May 27, 1976

HIGHLIGHTS OF THE NATIONAL COMPUTER CONFERENCE/124

Can semiconductor makers grab the market for IC converters?/77

16-bit microprocessor chip performs like a minicomputer/99

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Electronics

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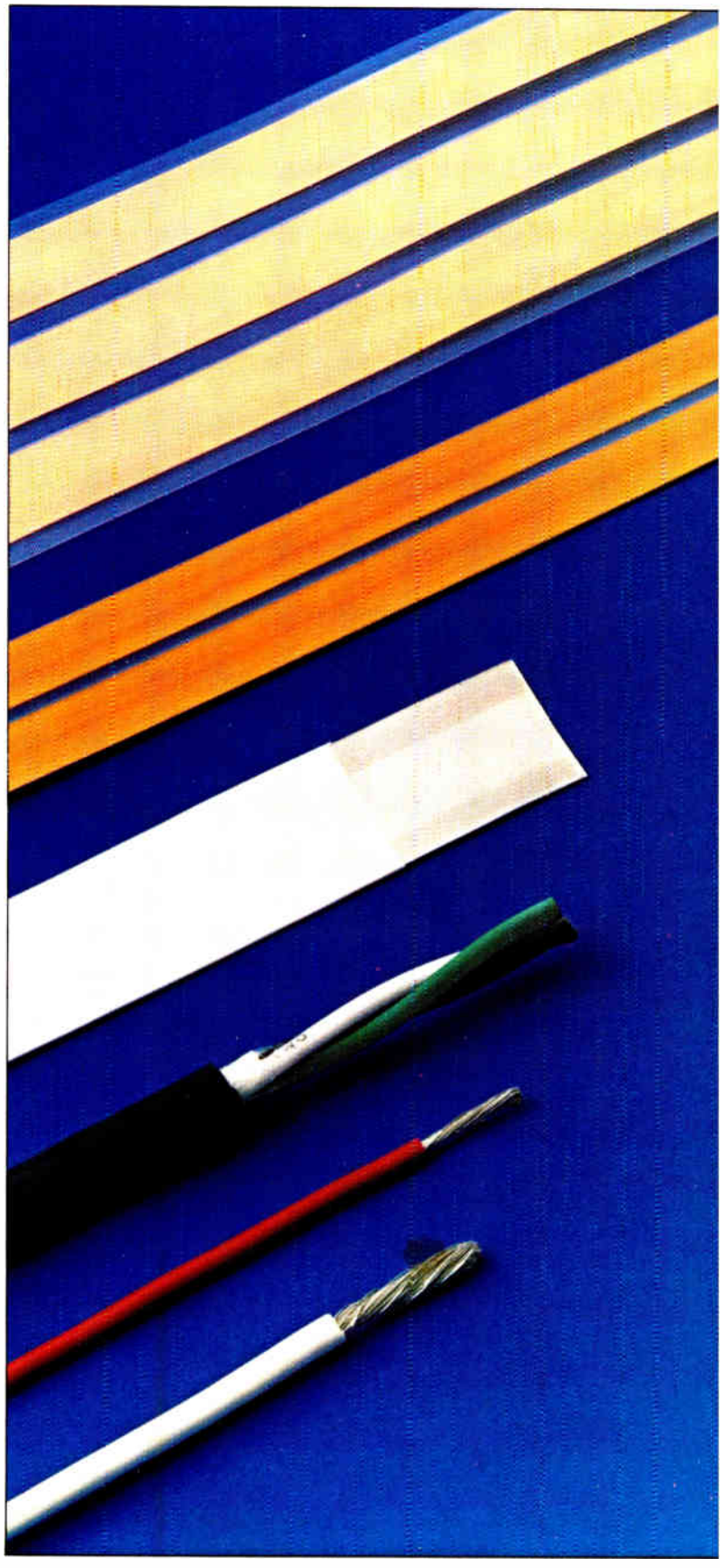

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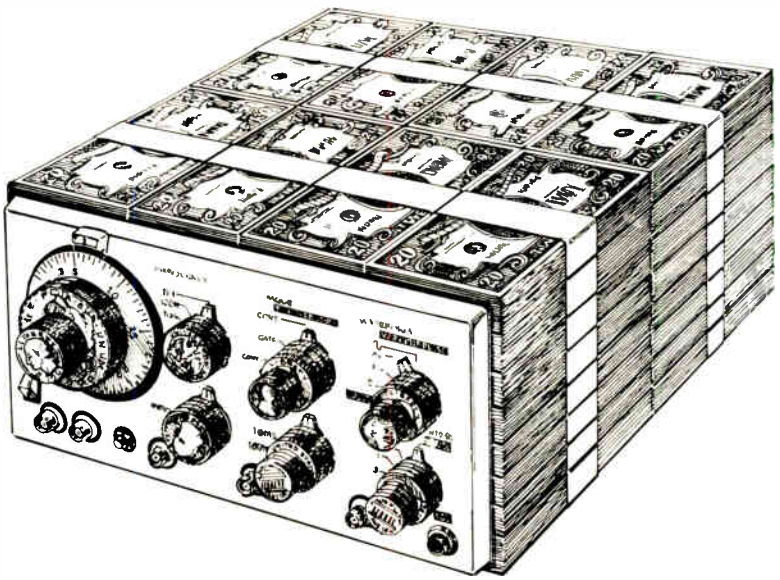

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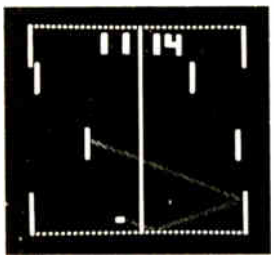
Tennis, hockey, squash, handball, target practice, skeet shooting (all on one chip) anyone?



GI's "six-on-one" TV game chip is fast breaking the TV game wide open.

It's a sure winner. For us, the chip maker. For you, the game maker. For, there's nothing else in the world like it. Not even close to it.

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There are other options, too, you'll find in no other game chip.

True color. Colored balls that don't change color. Team colors for the paddles. And if you want to play your tennis on grass, just color it green.

More. If you want to give your players a rechargeable battery-powered option, you can give them that, too. The "six-on-one" uses only 30 milliamperes.

As we said, you can't do that with any other game chip.

Scoring is automatically displayed on the screen. External electronics required are minimal. Interfacing is simple, through the antenna.

The "six-on-one" chip is in a standard 28-pin, plastic, dual-in-line package.

But that's about the only thing standard. Everything else about the "six-on-one" makes it exceptional.

In TV game chips today, it's the name of the game.

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Electronics
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Highlights

Cover: Distributed processing grows, 91
Decentralization of computer operations, sparked by technology-induced reductions in systems cost, is a fast-growing approach to data processing. Improvements abound in hardware and software, although the latter is moving ahead more slowly.

Cover illustration is by Fred Sklenar.

IC converters challenge hybrid models, 77
Major semiconductor manufacturers are selling integrated-circuit data converters, but most observers don't see an across-the-board challenge to the traditional hybrid devices. The high-performance, precision end of the market should belong to the hybrid builders for the foreseeable future.

16-bit chip tackles big jobs, 99
The performance of a minicomputer at the cost of a microprocessor system is the boast of a new processor. Its 16-bit words can reach large blocks of memory two bytes at a time.

Computer show booms into New York, 124
All figures point to a banner year at the National Computer Conference: some 50,000 showgoers expected, about 300 exhibitors on hand, and 126 technical sessions scheduled. This preview of the sessions is followed by a sampling of the new products to be displayed.

And in the next issue . . .
Digital watches, now the hottest consumer-electronics item, are the topic of a special report . . . what's been happening in cathode-ray-tube technology . . . a large-scale integrated microprocessor designed to match many device families.

Electronics

The National Computer Conference is due to open soon in New York City, and the conference organizers look forward to healthy attendance figures. Indeed, they are estimating that 50,000 showgoers will crowd into the New York Coliseum to see the wares of some 300 exhibitors, as well as pack the conference rooms of the New York Hilton and Americana Hotels, where 126 technical sessions are being held.

On page 124, you'll find a survey of what's in store at the show, with a detailed summary of the technical sessions. And on page 131, we begin a preview of some of the more interesting new products that will make their debut at show time.

There's some interesting jockeying for position going on as the major semiconductor houses start making the run for a chunk of the data converter market. Banking on their early lead, the traditional makers of modular or hybrid models think they can outpace the newcomers.

Larry Curran, our Boston bureau manager, who put together the Probing the News story that starts on page 77, looks at the competition this way. "With few exceptions, the consensus seems to be that the traditional makers will serve the high-performance, precision end of the market for the foreseeable future, and the monolithic houses will chip away at—and possibly dominate—the less demanding jobs that don't require much more than 8-bit resolution or substantial speeds."

In the process, though, there are sure to be some innovative products and marketing developments. For example, a round of hybrid converter price-cutting was triggered by announcements and rumors of impending actions by the major semiconductor makers. So be sure to read our story for the background needed to read the trends in the embattled converter market.

And while we are on the subject of hotly contested markets, just look at what is going on in video games. The pitch of excitement there is somewhat like the early days in hand-held calculators.

"The scramble to get part of the action in this lucrative new market, which started last year," says Jerry Walker, our consumer electronics editor, "now involves semiconductor houses, traditional arcade and toy companies, new electronics-oriented firms, Far East assemblers, and a couple of television-receiver manufacturers."

The big barrier, though, to reaching the entrepreneurial pot of gold is the current limit on capacity to make the video-game chips. Only one IC supplier is shipping a dedicated chip, although several others are speeding devices to market, and there should be a better supplier situation later in the year.

What with Government certification of products and the headaches of designing sophisticated new games, the burgeoning field is not without its problems. Yet the public's fancy seems to have been captured. You'll find the complete story on how the video-game game is being played on page 80.

May 27 1976 Volume 49 Number 11
94 195 copies of this issue printed

Published every other Thursday by McGraw-Hill Inc Founder James H McGraw 1860-1948 Publication office 1221 Avenue of the Americas N Y N Y 10020 second class postage paid at New York N Y and additional mailing offices

Executive editorial circulation and advertising addresses Electronics McGraw-Hill Building 1221 Avenue of the Americas New York N Y 10020 Telephone (212) 997-1221 Teletype 12-7960 TWX 710-581-4879 Cable address M C G R A W H I L L N E W Y O R K

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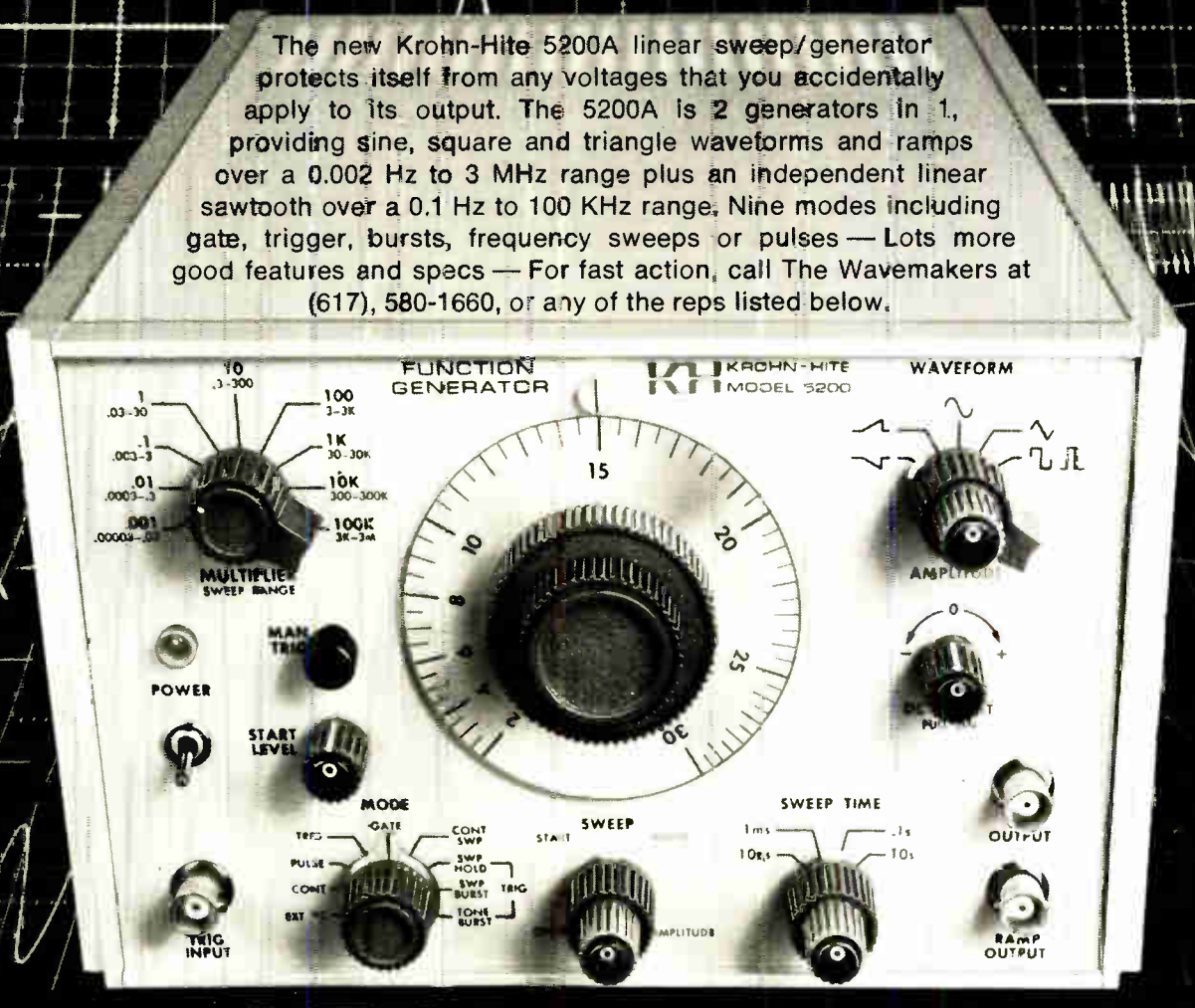

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Readers' comments

Settle patent issue privately

To the Editor: Quite a bit has been said in your magazine about employee patent agreements. Having for many years dealt with such situations, I tend to react unfavorably to such complaints by employees. Obviously, they are hired, paid, and provided with the use of expensive facilities—all in the expectation that better products will result. As a matter of fundamental philosophy, it is morally right that the entity supplying the capital for this should be entitled to any inventions.

The foregoing must sound like something out of Adam Smith or Ayn Rand. In principle, it may be; in practice, however, too many employers have forfeited their right to claim its benefit.

Engineering salary ranges are pegged to years of experience. Seldom is any real difference made on the basis of merit, as measured by the scope of actual contribution to the business. When the latter is recognized, it is usually by way of promotion in the management ladder. Too often, this removes creative talent from the chance to create further, in the engineering sense.

As a matter of plain common sense, an employee has to be rewarded in his paycheck for any significant contribution, whether it shows up in the actual product or only in the patent portfolio, which also has some value. For sure, the assignment and apportionment of values in such things may at times require the judgment of Solomon.

But if the employers don't try to implement something along these lines, it is certain that Congress or the courts will intervene. Should that happen, experience in other areas suggests that neither employer nor employee will win. Instead, complex formulas will be developed with the Government as arbiter.

Are you, Mr. Employer, willing to let the Government dictate what must be done in this area? And you, Mr. Engineer, have you decided to submit to become a slave to whatever the Government decides?

Hugh H. Drake
Fort Collins, Colo.

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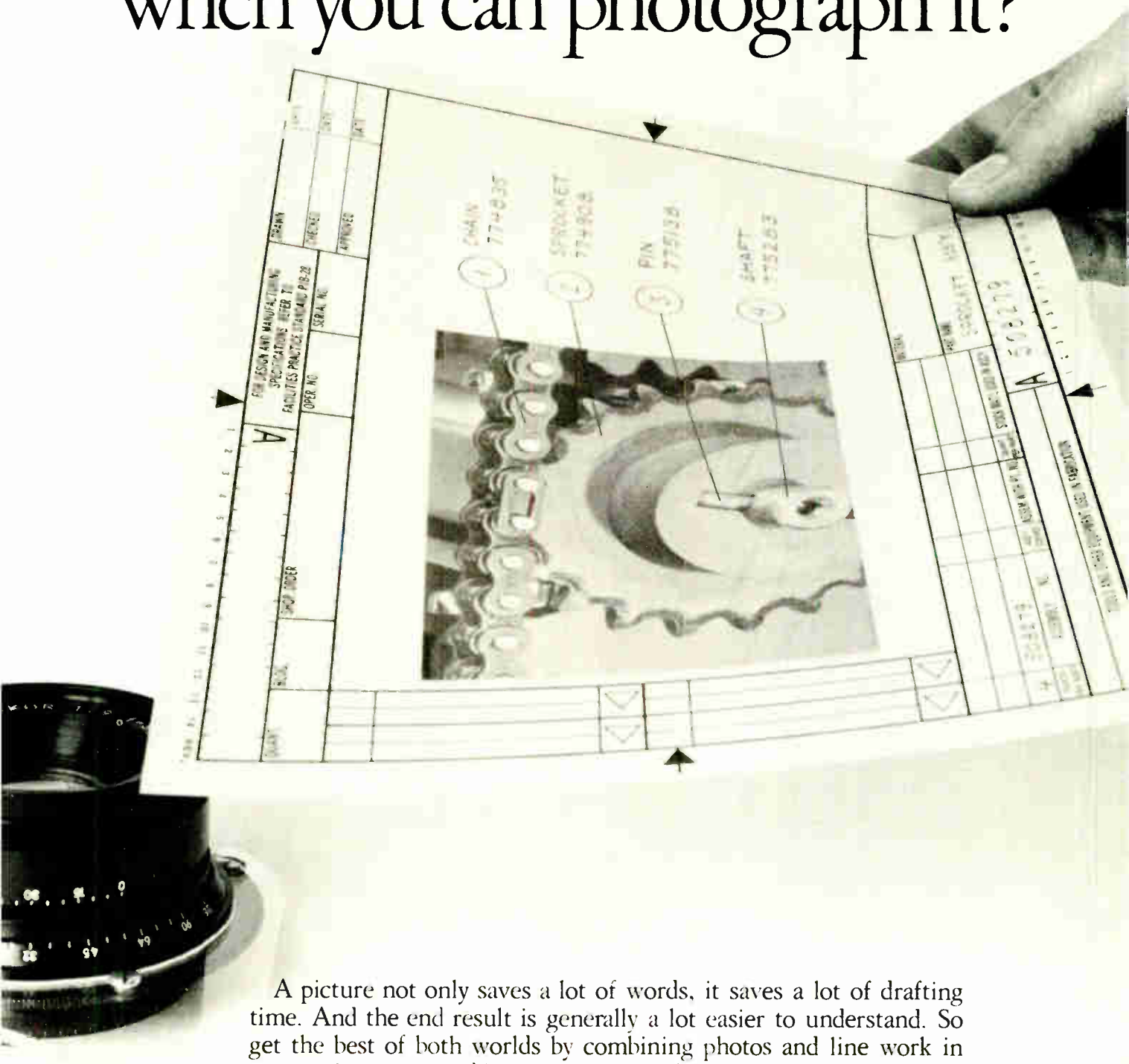

A picture not only saves a lot of words, it saves a lot of drafting time. And the end result is generally a lot easier to understand. So get the best of both worlds by combining photos and line work in your maintenance and instruction manuals, assembly and installation drawings, and other complicated designs.

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News update

■ Nippon Electric Co. is using its new silicon-nitride process [*Electronics*, June 12, 1975, p. 38] in two products, but the company won't say which two. The process, which calls for the addition of a silicon-nitride layer to an IC, is said by Nippon to relax the stress from previous processes and improve performance. While attaining its primary goal of higher current gain at low current levels, the new process also offers less noise and lower transistor input offset voltages and currents. A Nippon source says also that rejects because of failure to meet functional specs, such as gain value, are greatly reduced.

The two devices now utilizing the silicon-nitride technique were existing products that are produced in quantity. In the future, Nippon plans to use the process for new products, especially precision circuits, although a few more high-volume parts may be converted. The company says it expects to be using the process for a large number of products in the next year.

■ The 8,192-bit n-channel memory device on a 1.1-by-1.6-millimeter chip [*Electronics*, May 29, 1975, p. 46] developed by International Business Machines Corp. is still in the lab. But scientists at the Yorktown Heights, N.Y., facility are continuing to work on the device, aiming particularly at making it even smaller. "We're trying to make these things smaller and understand the problems that go along with making them smaller," says an official at the lab. "It's a period of refinement and exploration." To help do the job, a new, more advanced pilot production line is being installed. The official says the lab team hopes to report higher densities by combining electron-beam lithography with ion-implantation production techniques late this year or early next year. When they announced their development last year, IBM scientists foresaw no obstacles to early fabrication of a 16,384-bit version because of the fine geometries they already had achieved.

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Editorial

At last, a science adviser

Largely unheralded, the framework for an office of science adviser in the White House has been rebuilt. Significantly, The National Science and Technology Policy, Organization, and Priorities Act of 1976, recently signed by President Ford, goes beyond previous legislation in this ever-more-critical area of national policy.

For one thing, the new Office of Science and Technology Policy will be headed by a director who is subject to confirmation by the Senate. While not a Cabinet-level position, the directorship will, thus, be in the public eye—and under public scrutiny—more than a presidential appointment would be.

For another thing, the new office is charged with preparing an annual report detailing the five-year outlook both for national problems that have been identified by scientific studies and for opportunities for science and technology to help in meeting national goals. That report will be separate from the President's annual report on science and technology.

What's more, Congress has mandated that the OSTP director set up a special intergovernmental panel to take a close look at state, regional, and local problems that may be valid targets for solutions using science, engineering, and technology.

Two other provisions of the act should go a long way to closing the serious—in many ways crippling—communications gap that now exists between the nation's political leaders and its science and technology community. One directs the president to form a special committee, headed by the OSTP director and numbering no more than 14 members, to make an in-depth study of the Federal Government's complete science and technology establishment and how it works. The act envisages a two-year study period, but provides an option for the President to extend this time.

The other important provision gives a new, legislative status to the existing inter-agency Federal Council for Science and Technology, set up by the order of President Eisenhower. While the new Federal Coordinating Council for Science, Engineering, and Technology has been given no new functions—indeed, it is strictly an advisory group—it has been placed under the chairmanship of the OSTP director. Significantly, too, the word "engineering" has been added to its title.

It is heartening that Washington has heeded repeated demands that the science advisor have as wide a participation in Government deliberations as possible. With the act, the director has been given a number of tools crucial to establishing a useful science adviser, not just to the national Government, but to the nation as a whole.

Good news from Electro 76

The curtain has come down on Electro 76, the Boston run of the IEEE annual convention. While evaluations of the show range from the enthusiastic to the dissatisfied, on balance they indicate that for a first-time event, the Boston show has proved to be a viable proposition.

Electro 76, in fact, exceeded the expectations of many exhibitors, including some of those who came all the way from the West Coast. What's more, it was quite a bit more successful than we thought it could be when, a year ago, the Boston/New York alternation was decided upon. For that we are glad because the show is an important forum for technology and the marketplace, and we want to see its vigor restored in full.

We were going to second source Intel, but we couldn't wait.

Advanced Micro Devices has developed, introduced and is volume-producing the first family of 4K static RAM's. They're yours now. Off the shelf. Sorry, Intel.

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New Intel microcom system costs, increase

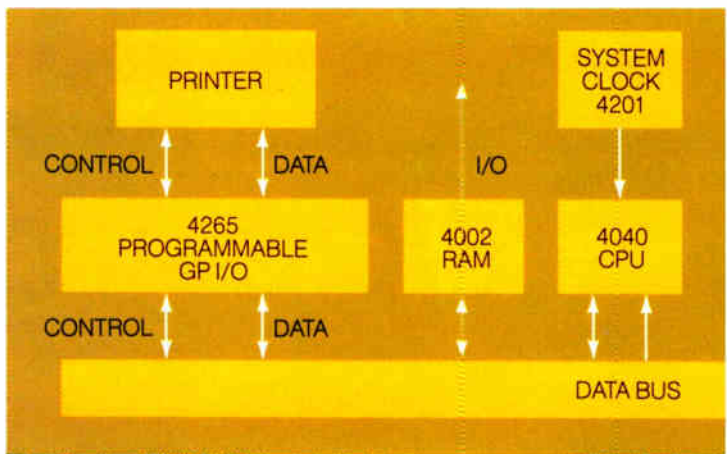
Intel has two new LSI components for the MCS-40™ microcomputer system which will help you cut system costs, increase throughput and reduce the number of components you have to stock for I/O interface requirements. The new Intel 4269 Programmable Keyboard Display and the 4265 Programmable General Purpose I/O devices eliminate the large number of discrete SSI/MSI components previously required for keyboard, control panel, indicator array, alphanumeric display, printer, communications and other I/O interfaces. These new LSI parts increase system throughput up to 50%, and make it easy to add standard Intel memory and system peripherals.

The 4269 Keyboard Display can be software programmed to interface to various keyboard and display elements and makes it possible for you to eliminate fifteen or more discrete components.

It significantly increases system throughput since it performs the scan, storage, refresh, and other simultaneous keyboard/display tasks previously required of the 4004 or 4040 CPU.

