 to 8 bits per character, plus optional parity, which may be even or odd. Synchronous byte-oriented protocols are handled by the S10 in several modes that allow character synchronization to take place with one or two characters or with an external sync signal, says Freeman.

Zilog Corp., 10460 Bubb Road, Cupertino, Calif. 95014 [361]

Graphics plotter prints 8,192 dots per second

Designed to be driven by an 8-bit microprocessor with a minimum of software overhead, the EX-810 printer/plotter can plot 8,192 dots per second with up to 512 dots per row in its graphics mode. It can also function as an 80-column alphanumeric printer with a speed of 160 characters per second. The unit is equipped with a TTL-compatible con-

troller that takes care of all the internal timing functions necessary to drive the printhead and advance the paper. The unit, which prints on 5-inch electrosensitive paper, sells for $795 in small quantities.

Axiom Corp., 5932 San Fernando Rd., Glendale, Calif. 91202. Phone Simon Harrison at (213) 245-9244 [363]

Suitcase instrument helps maintain microcomputers

The µScope 820 microprocessor system console is a portable instrument that provides active control over microprocessor-based systems for fast troubleshooting, be it in the lab, on the production line, or in the field. Based on Intel's new 8085 microprocessor, the 820 will initially be used to service systems built around the popular 8080A. How-

ever, it has been designed to be easy to reconfigure for the service of systems that are built around other microprocessors.

The system's suitcase-type carrying case measures 19 by 15.5 by 7 inches and contains its own power supply along with storage space for personality probes, manuals, and other material. The basic unit is priced at $1,520; a probe set for the 8080A sells for $480. Delivery time is 90 days.

Intel Corp., 3065 Bowers Ave., Santa Clara, Calif. 95051. Phone Rob Walker at (408) 246-7501 [364]

16-channel data-acquisition unit interfaces with 6800

The MP21 is a complete 16-channel data-acquisition system designed to interface directly with 6800, 650X, and F8 type microprocessors. Housed in a quad in-line package, the hybrid unit is completely self-contained. It includes a 16-channel analog multiplexer, a high-gain instrumentation amplifier, an 8-bit analog-to-digital converter, and all

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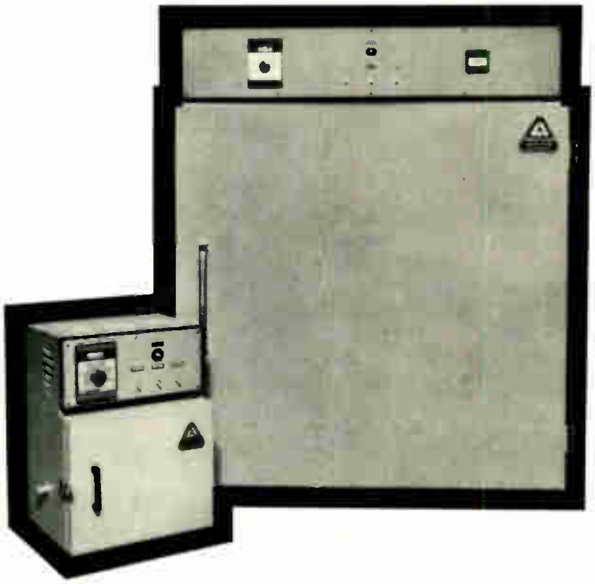

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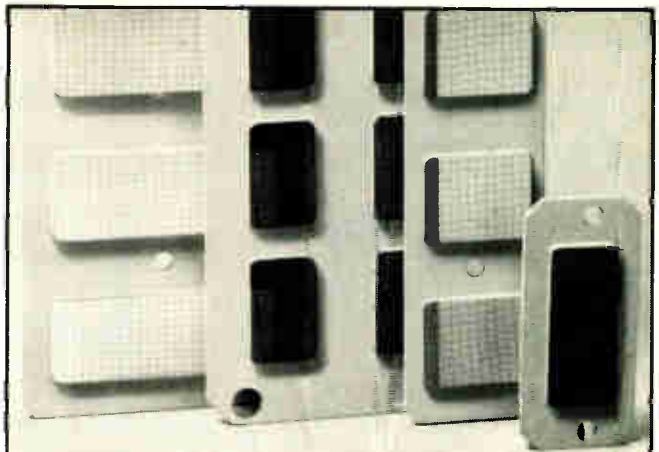

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Now you can easily load your programs, bootstraps and diagnostics into any make or model of computer or terminal you currently own through an approved 20 mA interface. Available in 300 baud and 2400 baud versions, the small (12" x 8") and light (3kg) (6.5 lbs.) self-contained unit can go just about anywhere you need an input device. All for a mere $750.

For complete information on the PRSO1, call your nearest Digital office; or write Digital Equipment Corporation, Traditional Products, 125 Northeastern Boulevard, Nashua, New Hampshire 03060.

digital

Circle 178 on reader service card

necessary address, data-, and control-bus interfaces. Because it is compatible with the previously mentioned microprocessors in both timing and logic level, it requires no external logic. Only one external component is needed: a resistor to set the gain of the instrumentation amplifier. If the resistor is omitted, the amplifier is set up to have a gain of 2. The MP21 sells for $195 in small quantities and $140 each in hundreds. Delivery of the data acquisition unit is from stock.

Burr-Brown, International Airport Industrial Park, Tucson, Ariz. 85734. Phone C. R. Teeple at (602) 294-1431 [365]

Computer with 16 kilobytes of memory sells for $1,899

The Horizon-1 microcomputer is a high-speed unit with 16 kilobytes of random-access memory, a disk controller with one Shugart minifloppy drive, and full extended disk Basic. It is built around a full-speed (4-megahertz) Z-80 microprocessor and sells for $1,899. A kit version goes for $1,599. The Horizon-1 is equipped with a serial input/output port for connection to any terminal that operates at a standard baud rate. A version with two Shugart minifloppy drives sells for $2,349 assembled or $1,999 for the kit.

North Star Computers Inc., 2465 Fourth St., Berkeley, Calif. 94710 [366]

Unit connects fast processors and memories

The MC10803 is an integrated circuit that provides an interface between a high-speed processor subsystem, such as the MC10800 4-bit arithmetic-and-logic unit slices, and system main memory or peripheral equipment. The chip contains its own ALU to generate memory addresses and handle the bidirectional transfer of processor data. Specifically, the device contains six 4-bit registers, an ALU with encoded function and operand select logic, and data-transfer circuitry. It performs a total of 13 basic ALU functions and 17 data-transfer operations on seven possible operands, according to the company.

Like all current MC10800-family devices, the MC10803 is directly compatible with all units in the MECL 10,000 series. It is housed in a 48-pin quad in-line package and sells for $40 in hundreds. Delivery of the interface circuit is from stock.

Motorola Semiconductor Products Inc., P. O. Box 20912, Phoenix, Ariz. 85036. Phone Jerry Tonn at (602) 962-2515 [367]

TOPICS

Microprocessors

MITS Inc., Albuquerque, N. M., has developed a timesharing Basic package for microcomputers that provides instantaneous keyboard response even when the system is supporting the maximum number of users. In its largest configuration, the package runs eight programs simultaneously. A typical four-terminal system sells for less than $12,000. . . .**National Semiconductor Corp., Santa Clara, Calif.,** is offering a number-crunching LSI circuit to perform the complex numerical operations in a microcomputer system. The MM57109 is basically a scientific calculator without a keyboard or display. A p-channel MOS device, it sells for $12 each in hundreds. . . .**Facit-Addo Inc., Hartsdale, N. Y.,** has announced a compact optical tape reader for use as an input peripheral in microcomputer systems. The model 4031 is an asynchronous machine that can operate at any speed from 0 to 120 characters per second.

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engineers

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You will be responsible for ink jet technology development for low speed non-impact printers, including direction of a staff of engineers, technicians, and design and drafting personnel. A BS degree plus a minimum of 10 years' related experience including project management, and low cost design engineering are required.

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You will be a member of a technology team which will establish and provide design approaches for use in electrophotographic high speed printer products. Two to six years of EPG design and development experience with specialization in EPG image development and fusing needed. BS degree in engineering or physical science or equivalent experience required.

MANAGER, MECHANICAL DEVELOPMENT

Leading the team responsible for development and application of mechanical aspects of ink jet technology, you will have a subtantial annual budget, and a staff of approximately 10 engineers, technicians and support personnel. A BSME, MS preferred, plus a minimum of 10 years' related experience, including accountability for the design of a portion of a manufactured product are required. A background in low cost design and project management is also desirable.