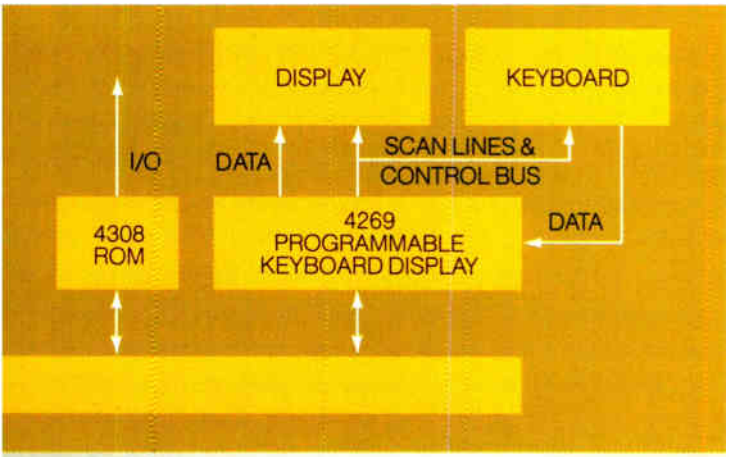
When programmed as a keyboard or line sensor input interface, the 4269 can scan up to 64 key closures or lines. When a key closure is detected, the 4269 generates a system interrupt and stores up to eight characters in its first-in/first-out buffer before requiring CPU service.

In alphanumeric applications, the 4269 eliminates the need to use the CPU



* Self-Scan is a registered trademark of the Burroughs Corporation

puter I/O devices cut throughput up to 50%



and system memory for display refresh since the necessary memory and control are built in. One 4269 can operate and refresh alphanumeric displays or indicator arrays with up to 32x4 digits, 16x8 characters or any configuration of 128 elements or lights, including a 20-character Burroughs Self-Scan* Display.

The 4265 General Purpose Programmable I/O is ideally suited to implement custom interface requirements. Up to four devices can be controlled by the CPU. Each 4265 has 16 I/O lines organized into four ports which can be used in 14 different data transfer and control/interface organizations. The 4265 provides synchronous/asynchronous control, buffer inputs and outputs, bit set and bit reset capability on output port lines and byte transfer control. It can be used to add industry standard RAM memory such as Intel's 5101 CMOS RAM. And the 4265 lets you use system peripherals such as the 8251 Programmable Communications Interface (USART), the 8253 Programmable Interval Timer or the 8214 Priority Interrupt Control Unit.

To order, contact our franchised distributors: Almac/Stroum, Components Specialties, Components Plus, Cramer, Elmar, Hamilton/Avnet, Industrial Components, Liberty, Pioneer, Sheridan or L.A. Varah. For your copy of our MCS-40™ System brochure, use the bingo card or write: Intel Corporation, 3065 Bowers Avenue, Santa Clara, California 95051.

intel®

Microcomputers. First from the beginning.

Circle 12 on reader service card

People

Exar's Lieux has the I²L kit for the future

When Fairchild Camera and Instrument Corp. backed off from integrated injection logic in favor of complementary-MOS for its watches earlier this year, it lost some veteran linear designers through layoff and resignation. But Fairchild's loss was the gain, in one instance at least, of Exar Integrated Systems Inc., which hired J. Darryl Lieux (pronounced Leer), as its I²L project manager.

Under the directon of Lieux, who had been the manager of the departed Fairchild designers, Exar is bringing out the semiconductor industry's first I²L design kit. The kit is a tool with which Exar, a $5 to $10 million custom linear bipolar house in Sunnyvale, Calif., hopes first to interest designers in the possibilities of the technology and then capture their production needs (see p. 42).

Combination. A husky, cigar-smoking bear of a man, the 37-year-old electrical engineer believes I²L has great promise. "Its performance in memories now and in microprocessors in the near future will prove its usefulness," Lieux says. But going one step further, he predicts: "The greatest application and growth will be in areas requiring a combination of linear and digital functions," particularly in telecommunications, instrumentation, microprocessor-interfacing, and consumer-electronic games.

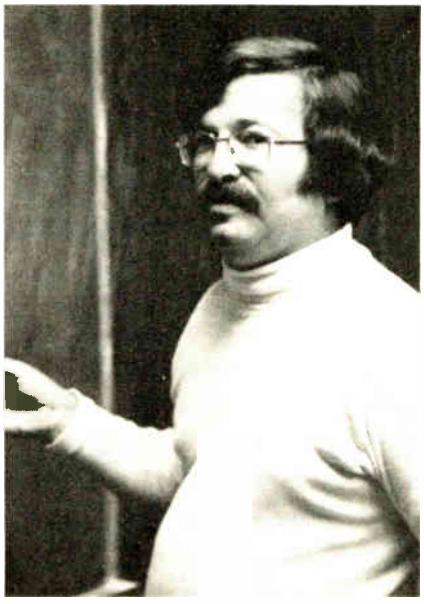
"There are a lot of systems out there that use transistor-transistor logic, standard C-MOS logic, and linear bipolar discretes and ICs," he says. "And ICs that combine linear and digital functions can be replaced on a single chip via I²L."

When it comes to design, Lieux should know. During his 10 years at Fairchild, he designed several of the industry's standard linear circuits, including the 723 voltage regulator, the 727 temperature-controlled differential amplifier, and the 728 temperature-controlled voltage reference.

Master slice approach. Exar's digital/linear design kit is built around a master-slice chip of 110 by 110 mils, the XR 400, that includes 256 quad-output gates with about 1,000 transistors. But Lieux will be hard at work increasing the chip's density. By next year, he expects the master-slice chip in the next-generation kit to contain the equivalent of 512 I²L gates.

"And in the reasonably near future, I expect to see gate densities of about 1,000," he says, "enough to put whole printed-circuit boards of components on one chip." And despite Fairchild's retreat, Lieux grumbles, "I still think I²L will be a good watch-circuit technology."

Appeal. A master slice makes things easier for I²L designers and J. Darryl Lieux.



Chenail to boost DEC's solid-state know-how

In a physical sense, at least, Joe Chenail (pronounced Sha-Nye) is back where he started more than 15 years ago: he's in the same building, but his employer is now Digital Equipment Corp. instead of Sprague Electric Co. The easy-going Chenail, 40, is operations manager for DEC's Worcester, Mass. facility, which is producing both metal-oxide-semiconductor and bipolar LSI devices for the minicomputer giant

SQUEEZE PLAY.

T10 relays by P&B let you mount your pc boards on 0.5" centers. They work in tight spots like a pro.

T10s are only 0.375" high. The lowest profile 3 amp relay in the Potter & Brumfield line.

They provide 0.1 to 3 amp switching @ 28V DC in 2, 4, and 6 pole models. Coil ratings are 6, 12, 24, and 48V DC. Permissive make, gold-flashed silver contacts are noted for low contact bounce, long operating life. Bifurcated contacts for low level switching are also available.

These relays are compatible with TTL and CMOS peripheral driver ICs, and TTL and CMOS buffers wired for current sharing. Ideal for telecommunications, copy and reproduction machines as well as computers and peripheral equipment.

Put a squeeze play on costs. Prices are as compact as the relays themselves.

For full information on the T10 series and all P&B relays, see your Potter & Brumfield sales representative or P&B Pro Shop distributor. Or, contact Potter & Brumfield Division AMF Incorporated, Princeton, Indiana 47671. Telephone: 812/385-5251.

European address: Electrical Products Group, AMF International Limited, AMF House, Whitby Road, Bristol B54 4AZ, England. Telephone: (0272) 778383, Telex: 449481, AMMAFOOO, BRSTL.

Go with the Pros and you can't go wrong.

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Circle 15 on reader service card

People

[*Electronics*, May 13, p. 34] in a 20,000-square-foot section of a Sprague building. In that capacity, Chenail is the man to watch as DEC strengthens its understanding of device processing and testing.

Strong technology base. He appears to be the right kind of man to get the job done. He spent 12 years at Sprague and four at Microsystems International Ltd., the now-defunct Canadian semiconductor manufacturer, and his career includes design, manufacturing management, and marketing. At MIL, he was vice president for marketing and sales. "I've always wanted to manage," Chenail says, "but I wanted a strong base in technology before I became a manager."

His experience in the semiconductor industry, particularly at MIL, taught Chenail that grandiose claims for process or design superiority are no substitute for delivery. Accordingly, he wants to build the capability to deliver ten times more than is now required of the Worcester plant, which was conceived as a second-source facility supporting any prime LSI supplier of parts to Digital Equipment. That's why DEC's n-channel and low-power Schottky processes are fully compatible with those of major semiconductor manufacturers.

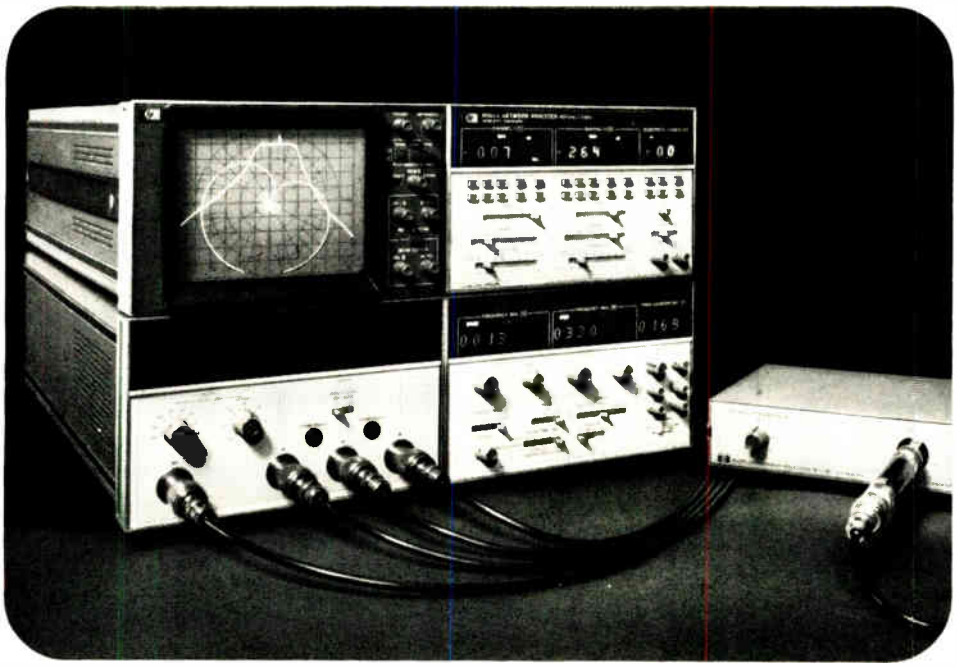
People integration. But Chenail's years in the semiconductor business also taught him that a big part of his job at DEC is to get device people to think more about the end use—the system—and to acquaint systems people fully with what LSI can do for them.

"We're trying to integrate an understanding of LSI back into the system groups," he asserts. "We don't want a semiconductor 'Taj Mahal' or a bunch of semiconductor 'young Turks' who don't understand the systems business. We're developing half-systems, half-device people."

For now, Chenail's prime personal goal is "to help create parts for DEC computer systems that make them more competitive because current semiconductor technologies are capable of delivering those products."

MEASUREMENT COMPUTATION NEWS
innovations from Hewlett-Packard

MAY 1976



in this issue

Broad line of instruments for the OEM

New HP-27 Scientific/ Financial Calculator

Synthesized outputs from 2 to 18 GHz

Advances in network measurements: new 1.3 GHz Network Analyzer measures all major parameters—including delay—over wide ranges with high resolution

The state-of-the-art for RF network measurements has moved significantly ahead with the introduction of the HP 8505A Network Analyzer. Over its extremely wide frequency range, 500 kHz to 1.3 GHz, this new analyzer measures the magnitude and phase of a network's transmission and reflection characteristics. Important in communications-related applications, the instrument also measures group delay and deviation from linear phase.

But the real story about the new analyzer is *how well* it makes these measurements! Major performance features include:

- Three independent input channe s, each with 100 dB displayed dynamic range.
- Dual-channel CRT display of swept-frequency response in rectilinear and polar form.
- High-resolution digital readout of measured parameters at any frequency within sweep range (frequency is counted directly).
- Direct measurement of group delay in both broadband and narrowband networks, (no charts or calculations needed).
- Direct measurement of deviation from linear phase using integral electronic line stretcher (with almost 5 wavelengths compensation range).
- Integral high-performance sweep oscillator with seven independent sweep modes and exceptional spectral characteristics.
- Simple yet complete programmability via the HP Interface Bus (HP-IB). Unique "Learn Mode" permits storage of manually-set control positions for later recall.

A wide selection of precision test sets are offered for use with the 8505A Network Analyzer. These include

(continued on third page)

IC Tester brings new economy, versatility and simplicity to testing

Five-function autoranging makes the HP 3476 the right decision

Set up this digital IC tester quickly with magnetic program cards. HP's low cost magnetic program cards are the key to lower cost testing—of primary importance with today's proliferation of IC types.

Insert an inexpensive magnetic programming card, and in five seconds this new multi-family Model 5045A digital IC tester is ready for dc parametric and functional testing of digital ICs. It's that simple—absolutely no other set-up or programming is needed. And it'll do some of your RAM and ROM testing too. Programming is so versatile that it can set-up a unique voltage and current level on each pin of the device under test within the limits of ±200 mA and 0 to 15V or ±7.5V range.

Flip a switch and the quiet built-in thermal printer prints out failure type, failed pins and the voltage and current on each failed pin. Use this data for diagnostic purposes, to detect failure trends, or to send back with the failed parts so the supplier can understand the reason for your rejecting his product.

We've also made your software problems as simple and inexpensive as we could. When you order a program type, we supply, for a very nominal cost, four cards: a pass/fail test card, diagnostic test card, and a duplicate of each for safekeeping. Our unique program coupon book makes purchasing programs simpler, faster and more economical. Buy a book of ten coupons and just mail us one whenever you want a program. There are 1000 devices in our standard program catalog right now and we're adding more all the time.

We've also simplified interfacing to a variety of automatic IC handlers. Order one of our standard options and the 5045A comes ready to plug into the handler—mechanical and electrical interfacing have been pre-arranged. All fast rise-time circuits are in a removable test head so they can be placed within inches of the IC tested.

Consider the large and ever growing number of IC types and you can quickly calculate how the low cost of the 5045A's program cards alone saves some users more than the cost of the tester itself....to say nothing of the money saved every day by the 5045A's simple, rapid, error-free operation and ability to handle a multitude of testing assignments. These HP cards are ¼ to ½ the cost of other available programs.

For additional information, check J on the HP Reply Card.

When you need to make measurements of current, voltage, or resistance, the HP 3476A/B will make your job faster and easier through complete autoranging on every function.

All readings are made directly in volts, kilohms, or amps—on an LED display. A rangehold button speeds and simplifies repetitive measurements.

There's no need to worry about polarity or zero...they're both automatic also.

It is *lightweight*: 0.77 kg (1 lb. 11 oz.), *compact*: 5.8 cm (2.3 in.) high, 16.8 cm (6.6 in.) wide and 20.6 cm (8.1 in.) deep.

You have a choice of AC power operation with the 3476A or, in the 3476B, AC power and rechargeable nickel-cadmium battery operation.

The 3476A/B was made possible through the perfection of a new microcircuit process—tantalum nitride on sapphire. All of the precision resistors required for the input attenuator are placed on a single chip. That means greater reliability and better temperature stability.

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

Compact new DMM with advanced circuitry and packaging resulting in high reliability. One circuit board contains all the electronics.

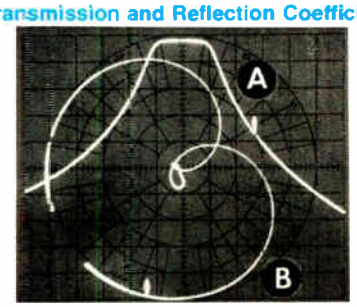
New network analyzer

(continued from first page)

HP 8502 high-directivity Transmission/Reflection Test Sets and HP 8503A S-Parameter Test Set (has HP-IB option) plus HP 11850 precision 3-way Power Splitters and several types of transistor test fixtures.

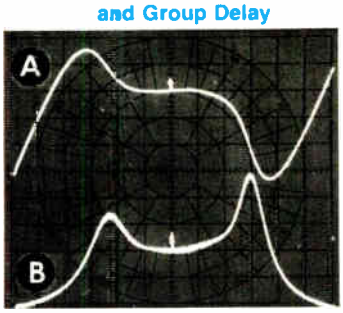
Examples of the measurement power of our new 1.3 GHz network analyzer:

Transmission and Reflection Coefficients



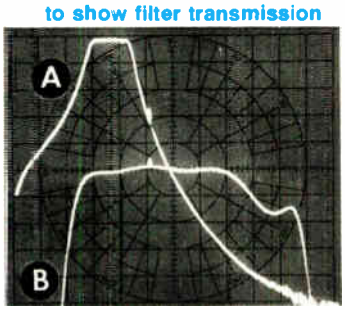
A. Transmission, 10 dB/div.
B. Reflection, (polar) full radius = 1

Deviation From Linear Phase and Group Delay



A. Deviation, 10°/div.
B. Delay, 5 ns/div.

Automatic Alternate Sweeps to show filter transmission



A. Total response, 10 to 500 MHz, 10 dB/div.
B. Passband response, 145 to 210 MHz, 0.1 dB/div.

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

New Interface for Real-Time HP-IB Minicomputer simplifies do-it-yourself assembly of automatic test and measurement systems

Now, system designers can connect HP-IB instruments, like the DVM, scanner, numeric display, thermal printer, timing generator, counter, and digital-analog converter shown above, to the powerful control, data processing, and storage capabilities of Hewlett-Packard Real-Time Minicomputers.

Automatic test and measurement systems using bus-connected instruments can now utilize the full power and flexibility of Hewlett-Packard's Real-Time Minicomputers with the addition of the new HP 59310B Hewlett-Packard Interface Bus (HP-IB) I/O Kit and real-time software Option 422.

The HP 59310B interface can serve up to 14 HP-IB instruments connected via standard bus cables. The Real-Time Minicomputer supports several HP 59310B interfaces at the same time for control of multiple instrument clusters for performing different functions or for optimizing throughput.

Over 35 different HP instruments currently mate with this IEEE Standard 488-1975 Digital Interface for programmable instrumentation. As a corporation, Hewlett-Packard is committed to steady growth in HP-IB capabilities.

With the Real-Time Minicomputer, initial setup requires only connection of instruments to the bus, setting of instrument talk/listen addresses, system generation, and programming. Programs in FORTRAN, HP Real-Time BASIC, or HP Assembly language can be developed on the Real-Time HP-IB Minicomputer at the same time it is controlling HP-IB instrument clusters.

A brochure describing the Real-Time HP-IB Minicomputer will be sent to you if you check G on the HP Reply Card.

HEWLETT-PACKARD OEM

With Hewlett-Packard, your OEM dollar buys more than just hardware

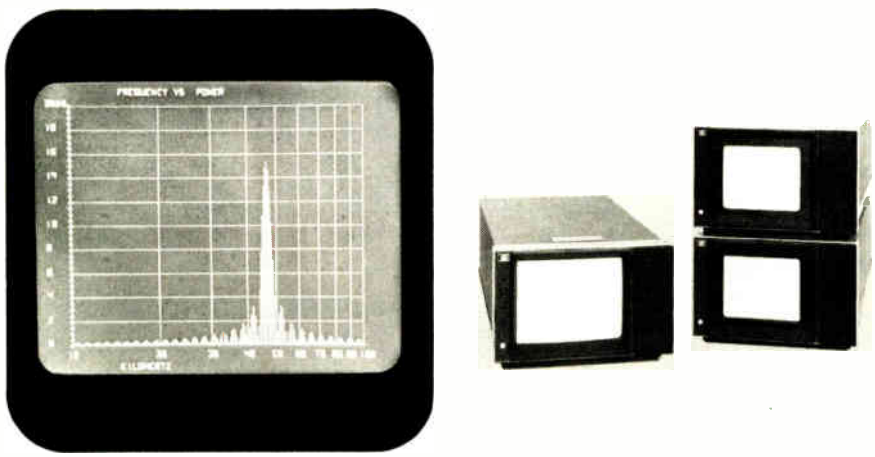
When you purchase OEM equipment from Hewlett-Packard, you are assured of product performance, service and applications assistance from a company that recognizes your reputation and success depend partly on the support you receive from your OEM supplier.

Confidence can be yours when you have HP instruments as part of your system. Complementing HP's reputation for leadership in new product development utilizing high technology is the knowledge that HP is ready to respond to your needs with over 3,000 sales, service and technical personnel located in 172 offices in 65 countries.

HP offers a highly competitive OEM discount structure across a wide selection of instruments. Through our purchase agreements, we can coordinate our equipment deliveries with your forecasted customer needs.

In addition, a wide selection of instruments can be custom tailored to meet your specific needs.

Choose an HP Display when your system needs a bright, sharp image



These HP high resolution CRT displays offer OEM users ease in integrating the modules into their packaging. Considerable effort has been taken in developing the structural, thermal and RFI characteristics.

End users of your OEM systems will judge capability by the information they are able to display. HP's 1332A, 1333A, and 1335A CRT displays make excellent choices for all types of systems—from spectrum, network, and chemical analyzers, to automatic test systems.

Each display has a very small spot size that focuses uniformly over the complete viewing area, regardless of writing speeds or intensity level. Fine image detail with excellent contrast and uniformity make them particularly well suited for applications involving complex graphics, especially those with alphanumeric data.

If you need a large viewing area and a brighter image at fast scan rates, consider the 1332A. The 9.6 × 11.9 cm viewing area offers superior performance.

For photographic recording of displayed data, the 1333A offers an extremely small spot size (.20 mm) for accurate photo evaluation.

The 1335A, a variable-persistence, storage, and non-storage display introduces a totally new CRT design. Erase, store, write, conventional or variable persistence can be selected with manual front-panel controls, remote program inputs, or a combination of both.

For convenience, all frequently used controls have been placed on the front panel for maximum accessibility.

Five large screen graphic displays are also available for OEM computer graphic and instrumentation applications. These models offer a linear writing speed of 25.5 cm/μs for visible writing.

Check C on the HP Reply Card for information on the HP 1310, 1311, 1317, 1321 large screen displays. For the smaller displays, 1332, 1333 and 1335, check D on the HP Reply Card.

A fine-line of recorders

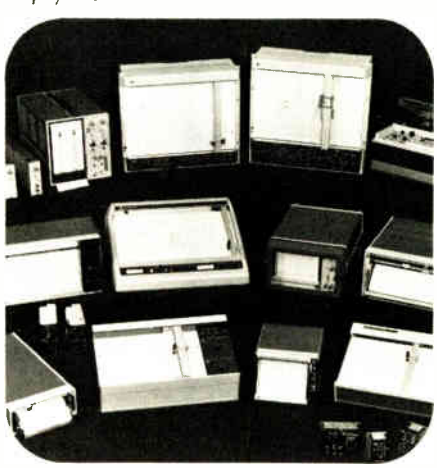
Hewlett-Packard offers a wide selection of analog recorders and graphic plotters designed to fulfill the needs for recording and displaying data in conjunction with your equipment.

X-Y recorders are available in two basic chart sizes built around a one-piece die-cast aluminum mainframe—a rugged platform for the modular features you select. These recorders are engineered for long, reliable service, even in harsh environments.

Three levels of performance parameters are available depending upon measurement needs. Certain models have high sensitivity and high common mode rejection. Metric and English scales are optional. Two-pen models are also available.

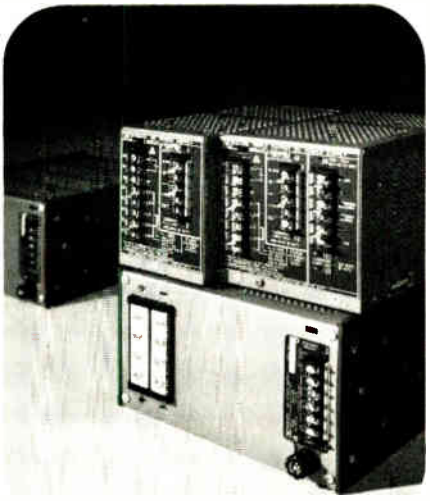
An OEM catalog describing other recorders and printers is available. Models include X-Y, strip chart, oscillographic, and instrumentation tape recorders, plus graphic plotters for computer, timeshare, and calculator use.

For your copy, check O on the HP Reply Card.



NEWS

Choose from 89 Models of OEM Modular Power Supplies



Switching and linear regulated OEM modular power supplies are available with rack mounting and power system accessories. All HP power supplies are UL recognized components.

You can select from five families of switching supplies that give top performance and reliability demanded by today's OEM. Ratings cover the range from 110 to 600 watts, with individual voltages from 4 to 48V in single output models. For smaller systems, there is a compact 110W triple output model with 5V, +12V to ±15V, and −12 to −15V outputs. All offer the benefits of technologically advanced 20 kHz switching regulation: high efficiency, small size, and low heat dissipation—factors that help cut your end-product size and cost.

Single and dual-output, linear regulated power supplies in the 6 to 200W range, with outputs from 3 to 48V are also available—in several different package designs.

A Special Design Group is ready to provide product modifications, assembled power systems, and applications assistance if the standard models do not meet your needs.

Complete specifications are contained in a new 20-page OEM brochure. Check P on the HP Reply Card.

HP's new microwave synthesized signal generators provide precision signals 2-18 GHz

Two new *fully programmable* microwave synthesizers are now available from Hewlett-Packard. The 8672A Synthesized Signal Generator covers the full 2-18 GHz range in one solid-state package only 5¼" high. With AM/FM and calibrated output usually associated only with signal generators, 8672A also offers the resolution, spectral purity, stability and programmability of a high-quality synthesizer. The complementary Model 8671A, provides 2-6.2 GHz with FM capability only and minimum +9 dBm output.

The broad 2-18 GHz range of the 8672A makes it ideal for use in ECM and broadband component testing. Frequency resolution is 1 KHz in the 2-6.2 GHz range, 2 KHz from 6.2-12.4 GHz, and 3 KHz from 12.4-18 GHz. Frequency stability is 5×10^{-10} per day.

The 8672A's exceptional spectral purity will be important for other applications such as satellite receiver testing. Spurious signals are more than 70 dB below the carrier at 6 GHz, −60 dBc at 18 GHz. SSB noise is more than −78 dBc, 1 KHz away from a 6 GHz carrier, and 109 dBc at 100 KHz offset.