PRINCIPL SCIENTIST
Electrophotographic printers

Lead a technology development team in establishing design approaches to new products. Ten years' EPG design and development experience with specialization in EPG image development and fusing required. A BS in engineering or physical science is also required.

IMPACT PRINTER DEVELOPMENT

MECHANICAL DEVELOPMENT ENGINEER

You will be responsible for the development of a new generation of band printers utilizing low cost innovative designs, in addition to responsibility for development of band printer paper stacker. Your background must involve the ability to direct a staff of approximately eighteen engineers, technicians and design and drafting personnel. Position requires BSME or the equivalent (MSME desirable) and a minimum of ten years' previous related experience including previous design accountability for a portion of a manufactured product, experience in project management and low cost design.

MECHANICAL ENGINEERS

Mechanical production design background including mechanical processes as they apply to design, and value engineering techniques. Proven product development experience with expertise in mechanisms, structures, electromagnetics, electronic packaging/cooling, and value engineering. A BSME or th equivalent plus 4-6years' related design and manufacturing experience.

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A strong background in electronic circuit design including digital logic design, microprocessor design, and programming is required. We are looking fr a BSEE or th equivalent with 3 years' design experience and the ability to direct engineering support personnel, design analog and digital circuits, AC power, and servi mechanisms.

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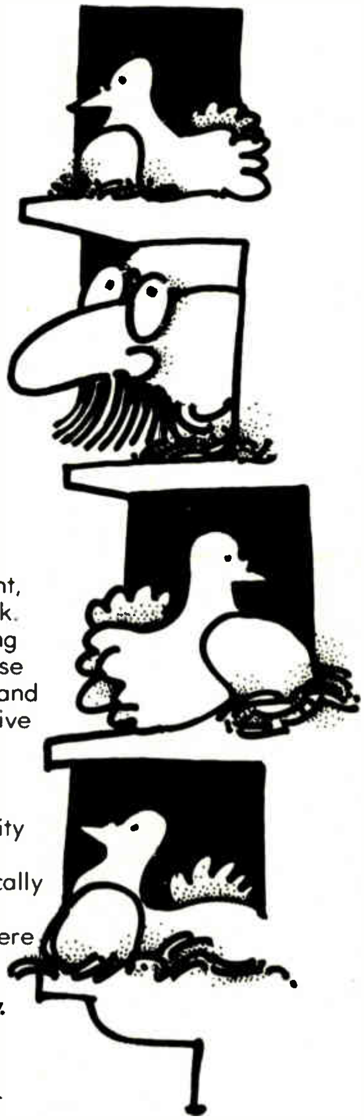

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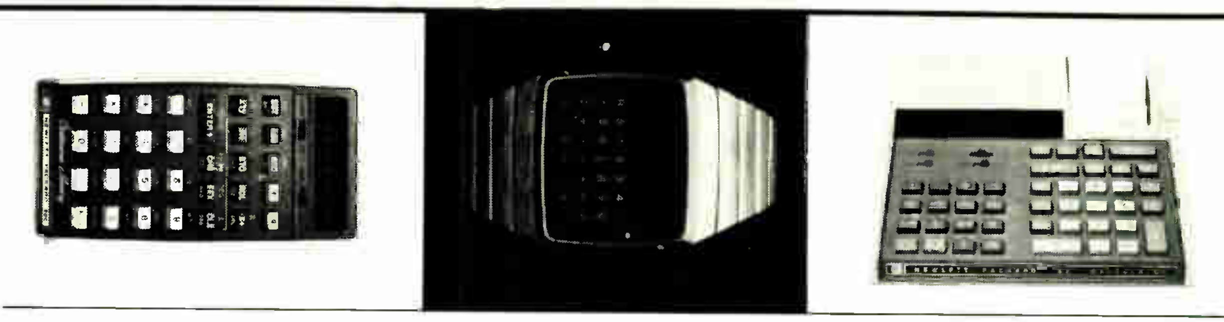

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Duties will be to implement distribution roll out of a new Hewlett-Packard product. You must manage the growth and maturity phases of the product life cycle. Requirements: We strongly prefer an MBA with electrical undergraduate degree.

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Production Engineer

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MOS Process Engineers

This opening in our LSI operation entails "hands-on" opportunities in the areas of diffusion and photomasking. The successful candidate will report to the process engineering manager with responsibility for medium volume production. Our commitment to engineering excellence provides ample opportunity for state-of-the-art process development. Requirements: BS/MSEE, ChemE with 1-4 years' experience desired.

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Components Engineer

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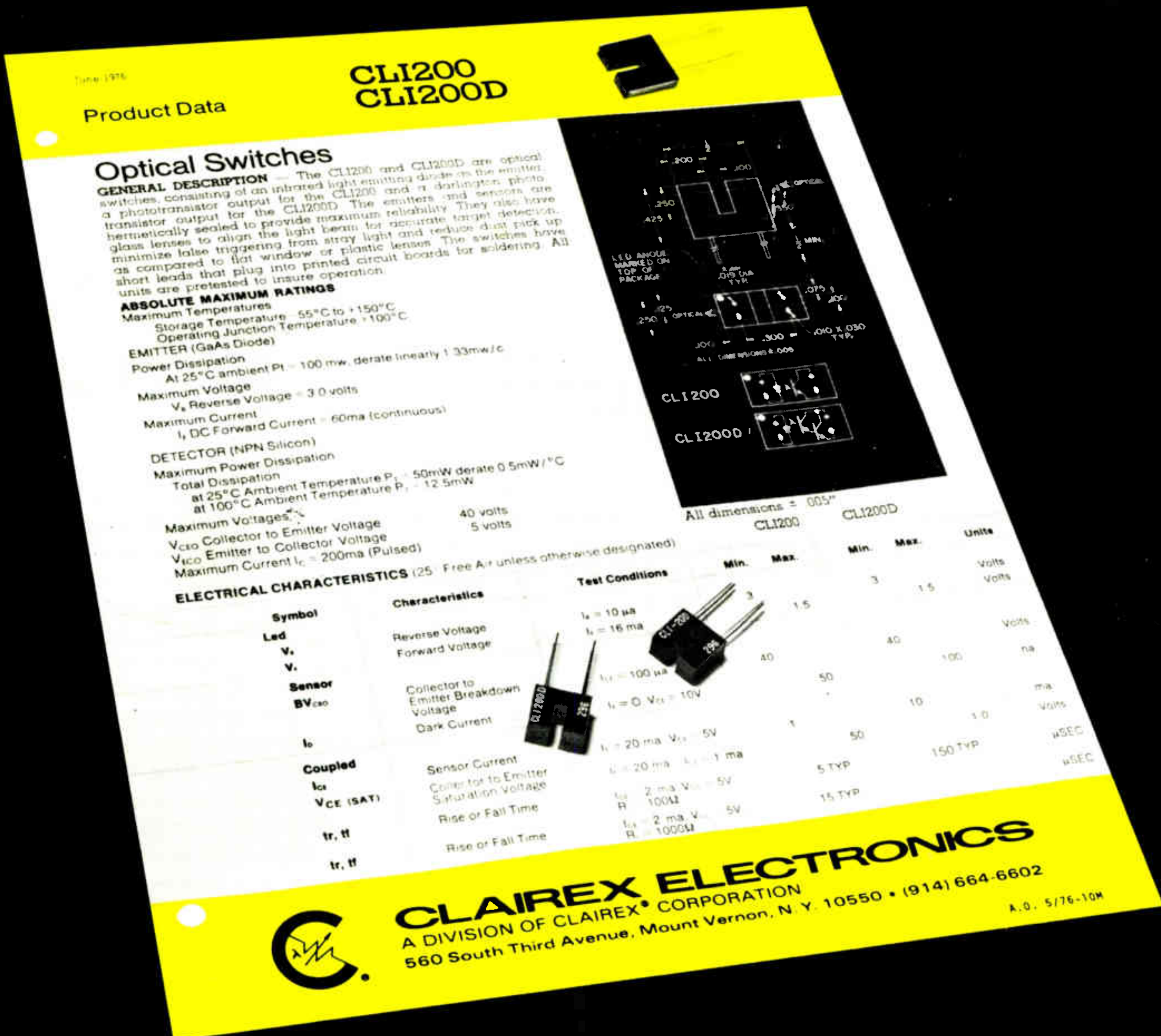

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