True signal generator performance is achieved with calibrated output from +3 to −120 dBm. Ranges are displayed on a 2½ digit LED readout and internal leveling is flat to ±1.25 dB.

Amplitude modulation signals are externally supplied but internally monitored with an AM bandwidth of 500 KHz at 6 GHz and 100 KHz at 18 GHz. Metered and calibrated ranges are 30% per volt and 100% per volt.

Broadband frequency modulation is possible to 10 MHz rates and 10 MHz peak deviation. Six calibrated ranges from 30 KHz per volt to 10 MHz per volt monitor the input signal. Simultaneous AM and FM may be applied.

All front panel functions can be remotely programmed, via the HP Interface Bus, as a standard feature. Frequency will typically switch within 15 ms.

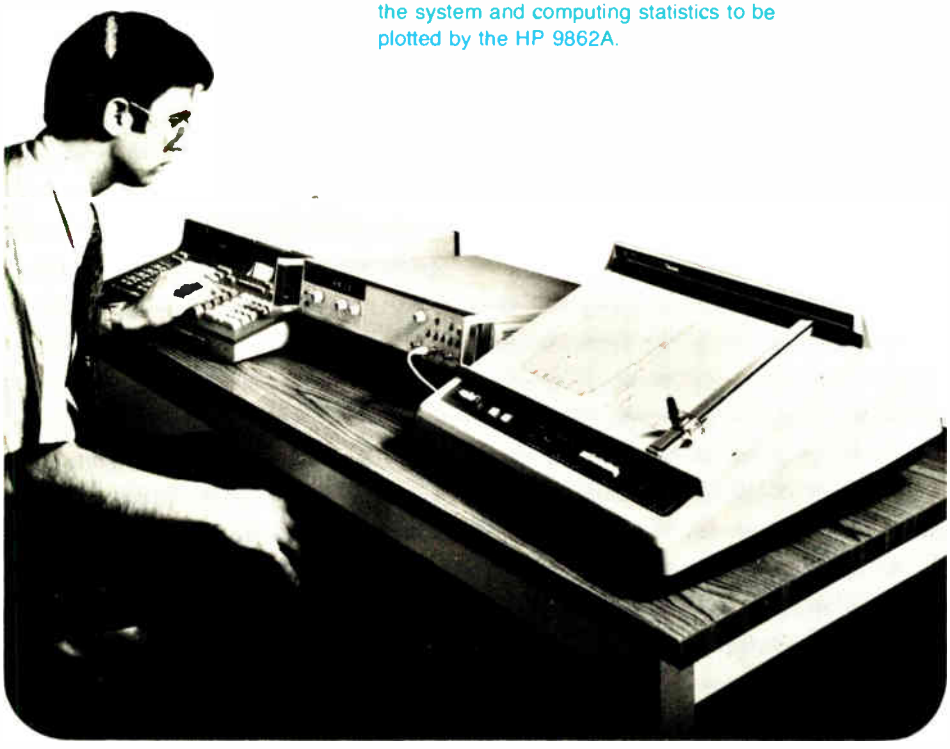
The HP 8671A Microwave Synthesizer (2-6.2 GHz) is ideal for many S and C band local oscillator applications, and offers the same wideband FM features as the 8672A.

For additional technical data, check M on the HP Reply Card.

The new HP 8672A Synthesized Signal Generator with wide dynamic range and exceptional stability provides features important to both broadband testing or to highly stable receiver tests.

New option adds complete "hands-off" operation to universal counter

Fully programmable front panel of 5328A universal counter facilitates assembling versatile measurement computation systems. System shown makes ordinary or statistical time interval and frequency measurements. An HP 9800 series programmable calculator is controlling the system and computing statistics to be plotted by the HP 9862A.



Add Option 041 to the Model 5328A Universal Counter for completely automated operation under computer or calculator control *plus* higher performance time interval measurements.

This new option adds full remote programming of all input signal conditioning controls. Trigger slope, trigger level, attenuators, AC-DC coupling, and 50Ω or 1MΩ input impedance can now be set remotely. This is in addition to all the other front panel controls which are remotely set by the Hewlett-Packard Interface Bus (HP-IB) Option 011, a requirement for this total capability.

Option 041 also significantly increases the resolution and versatility of the 5328A counter's time interval measurements. Included among the many improvements are 10 ns single shot time interval resolution and the HP exclusive jittered clock that can give more accuracy and certainty to averaged time interval measurements.

Combine Option 011 and 041 with the 5328A and you will have a counter that will simplify your automation and measurement tasks.

Other 5328A options available include a 512 MHz channel, choice of two types of built-in DVMs and an ultra-stable time base oscillator.

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

HP has integrated into the NEW HP-27 the most significant functions used by scientists and financiers

The HP-27 Scientific/Plus is the most powerful preprogrammed pocket calculator Hewlett-Packard has ever built.

Five new functions never before offered by HP include variance, correlation coefficient, normal distribution, net present value and internal rate of return.

You will be able to solve difficult scientific and statistical problems with the 28 math and trig functions, 15 statistical functions and 10 financial functions.

You can simplify complex calculations through the use of the 20 memories; store constants in 10 addressable registers; manipulate data in four operational stack memories.

Multiple clearing operations let you preserve data in some registers while preparing others for a new calculation.

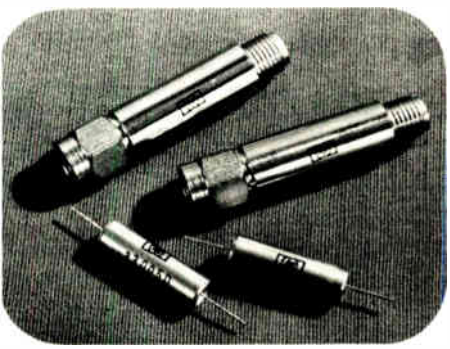
For today's engineer solving complicated equations or preparing budgets, cost analyses or forecasts, the HP-27 is an outstanding price/performance tool to assist in technical and resource management decisions.

Check A on the HP Reply Card.

The HP-27 offers all the scientific functions we've preprogrammed into earlier scientifics *plus* new stat and financial functions, new storage capacity, new clearing operations and engineering notation.

HEWLETT-PACKARD COMPONENT NEWS

Higher power for microwave impulse train generators



New coaxial step recovery diode modules are of rugged, reliable solid state hybrid integrated design.

Two new step recovery diode modules for comb generation are added to Hewlett-Packard's line. Model 33005C is a complete comb generator with dc return and 3mm connectors; Model 33005D is a cylindrical module with axial leads. Input frequency for both is 1000 ±50 MHz. Guaranteed output power at 18 GHz is −15 dBm with 0.5 watt drive. Applications include measurement of spectral behavior of linear components such as filters and slow wave structures, frequency and amplitude calibration of receivers and antennas, and reference frequency generation for phase locked systems.

When driven at the appropriate input frequency, the devices generate a train of narrow, high amplitude pulses at a repetition rate equal to the input frequency. The resulting comb spectrum consists of lines at all multiples of the input frequency up to and beyond 18 GHz.

Output pulses are typically 10 volts amplitude and 150 picoseconds wide with 0.5 watt drive at 1000 MHz. Input is matched to 50 ohms.

For technical data, check E on the HP Reply Card.

Two new hermetic LED displays with on-board decoder/divider

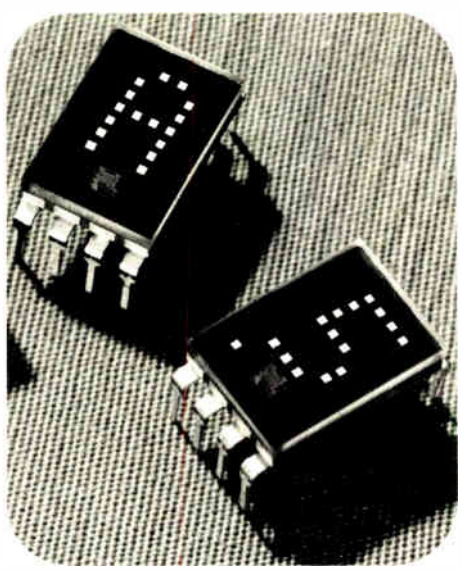
Two new series of LED 4×7 dot matrix numeric/hexadecimal displays are hermetically sealed for high reliability. Both displays provide a 7.4 mm (0.29") character height.

Models 5082-7356, -7357 and -7359 are intended for the industrial user who requires the degree of reliability offered by ceramic packages.

Models 5082-7391, -7392 and -7395 are intended for demanding requirements of military, satellite and spacecraft applications, and for industrial users demanding the ultimate in reliability.

These displays are categorized for luminous intensity assuring uniformity of light output from unit to unit within a single category.

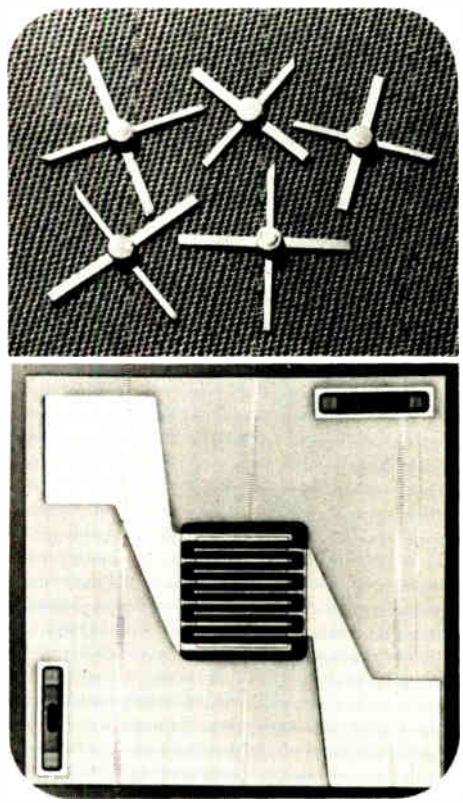
For more details on displays for high reliability applications, check H on the HP Reply Card. For less demanding applications, check I on the card.



New series solid state numeric and hexadecimal indicators with 5-bit memory designed for use in military and adverse industrial environments.

New ultra-low noise bipolar transistor with only 2.7 dB NF at 4 GHz

The chip is packaged in the HPAC-70GT, a rugged co-fired metal/ceramic hermetic package.



A new NPN bipolar transistor utilizing ion implantation techniques in its manufacture is provided with scratch protection over its active area.

Designers of ultra low-noise amplifiers will find this new microwave bipolar transistor ideal for use from 1 to 4 GHz in applications such as radar preamplifiers, ECM equipment, microwave links, broadband IF amplifiers and satellite systems.

The HXTR-6101 has a specified noise figure of 2.7 dB typical (3 dB max.) at 4 GHz and 1.5 dB typical at 1.5 GHz. Typical associated gain at NF conditions is 9.0 dB at 4 GHz and 15 dB at 1.5 GHz.

For further details, check N on the HP Reply Card.

We've revolutionized digital troubleshooting again—this time it's a current tracing probe

Put Hewlett-Packard's new Model 547A Current Tracer on or near a misbehaving logic circuit path and look for the light to illuminate at its tip. Now, you're on your way to solving some of digital logic troubleshooting's most difficult problems—you know just where logic current pulses from 1 mA to 1A are flowing...even in multilayer circuit boards...and for all logic families.

You'll be able to perform the following quickly and economically:

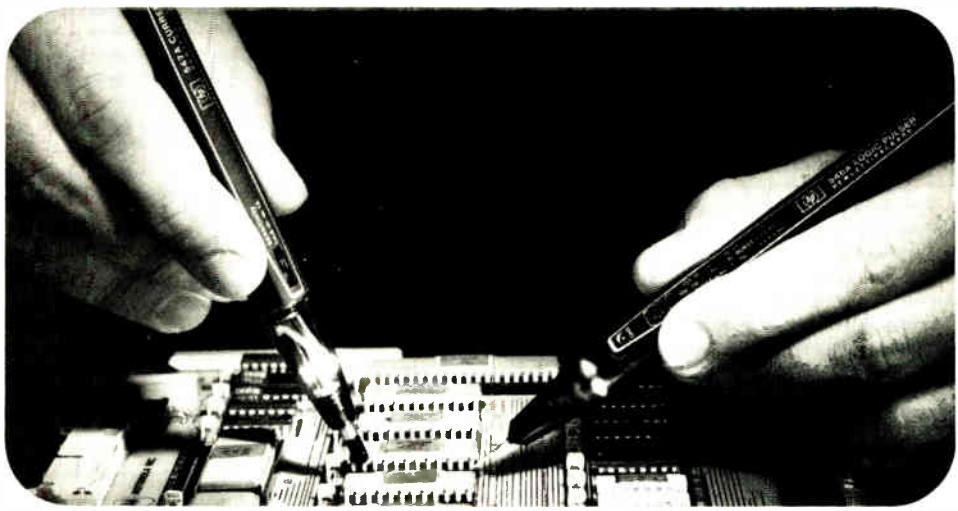
TROUBLESHOOT:

- Wired - AND/OR busses
- Three-state busses

PINPOINT:

- The one bad IC on a stuck node
- Hairline cracks/solder bridges
- Backplane/motherboard shorts

On a shorted node, all points are stuck in one state by the short. Many stuck node troubleshooting problems, particularly in wired-AND/OR configurations, result in wasted time and excessive costs since several ICs have to be removed before finding the bad one, and in the process, the circuit board may be damaged. Now, the 547A exactly pinpoints the one faulty point on a node. How do you determine that your circuit problem is a stuck node? With a voltage-sensitive logic probe like the new, all-family Model 545A announced in the March/April issue of Measurement/Computation News.



The Current Tracer's highly sensitive, shielded magnetic sensor precisely locates low impedance faults in digital circuits by "sniffing out" current sources or sinks in all logic families. If current pulses are needed, use the new programmable 546A Pulser to supply them.

The lamp in the 547A Tracer's tip indicates single-step current transitions; single pulses ≤50 ns wide; pulse trains to 10 MHz (typically 20 MHz for pulses ≤ 10 mA). Sensitivity is 1 mA for risetimes ≤200 ns and is adjustable up to 1A via a fingertip control. Power it from 4.5 to 18 Vdc, ≤75 mA.

If there's no current in the circuit or branch you're testing, you can supply it with our new Model 546A Logic Pulser. It's programmable to give one pulse per command, a 1, 10 or 100 Hz stream, or a burst of exactly 10 or 100 pulses. So now you can set your circuit into its 852nd clock pulse state if you wish. It'll produce lots of short duration current to drive TTL or CMOS high nodes low or low nodes high—automatically and without harm to the circuit. Use it as pulse source for troubleshooting with logic probes, too. It's an amazingly capable pulse generator—especially for its small size.

Circle B on the HP Reply card and we send data on all the above, and on our Logic Clip and Logic Comparator, too.

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Meetings

Chicago Spring Conference on Consumer Electronics, IEEE, Marriott Motor Hotel, Chicago, June 7–8.

National Computer Conference, IEEE et al., New York Hilton, Americana Hotel, and New York Coliseum, June 7–10.

Hybrid Microcircuits Symposium, U.S. Army Electronics Command, Fort Monmouth, N.J., June 8–9.

Power Electronics Specialists Conference, IEEE, NASA Lewis Research Center, Cleveland, Ohio, June 8–10.

International Microwave Symposium, IEEE, Cherry Hill Inn, Cherry Hill, N.J., June 14–16.

Electrical Insulation International Symposium, IEEE, Queen Elizabeth Hotel, Montreal, Que., June 14–16.

ICC '76 International Conference on Communications, IEEE, Marriott Motor Hotel, Philadelphia, June 14–16.

Joint MMM-Intermag Conference, IEEE and AIP, Hilton Hotel, Pittsburgh, June 15–18.

Fault-Tolerant Computing Conference, IEEE, Chatham Center, Pittsburgh, Pa., June 21–23.

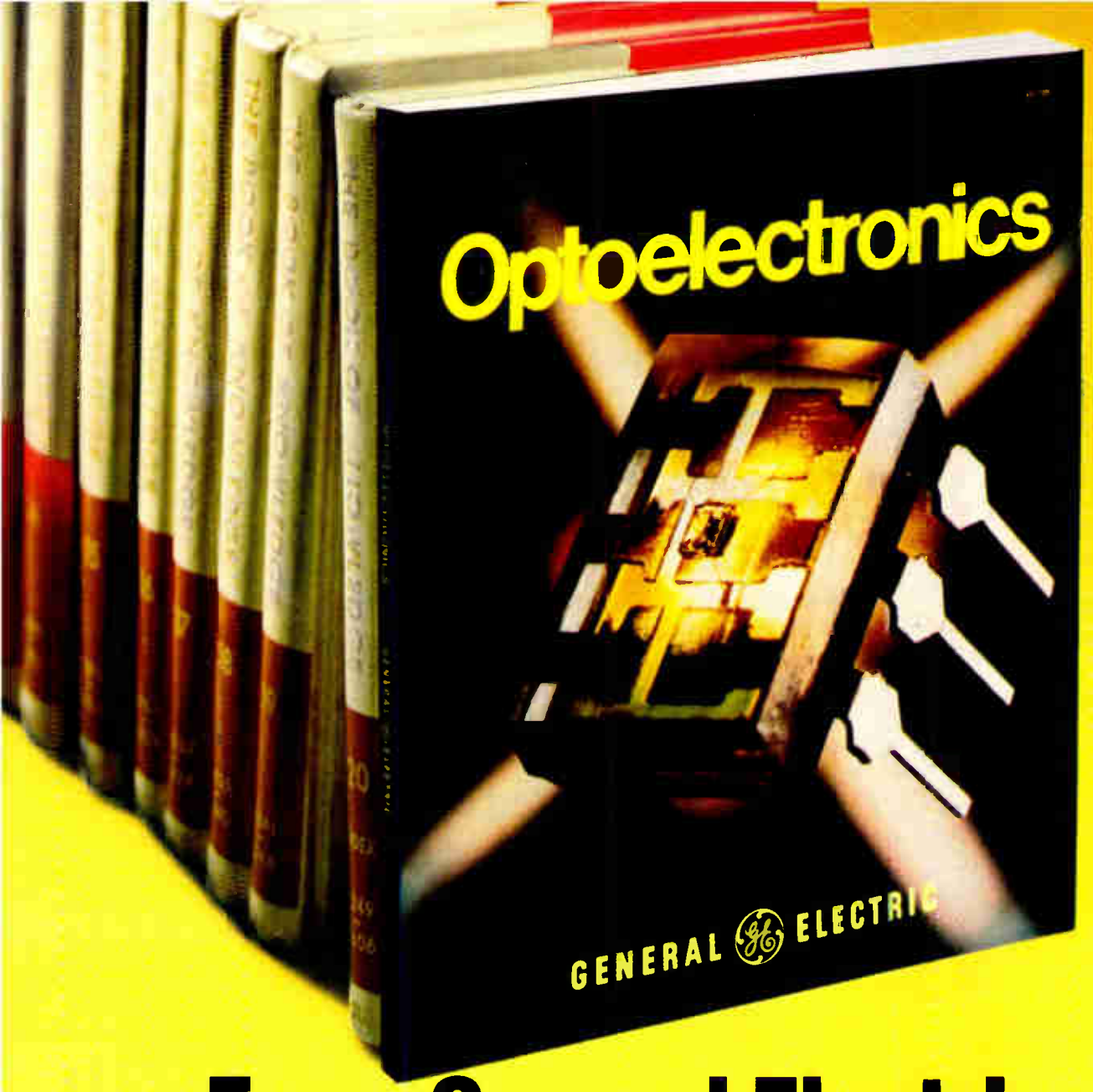
Device Research Conference, IEEE, University of Utah, Salt Lake City, June 21–23.

Electronic Materials Conference, AIME, University of Utah, Salt Lake City, June 23–25.

13th Design Automation Conference, ACM and IEEE, Rickey's Hyatt House, Palo Alto, Calif., June 27–29.

Conference on Precision Electromagnetic Measurements, IEEE, NBS, and URSI, NBS Laboratories, Boulder, Colo., June 28–July 1.

Symposium on Frequency Standards and Metrology, NBS and URSI, Copper Mountain, Colo., July 5–7.



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GENERAL ELECTRIC

The Battle of the 80's

Think of your next microcomputer as a weapon against horrendous inefficiencies, outrageous costs and antiquated speeds. We invite you to peruse this chart.

Features:	8080A	Z80-CPU	Features:	8080A	Z80-CPU
Power Supplies	+5,-5,+12	+5	Instructions	78	158*
Clock	2Φ,+12 Volt	1Φ,5 Volt	OP Codes	244	696
Standard Clock Speed	500 ns	400 ns	Addressing Modes	7	11
Interface	Requires 8222, 8228 & 8224	Requires no other logic and includes dynamic RAM Refresh	Working Registers	8	17
			Throughput	Up to 5 times greater than the 8080A	
Interrupt	1 mode	3 modes; up to 6X faster	Program Memory Space	Generally 50% less than the 8080A	
Non-maskable Interrupt	No	Yes	*Including all of the 8080A's instructions.		

Announcing Zilog Z-80 microcomputer products. With the next generation, the battle is joined.

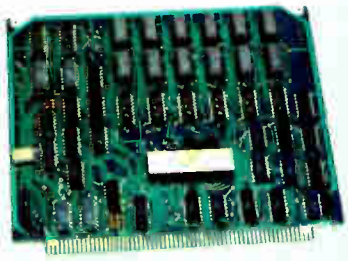
The Z-80: A new generation LSI component set including CPU and I/O Controllers.

The Z-80: Full software support with emphasis on high-level languages.

The Z-80: A floppy disc-based development system with advanced real-time debug and in-circuit emulation capabilities.

The Z-80: Multiple sourcing available now.

Your ammunition: A chip off a new block.



A single chip, N-channel processor arms you with a super-set of 158 instructions that include *all* of the 8080A's 78 instructions with *total* software compatibility. The new instructions include 1, 4, 8 and 16-bit operations. And that means less programming time, less paper and less end costs.

And you'll be in command of powerful instructions: Memory-to-memory or memory-to-I/O block transfers and searches, 16-bit arithmetic, 9 types of rotates and shifts, bit manipulation and a legion of addressing modes. Along with this army you'll also get a standard instruction speed of 1.6 μs and all Z-80 circuits require only a single 5V power supply and a single phase 5V clock. And you should know that a family of Z-80 programmable circuits allow for direct interface to a wide range of both parallel and serial interface peripherals and even dynamic memories without other external logic.

With these features, the Z80-CPU generally requires approximately 50% less memory space for program storage yet provides up to 500% more throughput than the 8080A. Powerful ammunition at a surprisingly low cost and ready for immediate shipment.

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- 4K Bytes of ROM/RAM Monitor software.
- Real-Time Debug Module and In-Circuit Emulation Module.
- Dual Floppy Disc System.
- Optional I/O Ports for other High Speed Peripherals are also available.
- Complete Software Package including Z-80 Assembler, Editor, Disc Operating System, File Maintenance and Debug.

On standby: Software support.

All this is supported by a contingent of software including: resident microcomputer software, time sharing programs, libraries and high-level languages such as PL/Z.

On standby: User support.

Zilog conducts a wide range of strategic meetings and design oriented workshops to provide the know-how required to implement the Z-80 Microcomputer Product line into your design. All hardware, software and the development system are thoroughly explained with "hands-on" experience in the classroom. Your Zilog representative can provide you with further details on our user support program.

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The Zilog Z-80 brings to the battlefront new levels of performance and ease of programming not available in second generation systems. And while all the others busy themselves with overtaking the Z-80, we're busy on the next generation—continuing to demonstrate our pledge to stay a generation ahead.

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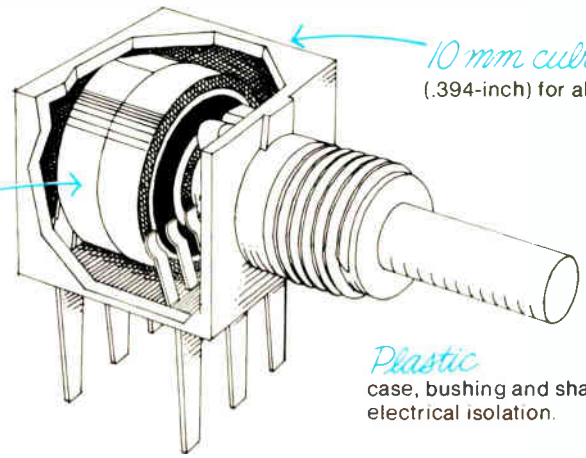
100 ohms to 1 megohm
conductive plastic resistance elements, ±20% tolerance, standard resistance values conform to IEC.



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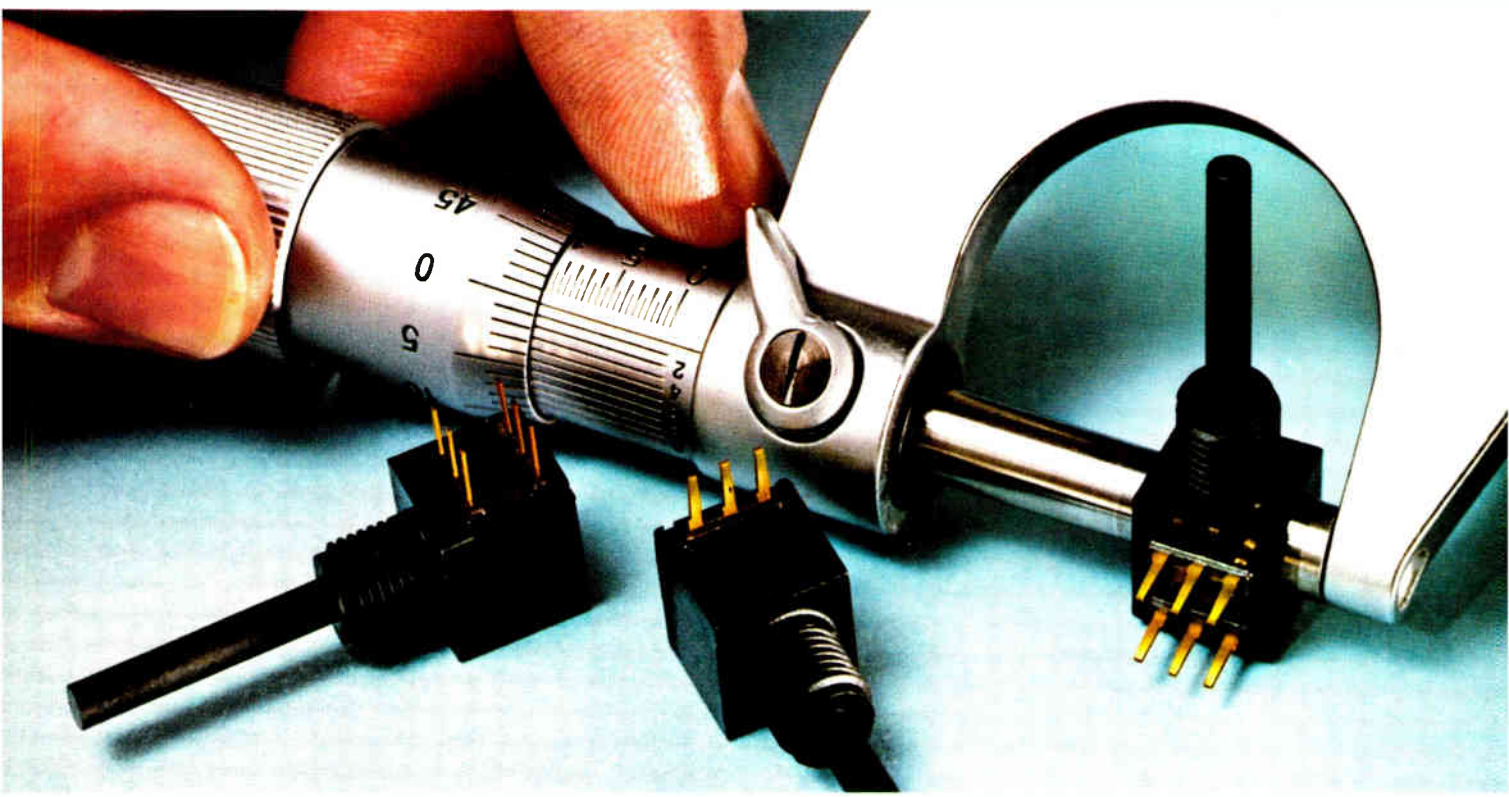
case, bushing and shaft for electrical isolation.



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EC131

Electronics newsletter

ICs to pass discretes in 1976 shipments

Shipments of integrated circuits are expected to exceed those of discrete devices in 1976 for the first time—$2.5 billion versus $2.4 billion. That forecast is in the just-released third annual semiconductor forecast by WEMA, the West Coast-based trade association for electronics firms. During 1975 the two categories ran almost even: $2 billion for discretes and $1.9 billion for ICs.

The WEMA report also predicts **worldwide shipments of semiconductors will be up 24% in 1976 over 1975**—$4.986 billion vs $4.028 billion. The total is expected to rise 20% to $5.971 billion in 1977 and another 12% to $6.999 billion in 1978. (During 1975, by comparison, semiconductor shipments declined 17% from 1974).

Of the total output of semiconductors expected in 1976, about 46% will be consumed in the U.S. Among the major product groups covered in the forecast, ICs in general are expected to jump 31% in shipments in 1976, 26% in 1977, and 17% in 1978. MOS devices will grow by 35% to $1.112 billion in 1976, 31% in 1977, and 22% in 1978. Bipolar devices will rise 25% to $841 million in 1976, 19% in 1977, and 9% in 1978. Linear devices will increase by 35% to $583 million in 1976 and discretes by 17% to $2.450 billion.

Texas Instruments to offer samples of bicolor LEDs

Watch for Texas Instruments to start supplying samples of bicolor light-emitting diodes this summer. Though the firm's optoelectronics team in Lubbock, Texas, **has designed a single chip that changes colors at different current levels,** it has chosen to go with two-chip packages, in which the polarity of the current determines which of two differently colored LEDs, wired in reverse parallel, will turn on.

TI is also packaging two LEDs of the same color back to back, in the hope that the devices will have a wide appeal as replacements for incandescents. With the addition of just a current-limiting resistor, the bidirectional package can be driven with ac—no blocking diode is necessary.

Data Precision to offer $189 3½-digit multimeter

Data Precision Corp. will enter a new, lower price range next month when it introduces a 3½-digit (2,000 count) multimeter selling at $189 **that offers even more than the Wakefield, Mass., company's hot-selling 4½-digit model 245.** While the older 245 lacks a 100-millivolt full-scale range, the new entry will measure five ac or dc ranges from 100 mV to 1,000 volts, plus five ranges of current and six ranges of high or low current resistance. The 100-mV range gives the 175 the same 100-microvolt resolution as the model 245, which lacks this range. Absolute accuracy on most ranges is within 0.1% of input, ±1 least significant digit, measured at 23°C, ±5°C, with a full year between calibrations. The unit has a frequency response to 50 kilohertz, with accuracy at that level rated at 3% of input, ±2 least significant digits.

RCA op amp takes on 741

RCA's Solid State division has extended the range of its mixed bipolar-MOS linear technology with a new operational amplifier that the Somerville, N.J., semiconductor supplier hopes **will bump out the 741 as the new industry standard.** The device, the CA3140, is built with the same MOS

input stage and bipolar gain stages as RCA's popular 3130 op amp, except that now designers have added internal compensation, high-voltage operation (4 to 44 volts) and 1,000-V input protection, making it a natural for general-purpose 741 slots. Input specs are excellent (current of 10 picoamperes, offset voltage of 5 millivolts) thanks to RCA's interdigitated MOS input stage, while ac performance (gain-bandwidth of 4.5 megahertz, plus slew rate of 9 V per microsecond) is quite respectable.

All-electronic phones to be installed by Bell Canada

Bell Canada will steal a march on the rest of the world in August when it scatters 200 of its E-phones (for all-electronic) across Canada for field tests. Even the ring will be electronically generated. The extensive use of LSI circuitry permits **all circuitry to be installed in the handset,** leaving the base free for added features such as a calculator, tape recorder, or memory for other devices.

National to build I^2L version of bipolar static RAM

Although many semiconductor industry insiders said that integrated injection logic was not a viable memory technology, there has been a sudden burst of product announcements. Now, National Semiconductor will make available in late June or early July its **45-nanosecond version of Fairchild's Isoplanar 93415-A** 1,024-bit bipolar static random access memory.

Designated the DM93415, National's bipolar device achieves its speed and small 100-by-100-mil chip size by combining oxide isolation and I^2L circuit techniques. Work is also in progress on a static 4,096-bit bipolar RAM with speeds in the 100-ns range that should be available in sample quantities by late 1976.

Digital thermometer can be submerged

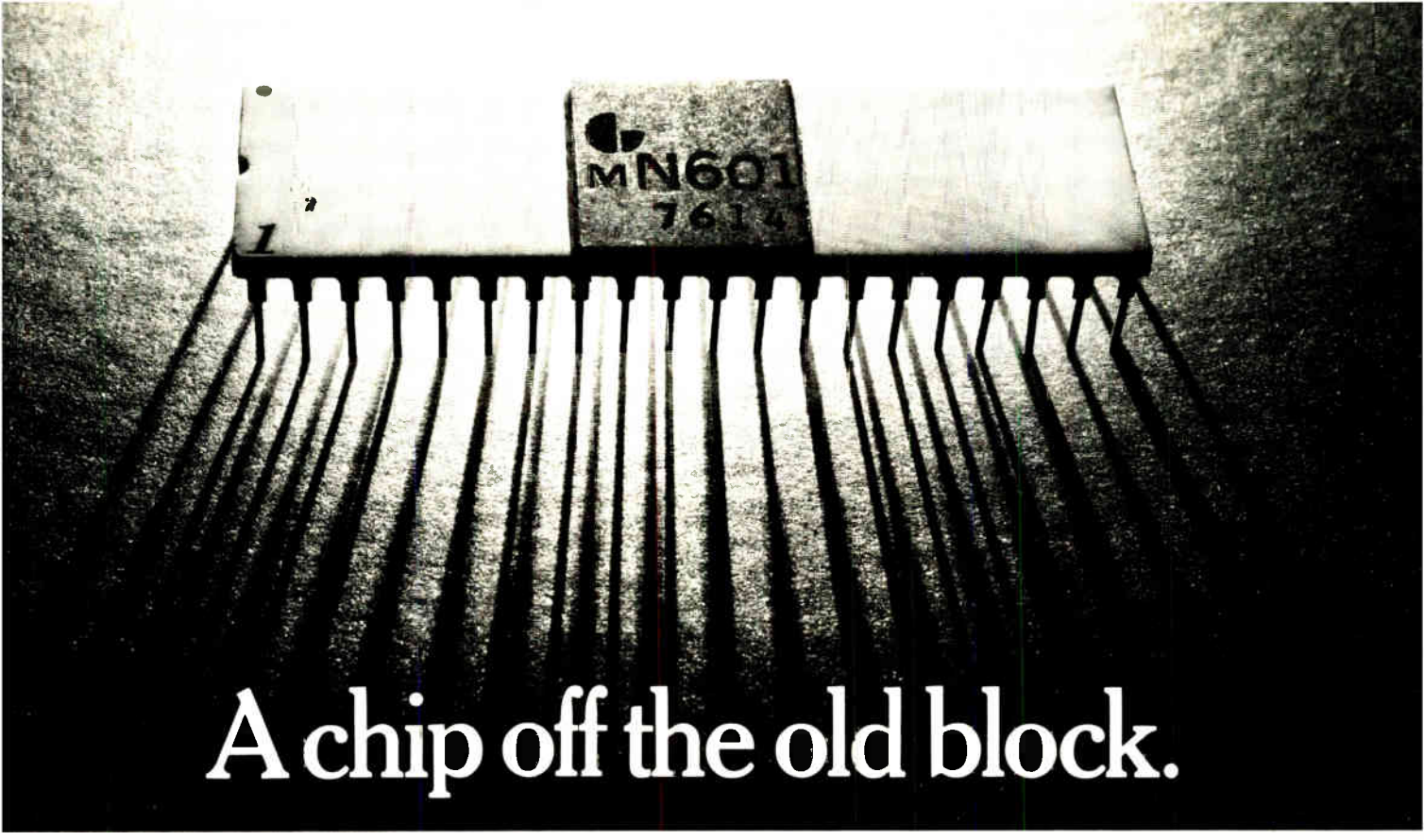
An innovation in digital thermometers, from ECD Corp., Cambridge, Mass., is a totally submersible and splash-proof device. Now in prototype, **it is expected to be used in component-temperature testing as well as chemical, photographic, and medical laboratories.** The instrument's target price is $189.

Fairchild readies line of watches in plastic cases

Fairchild Camera and Instrument Corp. is about to jump into the plastic-cased digital watch market already occupied by Texas Instruments and National Semiconductor. **Fairchild plans to announce next month several $19.95 five-function watches.** In addition to the plastic-cased models, the same C-MOS module will be used in a $25 metal-cased family to be announced at about the same time.

Addenda

Look for Hewlett-Packard to revise its 300 series minicomputers upward to a region where **it will compete with the DEC System 20 and the smaller models in IBM's System/370 series.** . . . The search for a general manager for Motorola's Integrated Circuits division is drawing to a close, in the view of John Welty, general manager of the division's parent Semiconductor Group. "We hope to choose him and have him on board **by the end of the second quarter,"** says Welty.



A chip off the old block.

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

As you can't see, it's a NOVA® computer.

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

The mN601 is the first microprocessor designed and manufactured by a minicomputer company. And it's the highest performance NMOS microprocessor on the market. With our 160 nanosecond RAM, it has a memory cycle time of 960 nanoseconds and the fastest instruction times going. Like an Add of 2.4 microseconds. And a Load of 2.9 microseconds.

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

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

And all that computer is in a single chip.

And because the mN601 is a NOVA, it uses the most mature, field-proven software you can get with any micro. So you can cut back on development time and cost by using compatible software like our diskette-based Disc Operating System and our Real-Time Operating System.

Also, the mN601 comes with the full documentation support you'd expect from a minicomputer company like Data General.

If you want more than a chip, you can get it. There's a whole chip set, a 4K computer-on-a-board and a fully-packaged 9-slot microNOVA MOS mini. And there's more.

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Circle 37 on reader service card

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Data Precision's Model 3500 5½ digit multimeter gives you more at reduced costs.

1. BCD Output and Digital Control

Parallel BCD output and digital control signal capability at *no extra cost.*

2. Ratio Measurements

DC/DC and AC/DC ratio measurement capability at *no extra cost.*

3. High Normal Mode and Common Mode Rejection

Model 3500 performance is significantly more effective in rejecting normal mode and common mode signals up to 80dB NMRR and up to 160dB CMRR.

4. Hi-Frequency Measurements

The Model 3500 AC voltage measuring capability is specified up to 100KHz.

5. High and Low Range ACV Measurement Capability

Provides a measurement capability of AC voltages on 5 range scales, including the low scale with 1μV resolution and a high scale to 700 volts RMS.

6. Zero Stability

Model 3500 incorporates Tri-Phasic ™ autozeroing performance eliminating the need for zero adjustment between measurements on any range and any function.

7. Price

High quality performance and accuracy for $995 complete.

The Model 3500 has a 6 months basic DC accuracy of ±0.007% of reading ±1 LSD, full autoranging from 1 microvolt to 1000V (DC or AC peak) and 1 milliohm through 12 Megohms resistance, 20% overranging and an easy-to-read ½ inch planar display.

The Model 3500 also features our Tri-Phasic ™ conversion cycle, Ratiohmic ™ resistance mode, and Isopolar ™ referencing, circuit techniques that increase performance and decrease price.

To arrange an immediate demonstration or for technical data and a comparative analysis of the Model 3500 contact: Data Precision, Audubon Road, Wakefield, MA. 01880 (617) 246-1600. TELEX (0650) 949341.

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...years ahead

Navy to test fiber optics aboard a sub

Analog link for a sonar array will use DuPont plastic cable; goal is inexpensive alternative to usual twisted-wire pairs

The Navy will be testing a fiber-optic link aboard one of its submarines early this summer, hoping eventually to replace heavy copper wiring with lighter, interference-free cables. The 52-channel analog link for a sonar array is being installed by the New London Laboratory of the Naval Underwater Systems Center, New London, Conn.

"We are using here-and-now technology without overspecifying components to show that optical fiber cabling is a relatively inexpensive alternate to shielded, twisted-wire pairs," says Fred Allard, a principal investigator for the fiber optic programs at the Center. DuPont Co.'s PFX0715 plastic-fiber cable will be used in the upcoming sea trials, with the sonar operated against real, not simulated, underwater targets.

Each cable, which is available commercially, houses seven optical fibers grouped in a closely packed hexagonal array that is jacketed with an opaque polyethylene for protection. The core material is polymethyl methacrylate sheathed in an optical insulator of lower refractive index.

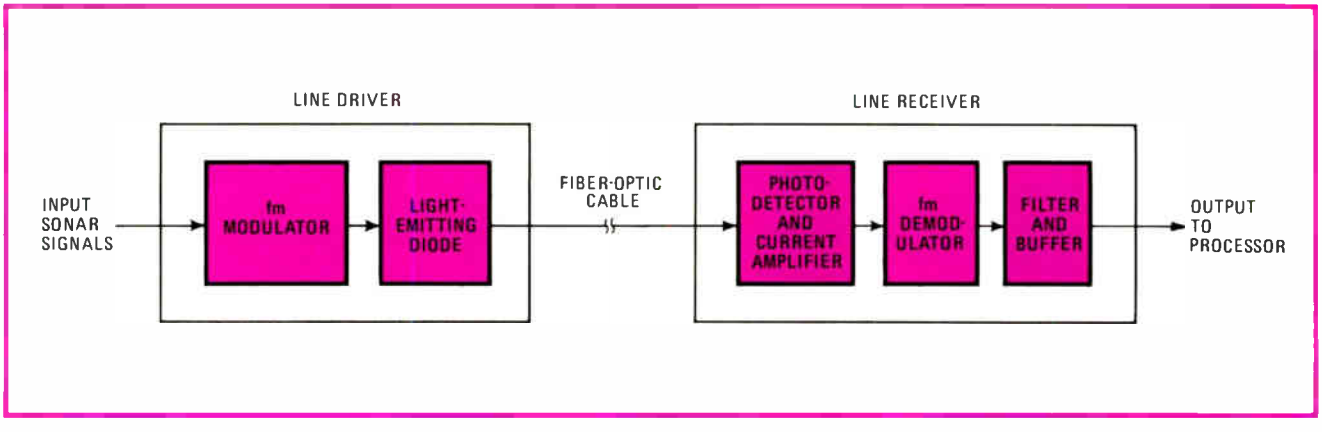
Special converter. To operate with the fiber-optic links, the Navy has built a 52-channel converter that translates the electrical output from the sonar to light signals at the transducer end and then back to electrical signals at the signal processor. The approach is straightforward, as shown in the figure below. The output of the sonar transducer is amplified and, in a line driver module, used to drive an fm modulator whose signal is applied to a light-emitting diode. Demodulation takes place in the line receiver module, with the demodulated output fed to the sonar processor.

According to Allard, it is hoped the tests will prove the ability of fiber optics to handle actual sonar data with accuracy at least comparable to what's obtained with conventional twisted wire. The Navy hopes to obtain a system capability of 100 decibels of dynamic range, crosstalk of less than 100 decibels, and harmonic distortion of less than 1%. Short-term reliability and maintainability as well as low cost are other musts for the link.

"We opted for plastic cables because they don't break the way some glass cables do," Allard explains. "And nothing is more cost-effective than plastic for our needs right now." He puts the cost per channel at about $100 in small quantities for everything but the cabling. The cable is priced at $3.30 per meter and has connectors at both board and cabinet level.

The light source for the line driver is an off-the-shelf Fairchild Semiconductor light-emitting diode priced at less than $2 in small quantities. Off-the-shelf integrated-circuit voltage-controlled oscillators

Light converter. In the developmental system, electrical signals in each sonar channel are converted to light for transmission in a 52-channel fiber-optic link. At receiver end, light is converted back to electrical signals for further processing.



(for the modulator) and connectors and hardware are also used. Cable cost, which Allard concedes is relatively high now, is expected to drop considerably once the manufacturer begins turning out larger production quantities.

The same is true for the photodetector/amplifier made by Control Products division of Devar Inc. At about $30 each, these small semiconductor devices are the most costly components in the modules.

If the tests prove successful, the next steps, says Allard, are to refine the cable and connector designs, miniaturize the line driver and receiver modules, and then integrate it all into the existing sonar system. □

Military

Air Force radar balances its costs

With performance and reliability balanced against acquisition cost and ease of maintenance, a new multimode radar for the Air Force is undergoing some arresting compromises. For one thing, the developer, Westinghouse Defense & Electronic Systems Center, Baltimore, found it could provide a more cost-effective system by lowering the mean time between failure to less than half the original specification.

Bomber bound. The design philosophy of the new system—called the electronically agile radar—was detailed last week in a joint presentation by the Air Force Avionics Laboratory, Dayton, Ohio, and Westinghouse at the National Aerospace and Electronics Conference in Dayton. About halfway through a 50-month design and development schedule, the $23 million EAR is intended for the manned strategic bombers—the B-1, B-52 and FB-111—of the next decade.

The radar is a phased-array system that will have more functions than three other radars in the Air Force inventory but cost no more. By combining electronic beam shifting and digital processing of radar returns, EAR will be capable of: terrain following and avoidance for low-altitude penetration to escape detection by ground-based radars; Doppler velocity measurements to compensate for an inertial navigation system's velocity drift; forward-looking ground mapping, plus a beacon-locating capability for ground support and in-flight tanker rendezvous. An air-to-air defense capability can be added later.

Target purchase price for the system is $640,000 in 1970 dollars, according to Westinghouse, which stresses that "cost of ownership over the life of the radar is the primary design criterion."

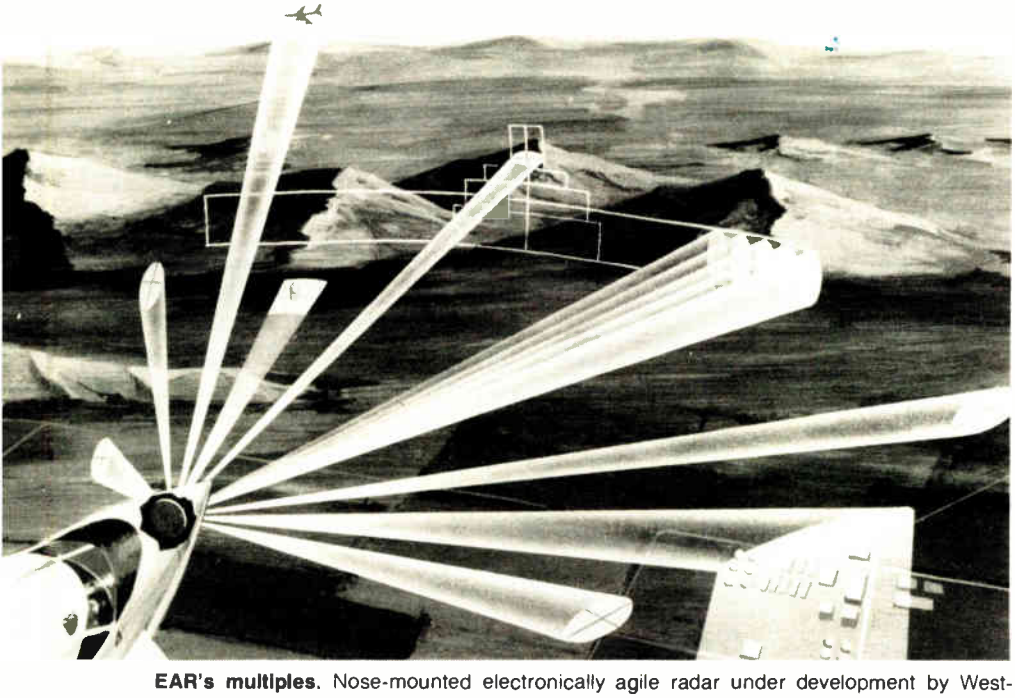
Tradeoffs. This is where Westinghouse is doing its balancing act. For example, Westinghouse says that by lowering mean time between failure to 130–150 hours from the original spec of 325 hours, the system became more cost-effective. Usually, lower MTBF implies higher maintenance outlays.

Key to the reduction is the use of EAR's digital-signal-processing capability with the system's minicomputer—the Westinghouse EP model—for built-in testing and fault-isolation. Built-in testing "should isolate 95% of the radar faults to a single line-replaceable module," which will be small enough to ship to a depot for repair.

Another cost-reduction effort is underway on the ferrite phase shifters being developed by subcontractors Raytheon Co. and Microwave Applications Group. The antenna's phase shifters account for about 10% of the radar's total cost, and Westinghouse wants their number cut from 2,000 to 1,818.

Other typical performance trades affecting design and price include elimination of a strip-mapping mode, halving of the transmitter's classified average power, and eliminating an entire liquid-cooling loop.

Redundancy. To keep EAR's probability of mission success high and costs down, Westinghouse has opted for what it calls "structured redundancy"—a technique that duplicates some critical components but not all, as is now required in ter-



EAR's multiples. Nose-mounted electronically agile radar under development by Westinghouse uses electronic beam shifting plus digital processing of returns for simultaneous all-weather terrain following and avoidance, navigation update, mapping and beacon locating. An air-to-air defensive capability (top left) could be added later.

rain-following radars. The transmitter subsystem is duplicated, but redundancy in the radar's digital signal processor is limited to one line-replaceable module. That module can be automatically cut in should one of the processor's 13 online modules fail.

Flight tests of one of the four development radars on board a B-52 are to begin in October 1977. With the tests, the Air Force and Westinghouse hope to prove the 34-inch diameter of the EAR antenna, larger than any of the other radars it replaces, plus its greater output power, will significantly increase resolution and target detection and improve resistance to electrical interference. □

SIRCS winners named

The Navy has picked teams led by McDonnell Douglas Astronautics Co., Huntington Beach, Calif., Raytheon Co.'s Missile Systems division, Bedford, Mass., and RCA Corp.'s Government and Commercial Systems division, Moorestown, N.J., to lead the concept formulation studies on the Shipboard Intermediate Range Combat System. The nine-month studies will be carried out in parallel. Unsuccessful team leaders submitting proposals for these studies were General Dynamics Corp., General Electric Co., Grumman Aerospace Corp., and Hughes Aircraft Co. [*Electronics*, Feb. 5, p. 49]. Each award is for about $1.5 million.

Winners of the parallel study awards will be required at the end of their effort to submit reports limited to 1,885 pages in six volumes, the last of which must contain their proposal for the second-stage validation phase. Two contractors for this phase are planned to be named in the second quarter of 1977. In addition to an executive summary, the concept development reports will include volumes dealing with technical considerations, cost analysis and methodology, ship integration, plus support and maintenance.

Navy seeks ideas for fleet defense

Conceptual design of a new fleet defense system for the 1990s and beyond has begun with the Navy's first contracts to industry for parallel definition studies, each to run nine months. The program for the Naval Sea Systems Command, Washington, is called Sircs (Shipboard Intermediate Range Combat System) and is the start of a major effort to counter an expanding Soviet blue-water fleet.

Despite its bagful of defense systems against specific threats being developed for the late 1970s and 1980s, the Navy wants Sircs as an integrated shipboard system for the 1990s. The new combat system will be modular to permit installation on ships ranging in size from giant strike carriers down to 1,000-ton support ships. After completion of concept-definition studies, two of three competing contractors will be selected in mid-1977 to continue on with the second phase of concept validation, or advanced development (see "Sircs winners named").

Threats. Precisely what the Navy sees as the air and surface threat to the fleet some 15 to 20 years hence is classified, of course. But one industry official likens it to what evolved in the Pacific near the end of World War II: "Remember the Kamikazes? They raised hell with our carriers until the Navy was able to throw together a makeshift system to put up a curtain of defensive fire around the ships. The concept of Sircs may be not much different, except that it won't be makeshift. It will be integrated, and the mix of target sensors, trackers, missiles and guns will be much more sophisticated," in terms of the way fire power from a fleet of ships is distributed.

Moreover, in the intermediate range—out to the horizon—Sircs plans some offensive capabilities against surface and shore targets, according to Defense Research and Engineering chief Malcolm Currie. He said earlier this year, in justifying the need for Sircs before Congress, that it will use existing systems, improved versions of existing systems, or replacement systems as is found necessary to meet the Soviet threat.

By its nature, Sircs will have to interface with certain major sensor, command and control, and weapons systems already in or destined for the Navy inventory. Two examples of such "must" systems are the Naval Tactical Data System, an automated command-and-control system that provides real-time combat information for controlling ships, submarines and tactical aircraft, and RCA Corp.'s Aegis surface-to-air missile defense system. Still in development and testing, Aegis relies on an advanced radar concept plus General Dynamics' SM-2 intermediate-range Standard missile for ship air defense.

Response. Just what the weapons system mix should be is what the Navy expects to learn from its first contract studies. It has given bidders freedom to recommend almost anything they want.

"If they think bows and arrows will do the job, then they can specify that," says Sircs project officer Cdr. Scott Mobley, with a smile. That freedom extends, if a bidder wishes, to waivers from using Mil Std and Mil Spec components—a reported first that may allow significant cost savings.

In driving for a design-to-cost system, the contractors will be required to describe detection-to-kill scenarios for Sircs systems installed aboard four classes of ships. For the small, up to 2,800-ton support ships, as well as for the planned FFX class of missile frigates that are to replace the DE-1052 destroyer escorts, the scenario involves defense against four airplanes or missiles that are attacking simultaneously. Contractors must analyze and partition subsystems down to what's called the third tier level—requirements for major equipment, manned operation stations, computer programs and their interfaces.

For the larger Spruance DD-963 destroyer class, the scenario involves defense against eight air targets,

while the scenario for CVA strike carriers and the proposed new AO class of large, relatively high-speed fleet oilers of the 1990s specifies 14 simultaneous targets. □

Industrial

Microcomputers cut paper-making costs

While large producers of paper began switching over to computer-controlled paper-making systems some eight years ago, smaller producers, in this low-profit-margin industry, found the payback time too long to justify the high capital expenditure. Even minimum systems often offered more capability than the small user could afford.

But now two manufacturers, Industrial Nucleonics Corp., Columbus, Ohio, and Sentrol Systems Ltd. in Downsview (Toronto) Ont., Canada, are applying microprocessors in systems they say will be cheap enough for that small user.

One such user is the St. Regis Paper Co. plant in Columbus, which is installing Industrial Nucleonics' first new system on a "very small machine by industry standards, producing only 14,000 tons [of paper] per year," says mill manager Dan Sachs. But the new control will for the first time tell Sachs precisely how his process is behaving.

Using relatively low-cost microprocessors is just one way of making the systems inexpensive, however. The two companies are also keeping things simple. They're looking after only the two "most important" parameters of the many involved in manufacturing paper—its "basis weight," or weight per square foot, and its moisture content.

At prices ranging from $150,000 to $220,000, the systems will be 20% to 40% cheaper than the lowest-priced computer-control system available until now.

Minimum output. "Previously, it would have been difficult to justify computer control on a machine that produced less than 120 tons per day," says Ralph Foose, manager of advanced systems at Industrial Nucleonics. "Now a mill that makes 50 tons per day can pay for the control system in one year through reduced scrap and material usage." He estimates that approximately 2,000 paper-making machines in the U.S. and Europe fit this category.

Sentrol's system handles all sensing, computation, and control with three microprocessors. An Intel Corp. 8080A, from Intel or Advanced Micro Devices Inc., controls a standard type of sensor head, with its radiation sources and detectors, that traverses the paper web. This head detects basis weight and moisture content from the paper's absorption of beta particles and infrared radiation, respectively. The 8080A transmits the information back to a higher-speed Digital Equipment Corp. LSI-11 computer-on-a-board that performs the control calculations. The LSI-11, in turn, generates process setpoints that are used by a second Intel 8080A to control the actual pressures, temperatures, and flow rates of the paper ingredients.

Such total microprocessor control is feasible, says Sentrol president Richard W. Lindsay, because the processor spends most of its time collecting data and only 10% of its time on control actions. The small $3 million Sentrol is content to concentrate on paper making.

More than micros. In its design, on the other hand, Industrial Nucleonics didn't rely solely on microprocessors. Instead, the company, which last year grossed $76 million supplying control equipment to sheet-products industries like paper and steel, hopes to use its system as the first step in a modular general-purpose process-computer family.

Industrial Nucleonics uses an Intel 8080A at the sensor head to relay data back to a Honeywell Level 6 minicomputer. This compares data with the setpoints, performs control calculations, and generates the process-control commands.

"We looked very hard at using micros by themselves versus using a hierarchical system with a minicomputer," says Ralph Foose. "But we found that most micros are not suitable for implementing complex control strategies or for doing a lot of number crunching," apparently a requirement of Industrial Nucleonics' control scheme. □

Solid state

First I²L kits seek to stimulate applications by circuit designers

Look for a number of specialized custom design programs using integrated injection logic to appear on the market this year. They'll be aimed at a mixed bag of users whose diverse applications cannot easily be handled by standard products but for whom I²L is ideal because of its ability to meld linear and digital elements on the same chip.

First on the market is Exar Integrated Systems Inc., Sunnyvale, Calif., out this month with a semi-customized master-slice approach combining I²L and linear bipolar elements on a single 110-by-110-mil chip. Close on its heels are International Microcircuits Inc. of nearby Santa Clara and Interdesign Inc., also in Sunnyvale, both reported to be developing similar master-slice programs. In such an approach, tooling costs are reduced significantly over full custom programs by using standardized, prefabricated master chips that are identical except for the last few interconnect steps.

Master slice. Exar's XR-400 program is typical of the approaches being taken. According to the vice president of engineering, Alan Grebene, the key is the master chip with its logic matrix of 1,024 I²L transistors and more than 200 conven-

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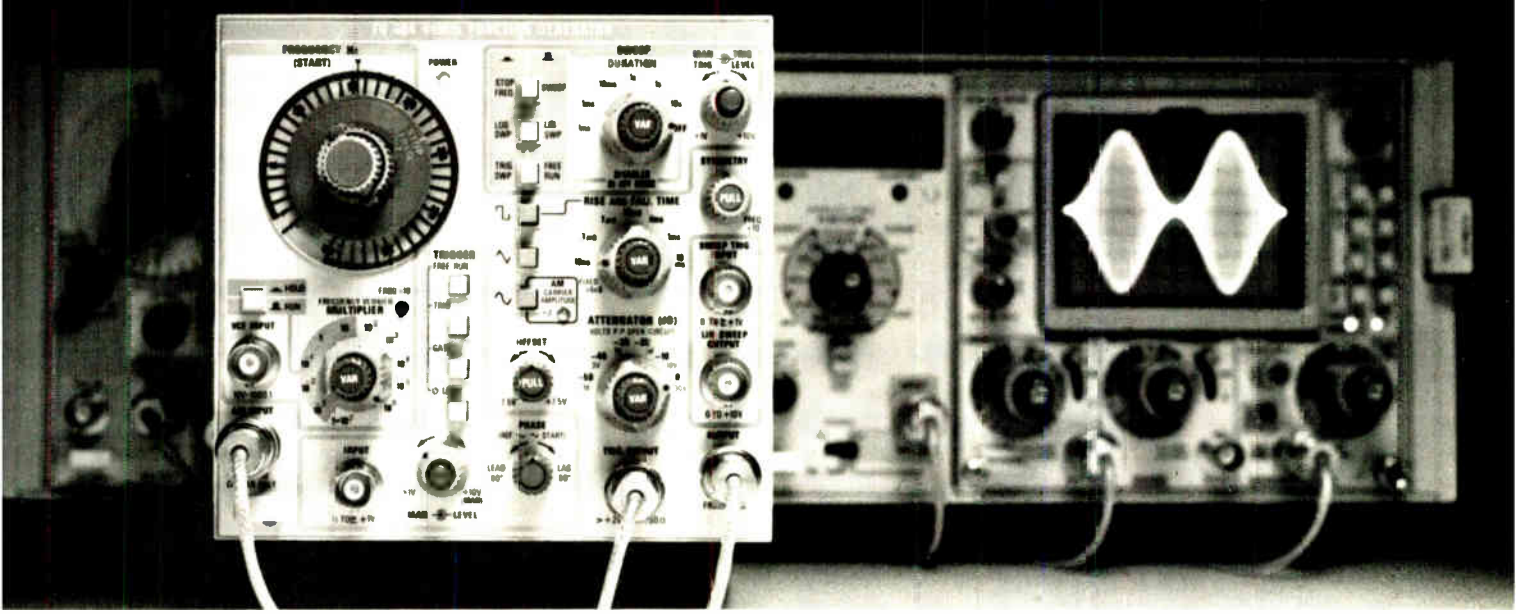

The TEKTRONIX FG 504

In its phase lock mode, the new FG 504 Function Generator will capture and track a periodic signal, such as a logic pulse or house standard frequency, letting you synchronize the generator's output or convert from one waveform to another. Its am input circuitry senses the presence of an applied modulating signal and reduces the output amplitude by one-half, allowing 100% upward modulation without adjusting the amplitude control. It can be frequency modulated, and it can be swept with its built-in logarithmic or linear sweep. Concentric knobs set the frequency start and stop points.

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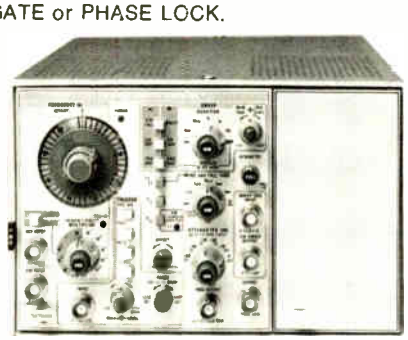
In the phase lock, trigger, or gate modes, a phase control shifts the output of the FG 504, so that you can create setups such as a bi-phase clock. A capable instrument for driving logic circuits, the FG 504 is a "clean," 50 Ω source of pulses to less than 20 ns wide and up to 30 V p-p. Post-attenuator offset enables use of the full ±7.5 V offset range with small signals.

The FG 504 features independent push-button selection of many of its operating modes, so you are not limited to typical "either-or" decisions. Special modes of operation can be set up through independent or simultaneous use of such functions as AM, VCF (fm), SYMMETRY, VAR RISE and FALL, SWEEP, Waveform HOLD, and TRIGGER or GATE or PHASE LOCK.



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For example, the FG 504 may be operated as a free-running burst generator by using the LIN SWEEP OUTPUT to gate the main generator. With the generator in the SWEEP mode but the START and STOP frequencies set the same, the actual sweep will be zero. Adjusting the trigger level controls the length of the burst. SWEEP DURATION controls the period between bursts.

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tional bipolar devices arranged in three separate regions.

One region is the I²L gate matrix, made up of 256 quad-output gates. It occupies the middle of the chip and is arranged in 32 cells of 8 gates each, with low-resistivity diffused crossunders between each cell. A second input/output interface section is made up of bipolar npn and pnp transistor arrays and resistors intended to serve as I/O interface between the I²L gate matrix and the chip's terminals.

The third region is the linear bipolar section with npn and pnp transistors and resistors laid out in an uncommitted form. They can be interconnected to serve as either linear or digital elements such as amplifiers, oscillators, comparators or clock generators.

30 parts. According to Grebene, the user is supplied with a design kit of 30 I²L building blocks in 16-pin dual in-line packages, which are derived from the master chip—gate arrays, flip-flops, counters, and latches, along with transistor-transistor-logic/I²L I/O interface circuits. From this, a system is breadboarded, evaluated and debugged. A circuit layout is prepared by interconnecting device terminals with pencil lines on oversize chip drawings that Exar supplies. It then develops two masks that customize the master wafers by opening contact windows for the metal interconnections of the components.

This semicustomized approach is not new. Indeed, it has been applied with considerable success by Exar and others on less dense arrays using both metal-oxide-semiconductor and standard bipolar technologies. ITT Semiconductors, West Palm Beach, Fla., has been marketing an I²L master-slice kit for watches since last fall [*Electronics*, Oct. 16, 1975, p. 30].

"The approach is most viable for users with low- to medium-volume needs—from 5,000 to 50,000 pieces," Grebene says. "Going the full custom route, in which the chip is specially designed from the substrate up, costs as much as $50,000 for the tooling alone, added to the cost of

News briefs

Electro/76 attendance below expectations
The first international IEEE show held in Boston, Electro/76, fell short of planners' hopes of reaching the 25,000 attendance mark; the total was 22,735. Last year's Intercon drew 20,471 to the New York Coliseum. Show officials were quick to point out, however, that the 25,000 target was a guess because they didn't know what kind of response to expect in New England. Exhibitor reactions varied but were generally favorable to moving the show between Boston and New York.

DAIS award goes to Hughes
Hughes Aircraft Co., Culver City, Calif., will supply the cockpit controls and displays for the Air Force's Digital Avionics Information System test bed being built at Wright-Patterson Air Force Base, Ohio. The $2 million contract from the Air Force Avionics Laboratory seeks two sets of hardware, along with support equipment and a cockpit configured for an A-7D aircraft.

The DAIS components include control panels and a programable display generator, three multipurpose displays, and head-up, projected map, and horizontal and vertical situation displays. The DAIS concept [*Electronics*, Feb. 6, 1975, p. 76] relies heavily on time-shared displays and controls.

New tape movers at NCC
Two new tape transports will be announced at the National Computer Conference next month in New York. Qantex division of North Atlantic Industries, Plainview, N.Y., has one that can handle large tape reels at 75 inches per second, a speed previously covered only by the more complex vacuum-column systems. The transport uses what the company calls a floating shuttle, a pair of idler wheels moving together in a straight line to buffer the tape speed as the reels accelerate and decelerate. Braemer Computer Devices, Burnsville, Minn., has a digital cassette tape transport for microprocessor use. It handles data at TTL levels at an 8-kilobaud rate.

National gains Rockwell executive
Michel A. Ebertin has left Rockwell International Microelectronics division, where he was director of calculator products, to fill a newly created job at National Semiconductor: operations director of calculator, game and microcontroller IC products. The new position underlines National's aggressive interest in the consumer-IC standard-product market.

Illegal payments laid to 27 electronics firms
Electronics companies comprise more than one quarter of the 95 U.S. corporations that have reported "possible questionable or illegal payments and related practices," according to the Securities and Exchange Commission. The commission identified the following 27 companies with major electronics operations: American Standard, AMF, American Telephone & Telegraph, Boeing, Burroughs, Carrier Corp., Coherent Radiation, Electronic Associates, Fairchild Industries, General Telephone & Electronics, General Tire and Rubber Co., Goodyear Tire & Rubber, Honeywell, International Telephone & Telegraph, McDonnell Douglas, Minnesota Mining & Manufacturing, NCR, Northrop, Rockwell International, Sanders Associates, Singer, Southern Bell, Southwestern Bell, Sybron Corp., United Technologies, Westinghouse Electric, and Whittaker Corp.

Cadmium sulfide cells look good to SES
SES Inc. (formerly Solar Energy Systems) in Newark, Del., says it's building a production line for cadmium sulfide solar cells with an annual capacity of 500 peak kilowatts. The thin-film cadmium sulfide cells have shown promise of being considerably cheaper than the more common cells made of single-crystal silicon. Shell Oil Co., which invested $3 million in SES in 1974 (less than a 10% interest), now owns 80% and has invested "considerably more money," says SES president Steven DiZio.

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Electronics review

an initial run of prototypes."

Exar calculates it could supply prototype devices for a tenth to a twentieth of the old cost and fabricate a full production run for less than half the tooling custom costs. □

IEEE

Rivers emphasizes limit on engineers

Besides providing a forum for product exhibition and technical sessions, the IEEE's Electro/76 in Boston earlier this month also brought into sharp focus the clash between Robert A. Rivers, a petition candidate for the IEEE presidency, and the current administration. Rivers, himself a member of the IEEE board, reintroduced his seven-point program [*Electronics*, April 1, p. 68] at a press conference during the show.

Joseph K. Dillard, the incumbent president, said that six of the seven points in Rivers' program are goals already developed by the Institute's U.S. Activities Board in Washington before Rivers announced his candidacy. The seventh point, however, control of the supply of engineers, is one thing USAB will not touch.

Rivers, president of Aircom Inc., Union, N.H., says the prime goal in his program is to make engineering a lifetime career with adequate compensation. He's also concerned that there isn't enough Federal funding of research and development to provide more engineering jobs, and there's too much promotion of the engineering profession by universities and others at a time when the economy can't support more engineers.

Disturbing. He's particularly disturbed by a recent brochure from the Junior Engineering Technical Society recommending a nationwide search for ninth- to twelfth-grade students with engineering aptitude. Worse yet, the brochure, which states that "the nation desperately needs qualified engineers," is endorsed by the Engineers Council for Professional Development, a body partially funded by the IEEE.

Rivers, however, favors controlling the quality and numbers of engineers by not promoting enrollments in engineering schools and by creating a new class of IEEE membership—professional engineer—between the present member and senior member classes. He has proposed this move as an amendment to the IEEE bylaws, but it has been rejected by the technical and regional activities boards.

Besides labelling the Rivers program a rehash of the Institute's own USAB goals, Dillard says it's "disruptive and divisive to the Institute to have another member of the board as a dissident candidate." Dillard is manager of the Advanced Systems Technology division of Westinghouse Electric Corp., East Pittsburgh, Pa.

Nor does he think Rivers and Carleton Bayless, a petition candidate for executive vice president, could get very far with their program without the board's backing, even if they were elected. Bayless and Rivers support each other's candidacy; Bayless is an engineer with Pacific Telephone and Telegraph Co. in Sacramento, Calif.

If a three-way race among the board's candidate Robert Saunders, perennial petition candidate Irwin Feerst and Rivers comes about, Dillard says Rivers could draw votes from the IEEE board's candidate Saunders, and possibly elect Feerst, which Dillard says would be a catastrophe. "At least Rivers has had some experience and knowledge of the Institute and the way it runs, although he'd have problems dealing with the board." □

Microprocessors

TI readies I^2L microprocessor

Underscoring its commitment to integrated injection logic, Texas Instruments is not only using I^2L for a version of its 16-bit TMS micro-

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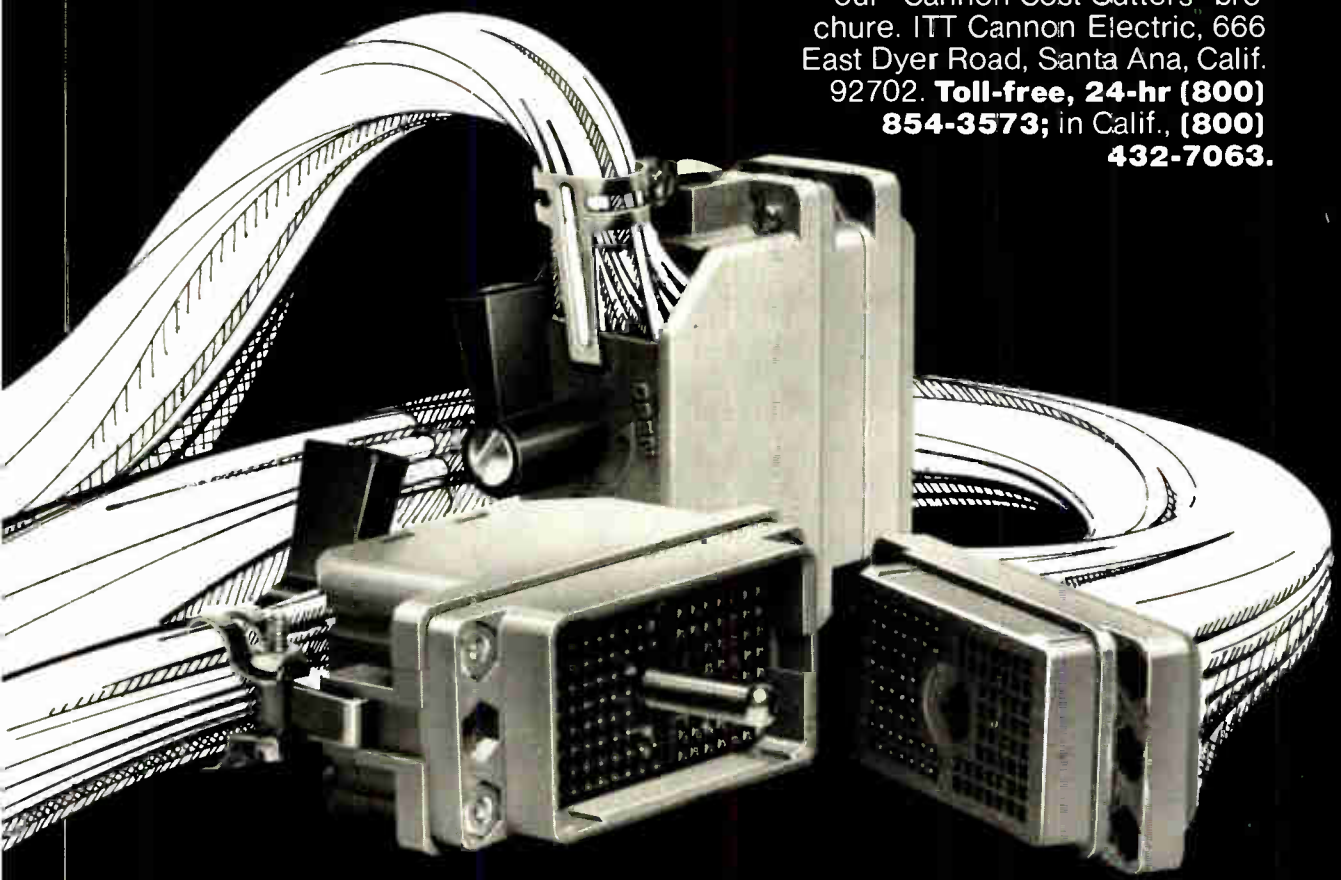

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Electronics review

New 8-bit competitor

Also in the works at TI is a version of the 16-bit 9900 microprocessor, called the TMS9980 and designed to compete with existing 8-bit devices. But while the data bus of the new part is half as wide, TI is retaining the 16-bit internal operation so as to retain the complete 69-instruction set that ensures software compatibility with the rest of the 990 computer family. It will have half the speed, since two clock cycles are necessary to load it, and unlike the 9900, it features an on-chip clock. Samples of the 40-pin device will be available in the fourth quarter.

For next year, TI reportedly plans another variation—a 16-bit device that's defined externally as a 4-bit machine, though the data bus may be variable in length. It's expected to be a microcomputer with random-access and read-only memories on the chip.

processor, but the first customer for the device will be TI's Equipment Group.

Last week, at the National Aerospace and Electronics Conference in Dayton, Ohio, the Equipment Group revealed that it will use the SBP9900 microprocessor in navigation receivers being developed for the Pentagon's Navstar/Global Positioning System. This month, the Semiconductor Group back home in Dallas obtained its first parts and plans to supply samples to other military customers later in the year, says Harvey G. Cragon, TI's microprocessor strategist.

"We don't see the SBP9900 competing with the [n-channel metal-oxide-semiconductor] TMS9900 [*Electronics*, Nov. 13, 1975, p. 36], although there could be overlap in some industrial applications, such as for equipment designed for portable or hostile environments," he says.

More than MOS. The I²L part will be more expensive than the MOS version, but by using I²L, TI picks up the advantage of operation at full military temperature range (−55 to +125°C), "and there's some indication that I²L is amenable to radiation hardening," Cragon says. The TTL-compatible I²L part requires a single static clock, instead of the four-phase clock needed by the TMS9900, and works from a single power supply, instead of three. As with all I²L, speed and power can be traded off; at the 3-megahertz clock rate of the MOS version, however, the I²L part dissipates 500 milliwatts—half that of the TMS9900.

In the Navstar receivers, the SBP9900 will be used as the navigation processor in the data processor subsystem, where it's expected to replace 350 to 400 transistor-transistor-logic integrated circuits. TI holds contracts totaling over $6 million from the Air Force Space and Missile Systems Organization to develop both a "hi-dynamic" airborne receiver for tactical aircraft and an eight-pound "Manpack" version [*Electronics*, July 10, 1975, p. 49].

Since the I²L device is software-compatible not only with the TMS9900 but with TI's 9900 family of microcomputers and minicomputers as well, all of the support hardware and software are already available, Cragon says. □

Consumer

Broadcast signal sets GE's color

Ever since television broadcasters in the United States agreed in 1972 to insert standard color-intensity and tint references in each field of composite video information, TV-set makers have considered the references an appealing way to tune a set, but one that's too expensive to execute.

General Electric Co.'s Television Business department, Portsmouth, Va., no longer thinks this way. It has introduced 19- and 25-inch receivers with a a signal processor that automatically adjusts colors to the trans-

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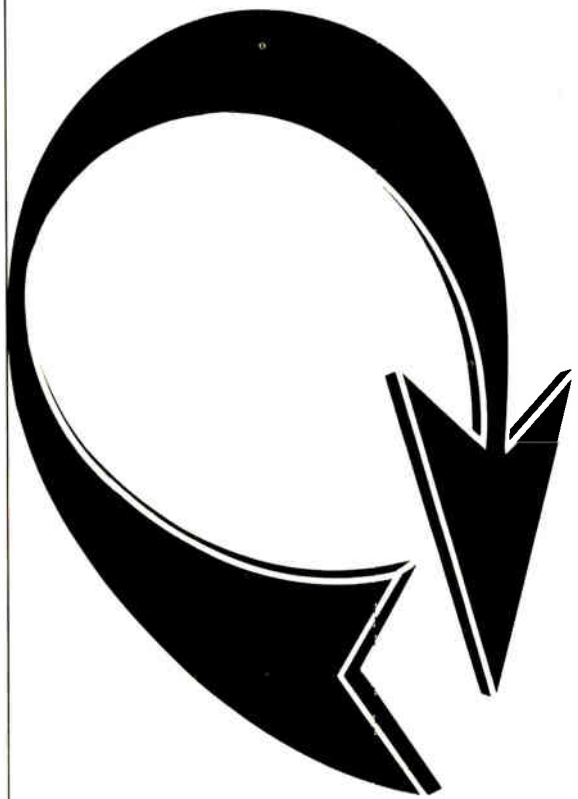

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mitted references. Combined in what is called the vertical interval reference, the signal is broadcast with most programing by the three major networks and the Public Broadcasting Service, as well as by most local TV stations.

Worthwhile boost. The VIR feature increases retail prices by about $30 for the 19-in. set and about $50 for the 25-in. receiver. But GE is depending on improved performance in showrooms to attract consumers. Conventionally, TV-set makers have preferred to rely on automatic color adjustment at a factory-set level, yielding the so-called one-button tuning.

"Until today, only broadcast technicians at each link of the TV transmission chain could use the VIR signal to adjust the transmitted color," Fred R. Wellner, general manager of GE's television department, points out. "But the broadcast-controlled picture is not just average color. It's automatically adjusted at the set according to the VIR signal."

By Federal Communications Commission mandate, the vertical interval reference is located in the nineteenth video line between the burst and synchronization pulses of the vertical blanking interval. It contains chroma, luminance and black reference signals.

Plug-in module. The processor senses the presence of the VIR signal by locating line 19 of each transmitted video field. It then decodes the color intensity and tint information and automatically adjusts the set's controls to match this signal. Five standard integrated circuits and some 30 discrete transistors, plus a power supply and control potentiometers, make up a plug-in module that processes the signal. However, according to Michael Palladino, head of TV advanced engineering for the firm, this function could be converted to a single custom MOS or bipolar chip.

Reception of the VIR signal is indicated on the set by a light-emitting diode. Controls for adjusting nonVIR programing or to cut it out entirely are available if the viewer wants to override the system. □

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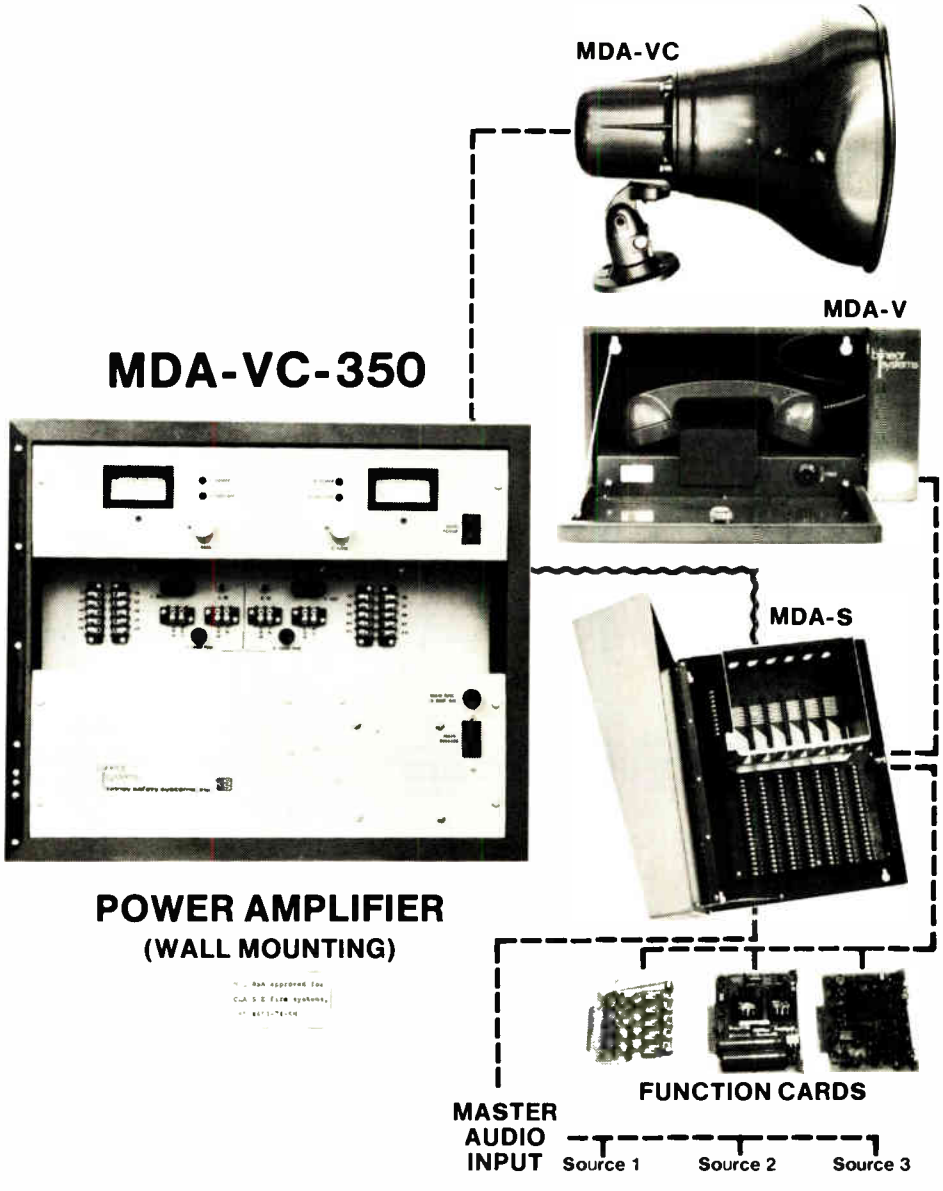

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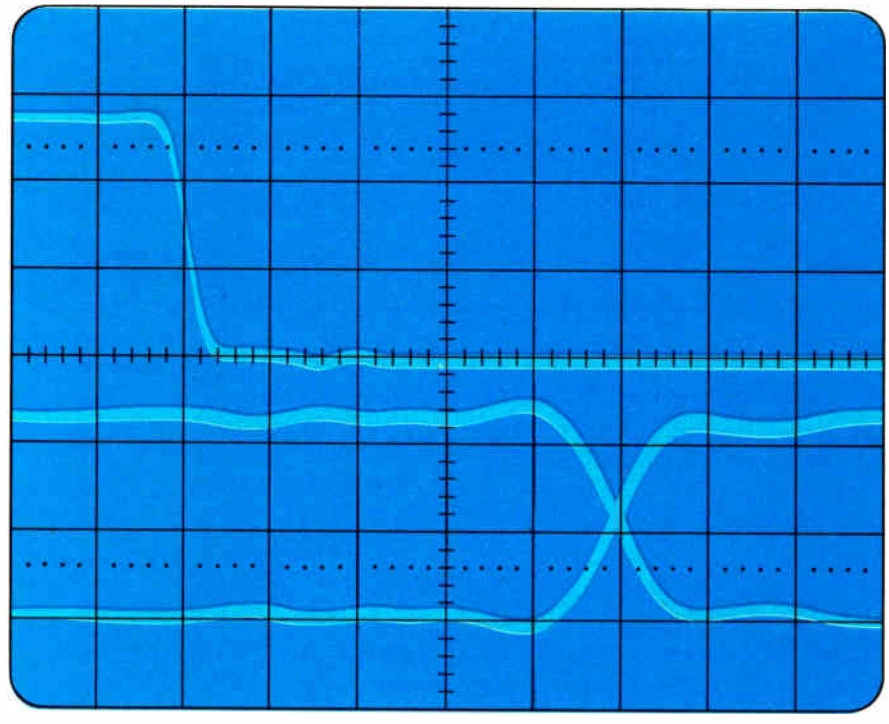
Intel's® newest family of 16-pin 1024-bit static RAMs offer bipolar speed, MOS economy and delivery from distributor stock.



The new 2115 and 2125 low voltage, silicon gate, n-channel MOS RAMs are plug-in replacements for the popular 93415 and 93425 bipolar RAMs.

Like the high speed bipolar RAMs they replace, these new MOS RAMs are fully static, requiring no clocks or refresh, drive TTL directly, operate at TTL logic levels and use a single +5 volt power supply. And they are available with either open collector (2115) or three state (2125) outputs.

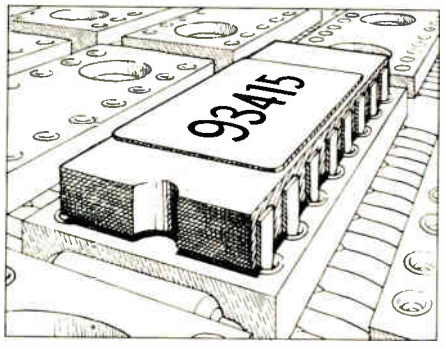
As bipolar RAM plug-in replacements, the Intel 2115 and 2125 MOS RAMs make it practical for system manufacturers to reduce all major systems costs simultaneously—power supply, cooling and packaging, as well as component costs. The high speed, 70 ns, 2115-2 and 2125-2 have a maximum power dissipation of 656 milliwatts per package compared to 815 milliwatts for standard 1024-bit bipolar RAMs.

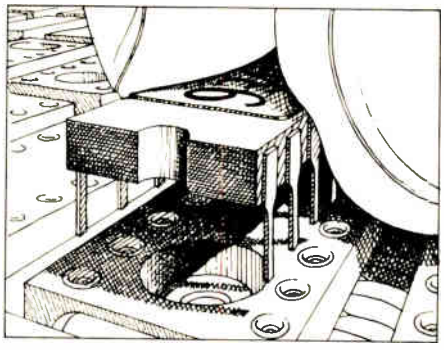
INTEL'S HIGH SPEED MOS 1K STATIC RAM FAMILY

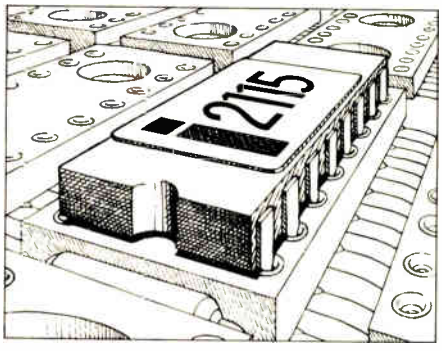
Part Number	Access times (ns)		Maximum Current (mA)	Output Option
	Typical	Maximum 0-75°C		
2115-2	60	70	125	OC
2125-2	60	70	125	TS
2115	70	95	100	OC
2125	70	95	100	TS
2115L	75	95	65	OC
2125L	75	95	65	TS

For applications that demand very low power consumption, the 2115-L and 2125-L can be used. These devices

first MOS plug-in 1K bipolar RAMs.







dissipate a maximum of only 341 milliwatts per package.

The 2115 and 2125 can also be used in new designs instead of dynamic or quasi-static MOS RAMs, thus eliminating clock, refresh and strobe circuits, multiple high voltage power supplies, special level converters, drivers and sense amplifiers.

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COMPARISON OF BIPOLAR AND INTEL MOS 1K STATIC RAMs

Part number	93415	2115-2
Pins	16	16
Circuitry	static	static
Technology	bipolar isoplanar	silicon gate n-channel MOS
Metallurgy	2-layer	1-layer
Max. access time	70 ns	70 ns
Max. cycle time	70 ns	70 ns
Max. power dissipation	815 mW	656 mW
Power supply	+5V	+5V
Output sink current	16 mA	16 mA

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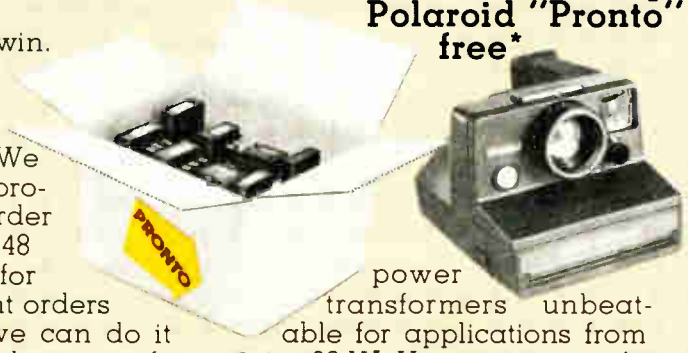

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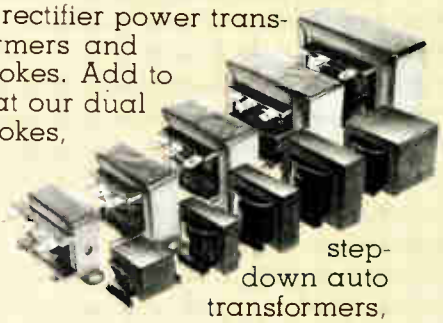

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Washington newsletter

DSCS-III competition unaffected despite funding cuts

Troubles with the two-part Air Force defense satellite communications system (DSCS) program have produced the unusual combination of **a cutback in recommended congressional funds and increased competition on the program.** The House Appropriations defense subcommittee not only reduced fiscal 1977 funds for six more of the TRW Corp.'s DSCS II satellites to just enough for four, but also chopped the funds for competitive development of the follow-on DSCS III to $10.6 million—also a 33.3% reduction. Nevertheless, the Air Force is using existing funds to proceed with DSCS III competitive studies by General Electric Co. and Hughes Aircraft, while TRW is proceeding with a parallel study on an uprated DSCS II with higher power.

Though TRW produced the first 12 DSCS II systems, the Air Force had two launch failures last year—a problem that recently led to House Armed Services Committee approval of the service's request to reprogram $13 million in fiscal 1976 funds to buy more satellites it says are "urgently needed."

Competitors organize to fight AT&T in Congress

Communications companies that see themselves threatened by the so-called Consumer Communications Reform Act are forming a new group to oppose the bill. The measure, supported by the nation's telephone companies, is gaining congressional support rapidly after a slow start [*Electronics*, March 18, p. 60]. The new group, with its own offices and staff, **will include carriers offering specialized microwave and value-added services, plus domestic satellite operators.**

Since the bill's appearance in March, several variants of the legislation have been introduced in the House, where there are now close to 100 sponsors. On the Senate side, two versions of the bill have a total of 10 sponsors. Although a vote before adjournment seems unlikely in this election year, hearings are expected, and the special carriers are running scared. So is the Federal Communications Commission, where chairman Richard Wiley and Common Carrier Bureau chief Walter Hinchman have both spoken out sharply against the bill. Its opponents see it as an attempt to stifle competition with telephone companies for communications services.

Navy told to study cheaper alternatives to Seafarer

In a budget cut by the House Appropriations defense subcommittee, the Navy lost half its fiscal 1977 $29.8 million request for its Seafarer program for extra-low-frequency communication with submerged submarines. **The cutback eliminated all funds for development of a northern Michigan site** for Seafarer's buried communications grid, but calls for the remaining money to be used on exploring alternative means to the program's goal. While the Navy will try to get the funds restored in votes yet to come, congressional observers are not optimistic. GTE Sylvania has been the principal Seafarer contractor so far.

Air Force weapons planners weigh PELSS/RPV package

The Air Force is considering whether to combine its precision emitter location strike system (PELSS), now in the early stages of development, with remotely piloted vehicles. Many of the combination systems would then be deployed over a target area, **forming an airborne grid for terminal guidance** that would let the service "lob weapons into the basket," says Gen. David Brown, Air Force chief of staff.

Washington commentary

NASA wants its 'aeronautics' back

The National Aeronautics and Space Administration, in its search for bread-and-butter programs to offset the demise of its Apollo lunar landing program, is coming back to first principles. It wants to resume the role it once held as leader in aeronautics technology before space flight began consuming its energies in the 1960s.

This is the conclusion to be drawn from NASA's concise three-volume study of some 150 pages just issued and titled "The Outlook for Aeronautics." The year-long study was undertaken at the NASA Administrator's request and completed last fall by a 15-man team composed of a dozen of NASA's top aeronautics managers with the help of two counterparts from the Federal Aviation Administration plus another from the Air Force Systems Command. Their conclusions after surveying 40 aeronautics industrial groups, 25 Federal and regional agencies, and 10 universities—all with strong aeronautics interests—are not unexpected. Yes, Virginia, there is a big aeronautics business out there, and NASA ought to be doing more to help it.

Forecast to 1985: slow

More interesting than NASA's assessment that its own role in directing U.S. aeronautical R&D be revitalized is its estimate of the trends between 1980 and 2000. Through 1985, NASA concludes, "relatively few new developments can be expected" since "lead times for application of aeronautical research and technology are generally long and can easily exceed 20 years." As the pattern of U.S. aeronautical R&D investment turned downward in the late 1950s and 1960s, the impact on U.S. applications is now beginning to be felt. Between 1985 and 2000, however, "new opportunities will exist for advances in aviation if adequate research and technology investments are made in the next decade."

Any lingering doubts about who should control that investment are quickly dispelled by NASA's citation of the National Aeronautics and Space Act of 1958, as amended, which created the agency. With regard to NASA's role, the study recalls the legislation's charge that "the general welfare and security of the United States require that adequate provision be made for aeronautical and space activities."

With broad public interest in its unmanned space programs almost nonexistent, NASA has come back down to Earth to revitalize itself and its supporters in industry and academia. In doing so, it has been careful not to alienate sister agencies. Indeed, NASA's wish to help in long-term, high-risk R&D appears to delight the FAA, which lacks the resources to perform such programs anyway. DOD is similarly intrigued with the prospect of having NASA as a subcontractor of sorts with its own congressional appropriation.

But what can NASA offer industry to help it through the forecast lean years to 1985? Avionics makers see some glimmerings in the study's proposal that "the development of lightweight, low-cost avionics will be necessary to assure that maximum benefit to air transportation from general-aviation aircraft" that will need such hardware to operate with new air-traffic-control systems.

The poll of industry for the NASA study recommended unanimously, to no one's surprise, a strong basic and applied aeronautics research program. In avionics, for example, typical recommendations beyond low-cost component development called for: investigations of application of digital systems to commercial aircraft; studies leading to development of advanced cockpit displays; systems analysis of an integrated navigation, guidance, and control system, and development of methods for redundancy management for new systems.

Jobs—the most telling argument

The development of more professional aeronautical engineers and scientists for the U.S. that would result from NASA's revitalization, however, is clearly the most telling political argument the agency will have next year when it tries to sell its new program to the White House and Congress. The sharp decline in the number of engineers and scientists in the aircraft and missile industries between 1969 and 1972 had its most severe impact, NASA points out, "on the younger segment of the work force."

Compounding that problem is the 1970–75 decline in engineering school enrollments at U.S. universities, which NASA's study says "may create critical personnel shortages by the end of the decade." Because of U.S. dependence on civil and military aviation, NASA believes a critical part of its new role involves "a responsibility to help ensure an adequate supply of qualified manpower." That manpower argument means jobs in an industry that is now somewhat flat. More jobs could be an argument that Congress will buy when NASA makes its next march on Capitol Hill. —**Ray Connolly**

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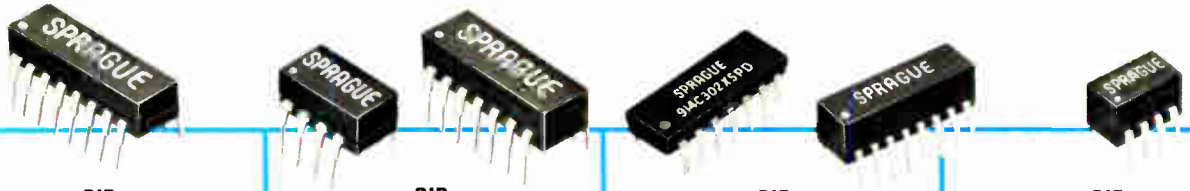

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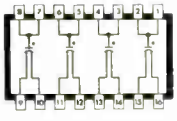

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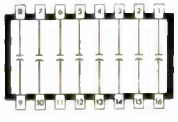

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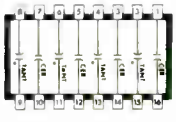

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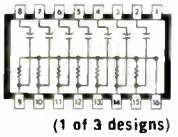

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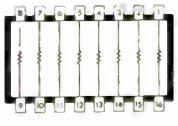

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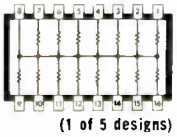

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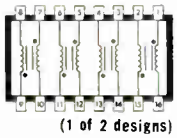

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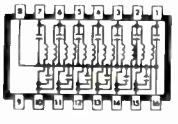

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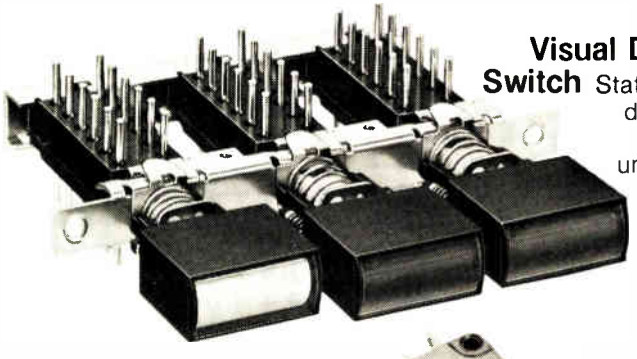

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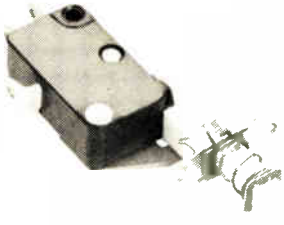

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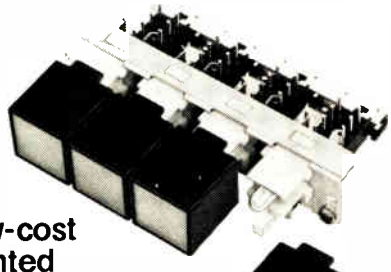

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ISOSTAT LICENSED

Solar generator has retracting wings, will generate 9 kW

The growth in satellite-communications traffic and the trend toward smaller ground stations call for more and more powerful satellites. So West Germany's AEG-Telefunken several years ago embarked on a development program aimed at solar generators capable of providing the power for future satellites.

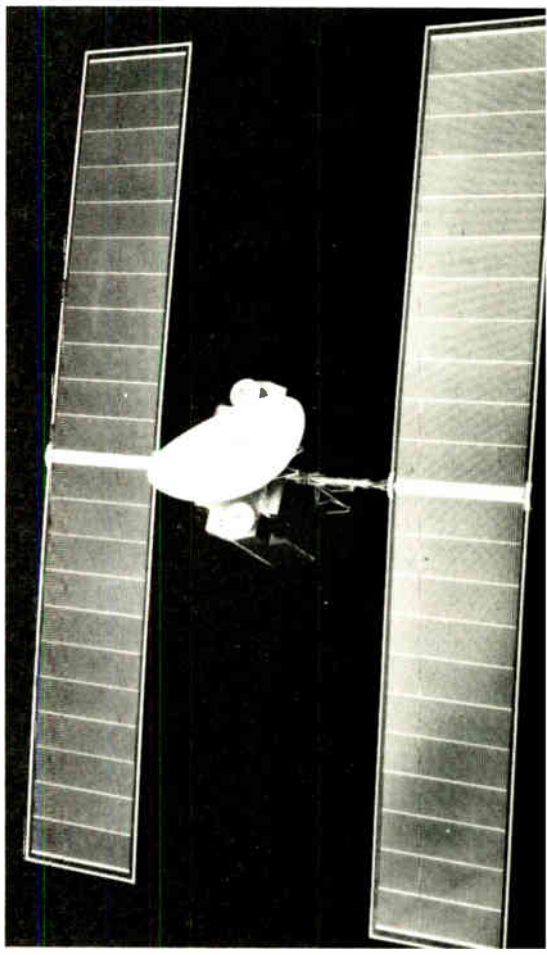
Part of this effort is a retracting-winged solar generator dubbed Dora (for double roll-out arrays), which is intended for future three-axis stabilized geostationary communications satellites. It is being developed under contract to the German aerospace-research institute.

Once completed, the generator will have 184,000 solar cells that will initially provide a total of 9 kilowatts of power. Even at the end of the satellite's normal lifetime of seven years, the generator is expected to supply at least 6.6 kilowatts.

Power. Dieter Rüsch, who is responsible for the Dora project's technical aspects, noted that these figures compare with a start-of-life power of 1.3 kW for Canada's recently launched CTS communications-technology satellite—the most powerful satellite to date and one for which AEG-Telefunken supplied the solar generator to the builders.

Of note, too, are Dora's mechanical features and physical dimensions. Rüsch says the solar generator is the first type with both deployable and retractable wings to be developed for nonmilitary applications. It differs markedly from solar generators with foldable or rollable paddles that can be extended in orbit but cannot be retracted. Paddles don't differ markedly from wings except for their fixed deployment.

In its deployed configuration, the system resembles the letter "H," with the satellite in the center. The generator consists of two wings, each having two so-called solar-cell blankets. Each blanket is more than seven feet wide and roughly 36 feet long. The deployed generator measures more than 72 feet from wing-tip to wing-tip



Sheer power. Workmen put the 184,000 solar cells on Dora's two retractable wings, each 2.8 by 22 meters, to generate 9 kilowatts for communications satellites.

Retracting. In the generator's retracted configuration, the two wings, including the structure of support rods, the actuators, and the intermediate layer of polyurethane foam to protect the solar cell, are stowed in a housing measuring 286 by 90 by 45 centimeters.

The generator's roll-in/roll-out capability provides a number of advantages, Rüsch points out. Solar cells in space are subject to bombardment by charged particles, which gradually decreases the cell's output. Since Dora's wings can be extended, they may be partially rolled out at the beginning of the satellite's mission and then ex-

tended more at certain time intervals. This will conserve the generator's power. In this way, also, Rüsch says, the generator's output can be held virtually constant for several years.

Another advantage of the roll-in/roll-out capability is the saving of fuel during any maneuvers to correct the orbit of the satellite. Before such a maneuver, the wings would be pulled in, which cuts down the surface area of the satellite.

Testing. At present, Dora's stowage and deployment mechanism is undergoing tests at AEG-Telefunken's Hamburg facilities, where the generator is being developed. The mechanism will soon be put to tests in which space conditions with a range of temperatures varying between −190°C and +180°C will be simulated.

Further work on Dora is aimed at reducing its weight. Rüsch says this can be done by more extensive use of magnesium instead of the somewhat heavier aluminum for some of the generator's structure components and by employing resin-reinforced carbon-fiber material for other components. □

France

Takeover kicks off phone expansion

A $22 billion expansion of the government-run French telephone system will more than double the number of phone lines in the next five years, with an emphasis on electronic switching for the all-new exchanges. And, starting right away, the bulk of the business will go to French-owned companies.

For the long run, the French government insists it's backing the French all-electronic time-division switching system championed by the Compagnie Générale d'Electricité. But that hardware won't be ready in quantity until the 1980s, so the government has opted for foreign technology for the crash program that will add 8 million new lines to the inadequate phone network. The equipment will be ITT's Metaconta and L M Ericsson's Axe systems. Both are computer-controlled space-division exchanges, but Axe eventually will be available in an all-electronic version.

However, the government settled on the two systems only after forcing the American and Swedish firms to sell their subsidiaries in France to Thomson-CSF. The French firm has agreed in principle to buy ITT's controlling interest in Le Matériel Téléphonique and to take control of Société Française Ericsson.

For the $160 million the firm will pay for International Telephone's 68% holding in LMT, Thomson-CSF also will get effective control over Lignes Télégraphiques et Téléphoniques. It may wind up with still another ITT subsidiary, the research-oriented Laboratoire Central des Télécommunications.

Thomson-CSF got the nod only after a round of jousting with CGE, the traditional leader among French companies in the telephone business. However CGE will get access to Metaconta technology and will team with its new rival in a government-backed effort to boost French sales in world telephone markets.

The American firm still owns the money-making Compagnie Générale FDE Constructions Téléphoniques, which presumably will get something like 20% of future French switching business. It formerly had more like 40%. □

Around the world

Japanese thyristor aimed at protection, control

Junction temperature, rather than voltage, triggers the Thermosenstor, a new thyristor from Mitsubishi Electric Corp. of Japan. The initial device, type TTO2A, turns on at 70°C, ±5°, but insertion of a resistor between gate and cathode will allow the switching voltage to go as high as 150°C. For large orders, the firm also may make devices that switch on without external components. The moderate, easily reproduced turn-on temperatures are due to precise control of doping density and depth. Low production volume and the large number of tests mean the prices will be between 65¢ and $1, compared to 30¢ or less for comparable thyristors. Principal applications probably will be in such areas as detection and protection against fire and overheating, as well as temperature control.

Analyzer from France digitizes images of curves

France's front-runner in professional electronics is trying its hand at instruments that analyze curves. The TS 1010 image analyzer from Thomson-CSF breaks down images such as photographs of plasma experiments into a matrix of 512 lines of 512 points each. A control console carries the electronics that digitize the information with 9-bit codes for the matrix coordinates of the points and 8-bit codes for the points' values on a gray scale of 256 levels. There's an internal memory of 4,096 words by 10 bits. An optional microcomputer—the R2E Micral S with a 3-megabit floppy-disk memory—can manipulate the raw digital images in a variety of ways.

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Circle 64 on reader service card

International newsletter

Intelsat gives award for switch model to French firm . . .

Thomson-CSF of France is starting on a $149,948 fixed-price contract from the International Telecommunications Satellite Organization **for a 17-month preparation of an engineering model of a satellite-borne microwave matrix switch.** Intelsat thinks the switch could be used in a future multibeam satellite, using the time-division multiple-access approach. After examining techniques, Thomson-CSF will incorporate the most promising in its model switch.

. . . while upping its capital ceiling to $900 million

To meet the capital requirements of its new Intelsat V spacecraft program, the International Telecommunications Satellite Organization has voted to boost the capital ceiling by 80% to $900 million. **The ceiling is defined by the 93-nation consortium at the sum of net capital contributions of its signatories plus all outstanding capital contractual commitments.** The increase was approved at the fourth annual meeting of Intelsat members in Singapore last month. At the same time, Intelsat, which had previously limited itself to handling international communications, approved requests of Nigeria and Zaire for use of satellite channels to handle their domestic public telecommunications services.

Japanese to make U.S. tour in fighter search

A Japanese Air Self-Defense Force fact-finding mission left for the U.S. on May 21 to collect data for the selection of Japan's next-generation fighters, code-named the FX. The defense agency says that the 11-member mission would include a doctor, who will examine effects of aircraft speed on pilots. The mission will return to Japan on July 15 after visiting three aircraft manufacturers—Grumman, which makes the F-14; McDonnell Douglas, manufacturer of the F-15, and General Dynamics, maker of the F-16. **Members of the mission will test fly the F-14 and F-15 but not the F-16 because the U.S. Air Force has only two at present.**

West German railways control traffic with data network

The German Federal Railways is embarking on the first phase of its so-called integrated transport control system, which is based on a national data network. It will monitor and control freight and passenger trains in all of West Germany. **The project calls for storing and processing information on the operational status of no fewer than 375,000 railways cars and some 8,000 locomotives.** About 100 Transdata 960 electronic switching units from Siemens AG will switch and coordinate the data flow between terminals at railroad stations and freight offices and the system's 20 Siemens computers. The terminals at the railroad stations and freight offices come from the Triumph-Adler group, an affiliate of Litton Industries.

France's Schneider seeks new backing

Schneider Electronique, the small French instrument company that pioneered low-cost multimeters based on custom LSI chips, is looking for new backers. Schneider ran into financial difficulties during last year's setback of the French instrument market, logging sales of just over $4 million—but no profits. **As a result, two of the company's major backers—a venture capital company and a government industrial development agency—want out.** ITT, which recently was forced to sell a major telephone-equip-

ment-producing subsidiary to Thomson-CSF (see p. 61) is nibbling. So is Great Britain's Thorn Electrical Industries Ltd.

$800 data terminal features custom MOS LSI chips

Because data terminals in time-shared computers using the telephone network are expensive, England's GEC Telecommunications Ltd. is offering a low-cost data terminal that combines a modem, printer, and telephone. **The $800 Datacom 10 is built around a standard General Instrument keyboard coder MOS chip and 5-channel custom MOS LSI chips** from GEC Semiconductors for the receiver, parallel-to-serial converter/transmitter, dot-matrix print-character generator, timing oscillator, and telephone interface. A simple printer using pressure-sensitive paper is used rather than more expensive light-emitting-diode displays. A slightly cheaper version, which also has a data rate between 110 and 300 bits per second, but without the built-in phone is due before the end of the year because present British Post Office rules forbid "foreign" telephones, GEC says.

NASA roughs out some fees for space shuttles

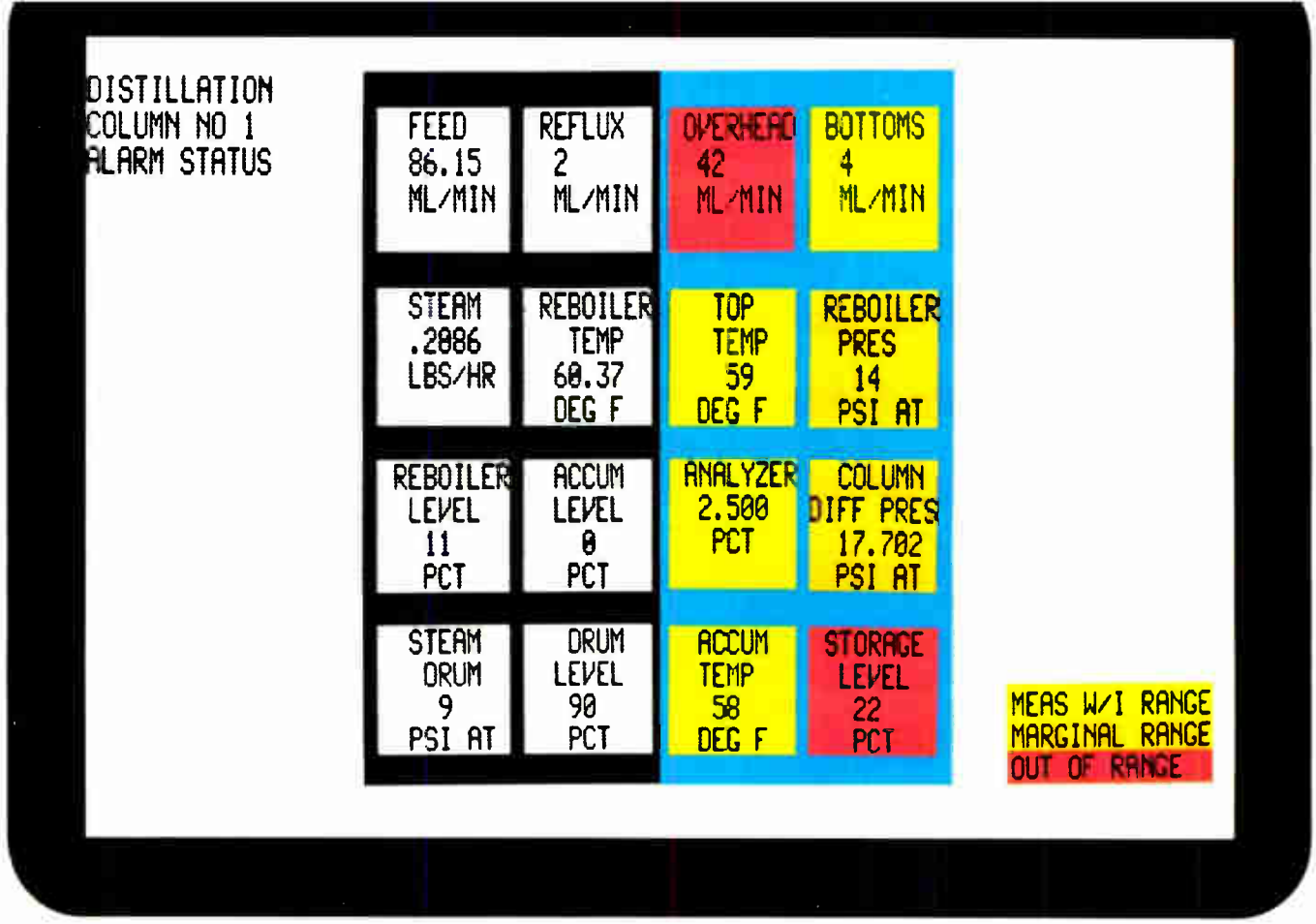
Anyone who wants to put an experiment, a communications satellite, or even himself into orbit during the early 1980s now can get a rough idea of costs. At a mid-May meeting, NASA officials told their European Space Agency partners in the Spacelab project that they figure **the charge for a full load—a charter flight, in effect—on the U.S. space shuttle would run to $18–20 million.** For sending a communications satellite into a synchronous orbit, the fee would run to $7–8 million, NASA estimates. There should be a firm schedule of space-shuttle transportation charges by the end of the year, and NASA will guarantee them for the first three years of operation. The first flight of the shuttle itself is slated for March 1979. The first flight with a Spacelab aboard will follow in May 1980.

Canadian unit buys travelling-wave tubes from Telefunken

Now that AEG-Telefunken has made a name for itself as a supplier of traveling-wave tubes for European satellite projects, **the West German company is beginning to chalk up sales for similar projects elsewhere.** The first major contract the firm has won outside Europe provides for developing 4- and 11-gigahertz tubes and delivering 23 of them to Telesat, an Ottawa-based Canadian aerospace organization. The 4-GHz tube, the TL4010, has an output of 10 watts while the 11-GHz version, the TL12025, has an output of 20 W. Both types have a 42% efficiency. The company is also offering to supply travelling-wave tubes to all firms bidding on Comsat's Intelsat V communications satellite system.

Fast French scope has bandwidth of 46 gigahertz

Thomson-CSF, best known for radars, broadcast equipment, radio links, and air-traffic-control systems, will make a mark in instruments at the early-June Mesueora show in Paris with a prototype of an oscilloscope having a bandwidth of 4 gigahertz. The TSN 660 scope, **designed around a special helix tube that incorporates a channel electron multiplier,** was developed for the French atomic-energy agency. It's intended for analysis of fast, one-shot transient signals that can't be handled with sampling techniques and for measuring recurring signals in the super-high-frequency band. **The company maintains this will be the fastest scope available commercially** when deliveries start late this year.



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Circle 67 on reader service card

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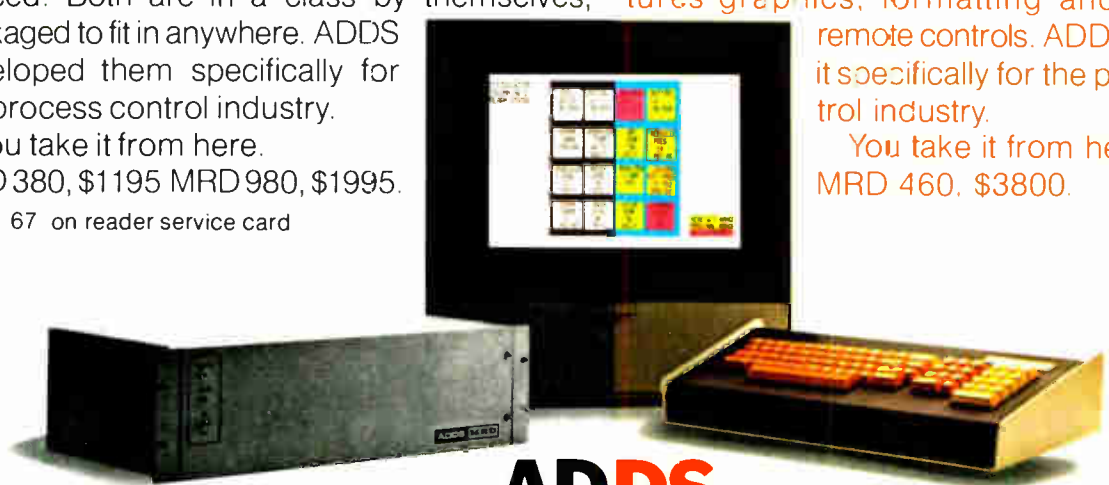

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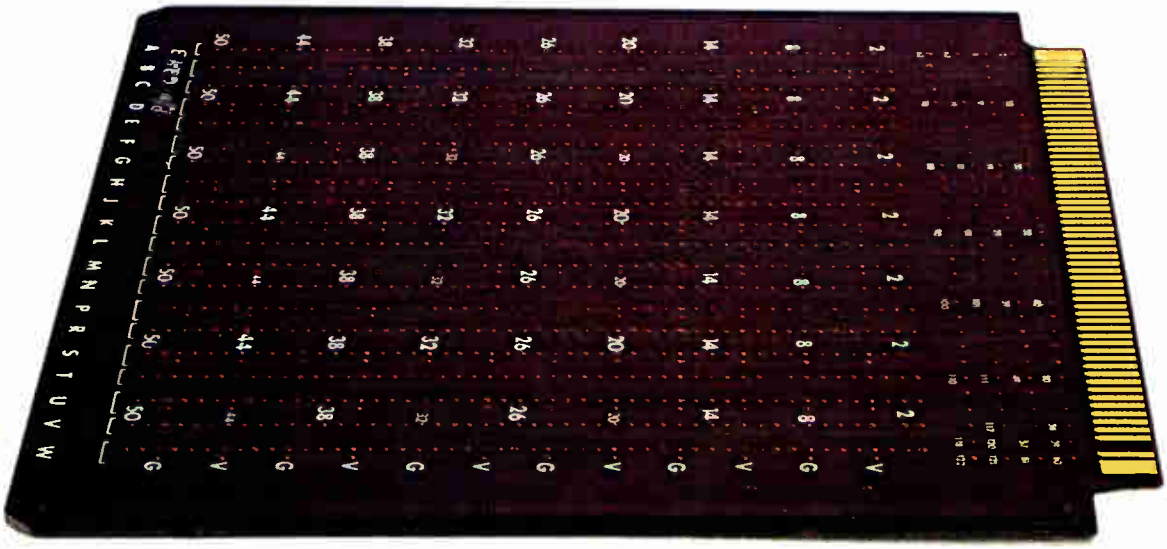
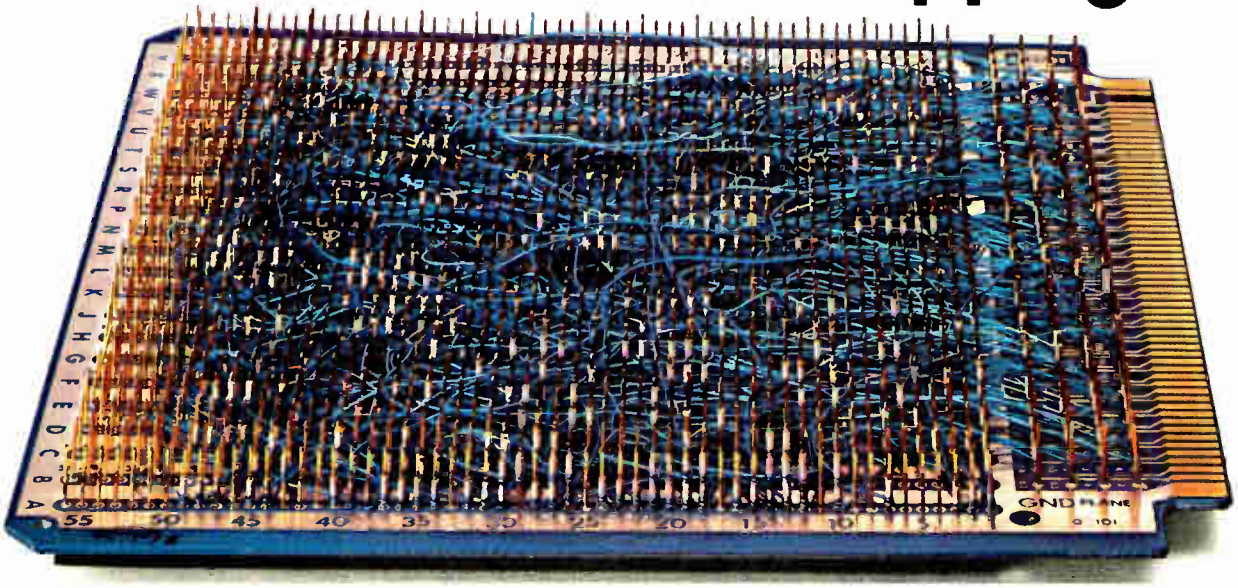
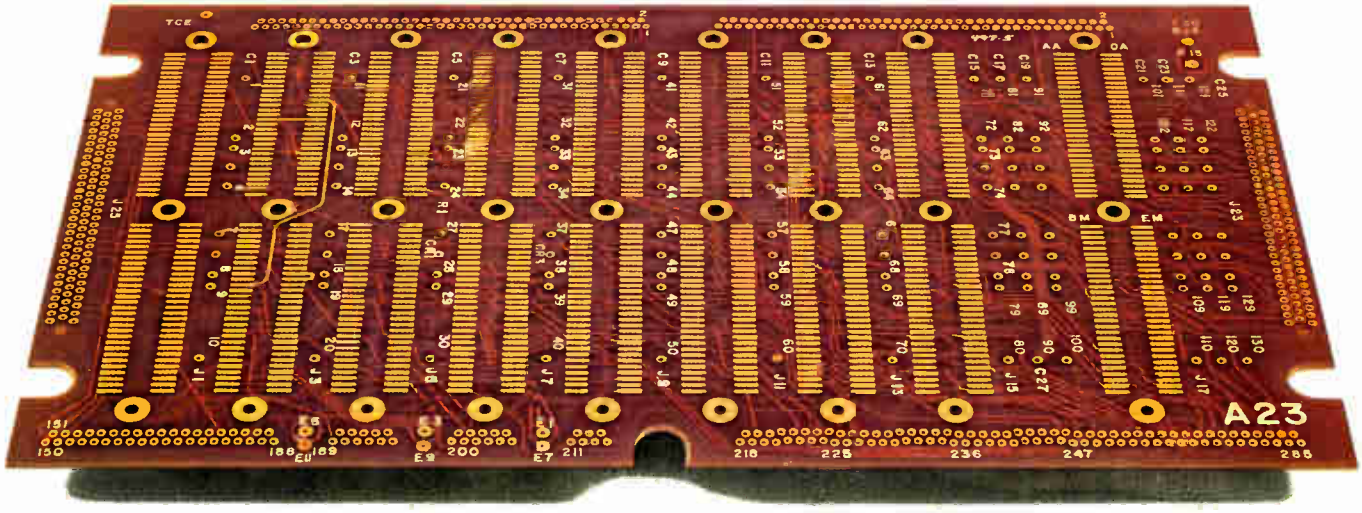


costs less than wirewrapping...

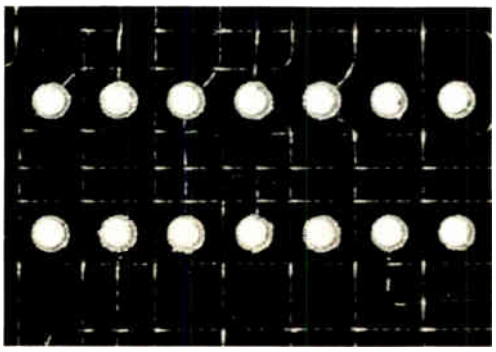


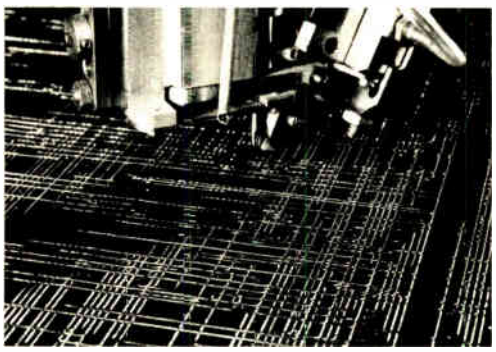
works better than multilayering.



Two major systems—wirewrapping and multilayering—have been used for complex electronic interconnection in the last 15 years. Despite improvements and refinements, each still has inherent disadvantages. That's why Multiwire was created by Photocircuits. It overcomes the disadvantages of wirewrapping and multilayering.

A Multiwire board is basically a customized pattern of insulated wires laid down on an adhesive-coated substrate by a machine operating under numerical control.





Multiwire vs. wirewrapping.

Today, interconnection costs are more important than ever. So take a long, hard look at a key advantage of Multiwire panels. They cost much less than wirewrapping in small or production quantities.

Here's an example of how much less: a Multiwire replacement of a 60 DIP wrapped-wire panel. Total tooling costs were just $750. In order quantities of 1000 pieces, the Multiwire boards at $45 each were more than $30 less than the wrapped-wire panel. (A 40% cost savings.) Multiwire prices also include a 100% continuity check.

But cost is not the only reason for the superiority of Multiwire over wirewrapping. There are also design advantages. For example, Multiwire offers two-dimensional packaging density equal to wirewrapping. But with Multiwire panels, you reduce board-to-board spacing. And Multiwire weighs much less too. So it can contribute substantially toward improving the envelope or three-dimensional package of your product.

Electrically, Multiwire is also superior. The extreme repeatability of the manufacturing process provides much higher electrical reliability as received—this is an important cost-saving factor. In addition, you get the controlled impedance characteristics required without variations.

Multiwire vs. multilayering

With Multiwire, reliability goes up and inspection cost goes down. Multiwire doesn't need extensive inspection—like multilayering does—for nicks, pinholes, hairline cracks, spacing violations and bridging. Yet Multiwire regularly yields better than 99% reliability at incoming inspection.

Compared to multilayering, designing a new Multiwire board is a far simpler operation. Component locations and a wiring list are all we need. Our computer-aided system does the rest.

Since the computer also takes care of deletions and/or additions, engineering changes are simplified. What's more, Multiwire makes it easier to find paths for interconnections, because the insulated wires can cross one another. For these reasons we can deliver finished Multiwire boards to your door in weeks rather than months.

The advantages of Multiwire over wirewrapping and multilayering vary from case to case. We'd like to help you evaluate possible time, cost, design and reliability benefits. For information and price estimates, call the Multiwire Marketing Department at 516-448-1111.

	Wrapped panels	Multi-layers	Multi-wire
Design & tooling cost	Low	Very High	Low
Design & tooling time	Short	Very Long	Short
1st piece delivery	Short to Very Short	Long	Short
Board cost in small quantities	High	High	Medium
Board cost in production quantities	High	Medium	Medium
2 dimensional packaging density	High	High	High
3 dimensional packaging density	Medium	High	High
Weight	High	Low	Low
Ease of changes	Excellent	Poor	Good
High speed electrical characteristics	Fair to Poor	Excellent	Excellent
Interchangeability with other techniques	Fair	Excellent	Excellent
Repairability	Excellent	Poor	Good
Controlled impedance	Poor	Good	Good
Electrical reliability as received	Fair	Good	Excellent

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DTS 517	5	500V	250V	1.6V	0.25 μsec
DTS 518	5	600V	275V	1.4V	0.25 μsec
DTS 519	5	700V	300V	1.4V	0.25 μsec
2N6573	5	500V	250V	1.5V	0.25 μsec
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The accompanying curves, charts and circuits tell part of the story. Prices, applications literature and electrical data from your nearest Delco sales office or Delco distributor can supply another part.

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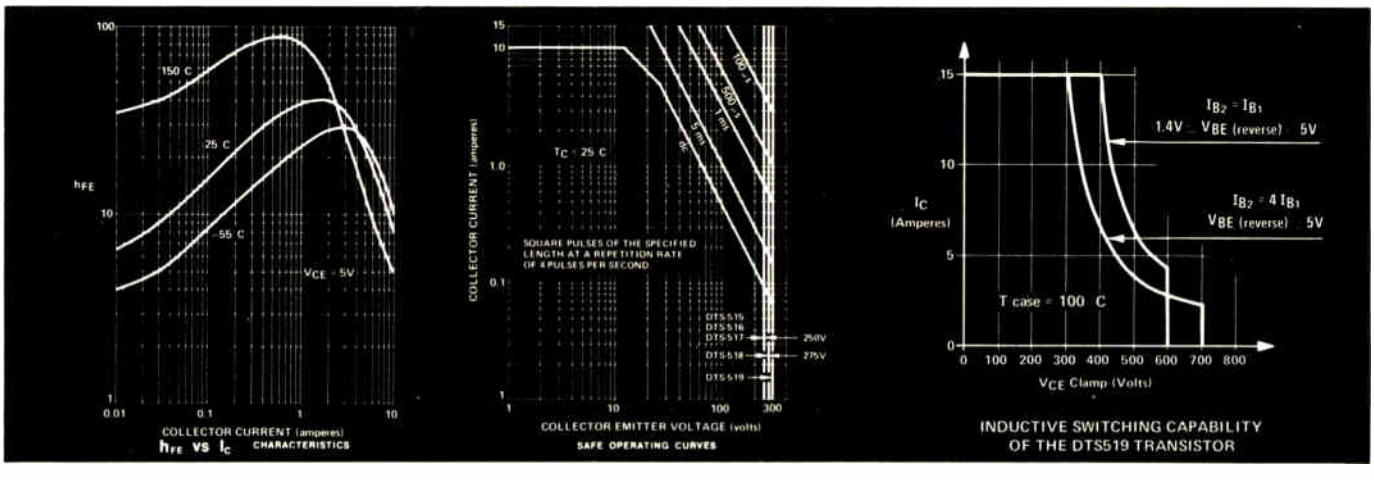

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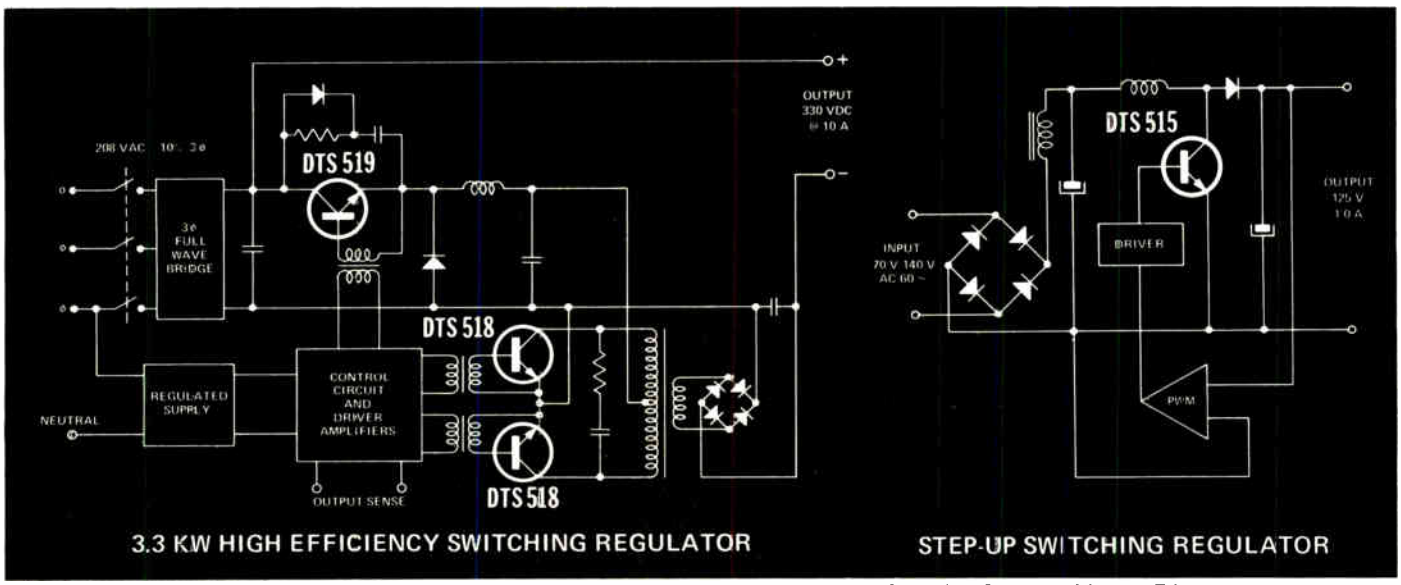

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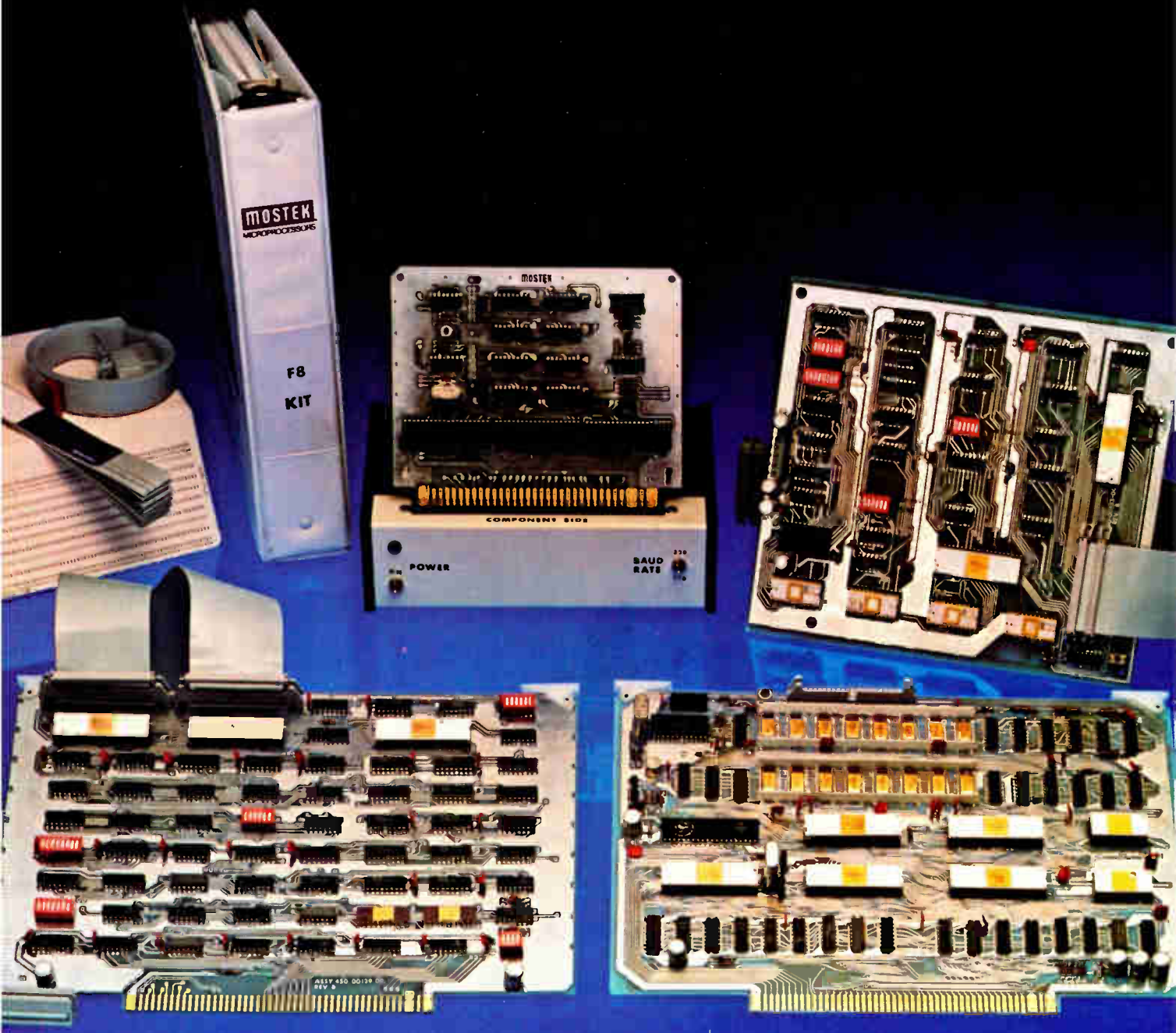
Delco Electronics
Division of General Motors

Announcing MOSTEK's F8 AID Station

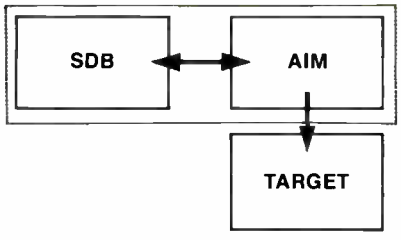


Develop F8 applications from concept to working production systems. Fast!

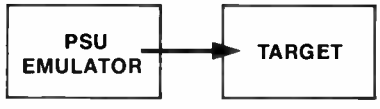
With MOSTEK's F8 AID (Aid In Development) Station you choose the configuration that works best for your application. It's a streamlined approach for maximum cost-effectiveness. And it allows you to completely debug software and hardware providing a fast confirmation of your actual application before you commit to expensive, time-consuming custom ROM patterns. The big advantage is that you determine the complexity and expense of the development system required for your application. You can use one or all of the development tools, depending on your requirements.

Example:
Start with the F8 Survival Kit as a low-cost training aid and evaluation system. Next ..develop and debug ROM or PROM firmware in your final system configuration (target) using SDB/AIM:

F8 AID Station



For PSU-based systems, the PSU Emulator is available for verifying or field testing ROM programming prior to ordering custom PSU's



The Mostek Survival Kit—$185.00

This high performance kit is a ready-to-go microcomputer for evaluation of the F8 instruction set, hardware features and performance. It includes a user operating system, (DDT-1), 1K of RAM, four 8-bit I/O ports, TTY interface, timer, interrupt and Fortran IV F8 Cross Assembler. MOSTEK's Survival Kit can be used for the complete development of many F8 control applications. Unassembled kit price is $147.00.

The Software Development Board (SDB)—$1295

With the SDB you can also execute and debug software for your F8 applications. In addition, the SDB offers the capability to create and edit "source" listings (using the F8 resident text editor) and assemble them into corresponding "object" code (using the F8 resident assembler).

The 2Kx8 user operating system (DDT-2) offers 10 basic commands:

.M s	display and update memory at s
.M s,f	tabulate memory block s,f
.P s	display and update port s
.P s,f	tabulate port block s,f
.E s	execute program at s
.B s	set breakpoint to exit program at s
.S s	single step execution at s in program
.L	load tape into memory
.D s,f	dump tape from memory block s,f
.C s,f,d	copy memory block s,f to d

Mostek's SDB also provides 8Kx8 of RAM, four 8-bit I/O ports, serial ASCII interface (110-9600 baud) and a parallel interface for high speed reader/punch.

The Application Interface Module (AIM)—$750

With SDB/AIM you can debug F8 applications in the actual hardware and software configuration of your final system (Target). AIM allows you to actually emulate the target ROM, or PROM with RAM. The RAM, which appears as ROM to the application, can be loaded, debugged and modified using peripherals independent of the target. All of the peripheral and debugging capabilities of the SDB can be applied directly to the final system configuration of any F8 application.

The Emulator—$435

This development aid is ideal for designing and field testing F8 μComputer systems which use one or more MK 3851 Program Storage Unit (PSU) circuits. It's electrically equivalent to the PSU but is field programmable rather than mask programmable allowing final hardware verification of all PSU programming prior to ordering custom PSU circuits.

Get started with the F8 Development Aid Station now. It's available at MOSTEK distributors complete with thorough documentation. Or call your MOSTEK sales representative.

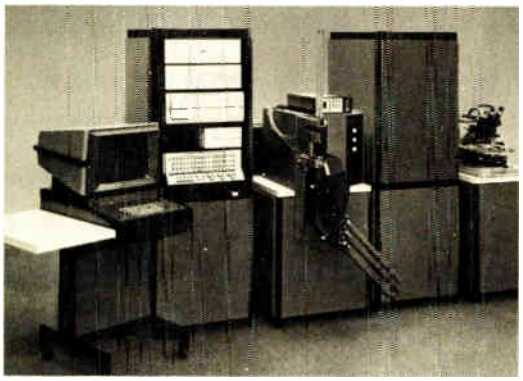
MOSTEK

In Europe, Contact:
MOSTEK Gmbh
TALSTR. 172
7024 Bernhausen
West Germany
Telephone: (0711) 701096

1215 West Crosby Road
Carrollton, TX 75006

Photo at left: F8 Survival Kit and documentation upper left; F8 PSU Emulator, upper right; Application Interface Module (AIM) lower left; Software Development Board lower right

THE J387: WHEN PRODUCTIVITY COUNTS.



Here are seven ways in which the J387 Memory Test System helps increase productivity. Study them closely. When it's time to invest in memory testing equipment, you'll want to remember them all.

REPEATABLE RESULTS WITH HANDLERS or PROBERS.
Because the system was designed to drive devices at the end of cable, test results are consistently repeatable even when wafer probers or automatic handlers are connected to the system.

NO TEST STATION TWEAKING.
The system's software eliminates the need to modify the program every time you change test stations. Once set, the times stated in the test program are always valid.

PROGRAM YOUR OWN PATTERNS.
Teradyne's new programmable pattern generator allows you to produce whatever patterns will exercise your memories best in the least amount of time.

TWO STATIONS MEAN HIGH THROUGHPUT.
The basic J387 arrives with two test stations because experience has shown that two usually offer the lowest cost per device tested. Should you require more, they can be added.

TESTS RAMs, ROMs, EVEN 16Ks.
The J387 will test many different RAMs and ROMs, including 4k devices in 16-, 18-, and 22-pin packages. Even memories with up to 16 address inputs can be handled.

ALL THE DATA YOU NEED.
You're provided with cumulative Schmoo plots, lot summaries, distribution analyses, datalogged parametric values, and all the other data you need to increase yield and improve productivity.

TERADYNE PRODUCTIVITY TURNS UP EVERYWHERE.
You'll find it in hardware optimized for memory testing. And in Teradyne's unique 10-year circuit module warranty. It's why we maintain a seven-day, 24-hour troubleshooting service. And a global service program backed up by local parts stocking centers.

Whether you're a memory user or manufacturer, the J387 delivers what you need. Optimized memory testing that will boost your throughput and increase your productivity. For the full story on the J387 Memory Test System, write: Teradyne, 183 Essex Street, Boston, Massachusetts 02111. In Europe: Teradyne, Ltd., Clive House, Weybridge, Surrey, England.

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For people with memory problems cut this out and save.

Will IC makers find converter niche?

Consensus foresees future for them in less demanding applications, while traditional houses dominate high-performance end of the field

by Lawrence Curran, Boston bureau manager

Crossfire between rival makers of data converters is generating enough smoke to obscure a clear understanding of what portions of the market are available to members of each camp. The rivalry, covering both analog-to-digital and digital-to-analog devices, is between traditional makers of modular or hybrid models and major semiconductor makers jumping into the fray with monolithic converters.

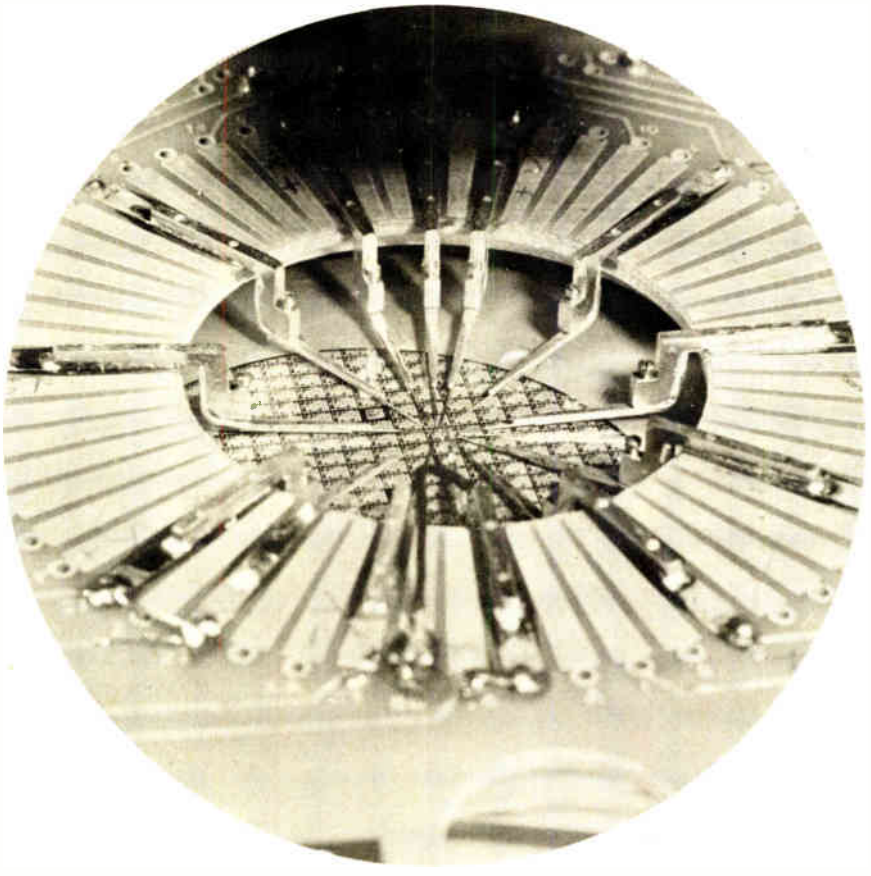
With few exceptions, though, the consensus seems to be that the traditional makers will serve the high-performance, precision end of the market for the foreseeable future, and the monolithic houses will chip away at—and possibly dominate—the less demanding jobs that don't require much more than 8-bit resolution or substantial speeds.

Price-cutting in the hybrid camp [*Electronics*, April 15, p. 35] has followed on the heels of converter announcements from big integrated-circuit houses such as National Semiconductor and Motorola, together with reports that Texas Instruments is tooling up. Below that tier, Teledyne Semiconductor has joined the monolithic side, and traditional module- or hybrid-converter producers such as Analog Devices Inc. and Burr-Brown Research Corp. are expanding or fine-tuning their monolithic production capabilities [*Electronics*, May 13, p. 38].

Coexistence. But there's no reason the hybrid and monolithic converter makers can't coexist for some time because of the differing needs of the market segments they're seeking. Perhaps Burr-Brown's Joseph Santen, product manager for data converters, says it best when he asserts: "The big semiconductor makers have their niche, and we have ours." Santen says that hybrid builders such as his own Tucson, Ariz., firm will always stay ahead of the monolithic houses in performance—reaching 16-bit resolution when a monolithic device is at 12 bits, for example, although neither achievement is near at hand.

At least one member of the hybrid camp, Carl Kramer, vice president for sales at Hybrid Systems Corp., Bedford, Mass., guesses that a complete monolithic 12-bit d-a converter is five years away. Ray Stata, chairman and president of Analog Devices Inc., Norwood, Mass., who is probably the most vocal and adamant spokesman for established converter makers, foresees considerable challenge for the monolithic houses to surmount before they make a mark in the precision or high-performance converter market. He strongly believes one of

Trimming. Analog Devices uses laser wafer trimming controlled by computer on its Norwood, Mass., production line. Here, a wafer is shown undergoing part of the routine.



the biggest hurdles is accuracy.

"They haven't had to be greatly concerned about 0.01% or even 0.1% accuracy in converter products requiring resolution of 12 bits and up," Stata asserts. Accuracy, in his opinion, is closely related to whether the product contains a stable voltage reference, precision resistors, and overall circuit precision achieved with dynamic trimming of the resistors after deposit on the monolithic chip.

Mixture. Furthermore, Stata maintains that a mix of both logic and linear components on the same chip is required for the precision portion of the market. "When you combine all these requirements and realize that production runs for individual converters don't reach very high volumes, those requirements don't seem to be in the mainstream of what semiconductor makers provide," he explains.

In the monolithic camp, National Semiconductor Corp.'s Dean Coleman readily admits that achieving 0.01% accuracy isn't a trivial task, but the whole market isn't at that accuracy, he maintains. "A lot of it is 0.05% or 10 bits, and 0.2% or 8 bits." Coleman, converter products marketing manager in Santa Clara, Calif., contends that semiconductor makers are beginning to dominate the 8-bit market, will do the same at 10 bits within a year, and within three years will capture the 12-bit converter market.

But his competitors are unconvinced. "The monolithic guys are going to have a tough time building a true 12-bit d-a or a-d converter, and while they're still struggling, we in the hybrid business will make a lot of money," says Lyle Pittroff, product-marketing manager for hybrids at Beckman Instruments' Components division. "Not only is the technology not obvious, but then they have to produce it in volume, with adequate yields, to sell for less than $10."

But Coleman doesn't think IC houses will dislodge established companies such as Analog Devices and Precision Monolithics from the converter market, essentially agreeing with the niche theory of Burr-Brown's Santen. Those niches for National include microprocessors, automobiles, and telecommunications. Microprocessor-interfacing is one example of a new application for converters where IC houses can move swiftly into a new market, "piggy-backing" the converters onto the microprocessors as part of a systems sell, Coleman claims. And in Detroit, "auto makers aren't going to pay for a 20% module or a 10% hybrid," he predicts. "It's going to be an 8- or 10-bit converter, and that's where we are now."

TI and Motorola are both eyeing the microprocessor-generated market for converters. But TI, too, concedes that monolithics won't drive out hybrids. "The hybrids will survive in the high-speed, high-accuracy end—for test equipment, for example," says Delbert Whitaker, the firm's linear marketing manager. The company will, by year's end, introduce a one-chip, successive-approximation converter for data acquisition in microprocessor-based systems. Although Whitaker won't elaborate, the chip is expected to be a high-speed 8-bit part built with a double-MOS process. On the chip will be a temperature-compensated voltage reference, high-performance integrators, buffers, comparators, and MOS digital control logic.

Kit. TI is also working on a two-chip kit for the digital-panel-meter market that does a dual-slope a-d conversion and will be accurate to 13 bits. But the 8-bit limitation of the microprocessor-related converter, and the need for two chips to get 13 bits in such meter applications, are further evidence that precision monolithic converters are still beyond the reach of single-chip processing technology. Motorola's approach (see "Motorola's monolithic building blocks") underscores that fact.

National's Coleman acknowledges that putting the voltage reference on the chip is about the most difficult job monolithic makers will have to do, and it won't be done industry-wide for several years. In the hybrid camp, Robert Jay, president of Micro Networks Corp., Worcester, Mass., says a stabilizer reference is only one of two tough nuts for monolithic processing to crack; the other is the need for precision thin-film resistors on the chip. Jay sees minimal-chip hybrids dominating the precision-converter market for the next several years.

Finally, considerations the major semiconductor makers may be underestimating in the precision part of the market are the rigorous requirements for component-matching and testing, and the need for more technical expertise in the sales force to handle application questions, say Analog's Stata and Dan Dooley, vice president of engineering at Precision Monolithics. □

Motorola's monolithic building blocks

Motorola's Integrated Circuits division in Phoenix is one of the few big semiconductor manufacturers in the data-converter market that brushes off the 0.01% deviation-from-accuracy requirement at 12 bits as no big problem in a truly monolithic device. "This doesn't scare us off," says Steve Faulkner, product planner for interface circuits. He says Motorola is in the beginning design phase for such a product.

Until it's ready, however, Motorola is offering building blocks that the customer can put together for his application. Faulkner says this approach is a practical solution to the very real need for a wide variety of products within a broad range of technical complexity. He cites the voltage regulator for Motorola's recently announced 10-bit digital-to-analog device as an example, claiming that customers can buy their own parts, assemble them, and still save money.

A customer has to decide how much to pay for a function, and some that won't spend $20 to $30 for a d-a converter would readily pay less than $10, in Faulkner's opinion. With that in mind, the company has an 8-bit d-a converter at $5.95 in quantities of 100, and another one with accuracy to 0.5% at $2.95 in hundreds. A laser-trimmed 10-bit d-a converter, about a month away, will sell for $9.95. The customer adds external circuitry.

What's new in solid state . . .

Gold CHIP LICs pile up 18 million hours with near-zero failure rate.

Test results from 18.2 million unit-hours and 1.5 million unit-cycles are in—and the verdict is unanimous. RCA Gold CHIP LICs are *significantly* more reliable than their counterparts with aluminum metalization. Here is a summarized report based on testing by three different kinds of users, plus—perhaps our severest critic—ourselves.

U.S. Army jungle/salt air tests

In Panama, the Electronics Technology and Devices Laboratory of the U.S. Army Electronics Command tested 63 Gold CHIP LICs to 1,479,000 unit-hours. The tests were done under conditions designed to reveal potential electromigrative shorts and metal corrosion: 27°C, 90-98% R.H., 4.5 V reverse bias. Result: zero failures. Or a failure rate of 0.062%/1000 hrs. at 60% confidence level.

OEM reliability tests

A major OEM systems manufacturer has completed extensive testing of Gold CHIP bipolar ICs. These were operated at high power and high junction temperature. After 15,000,000 unit-hours: 2 degradational rejects not related to metalization. That's a 0.02% failure rate.

U.S. Navy plastic IC program

The Naval Electronic Systems Command has awarded RCA Solid State Division a $1.44 million contract to apply Gold CHIP technology to plastic packaged ICs for military use. MIL-M-38510 specifications will be used.

RCA reliability tests

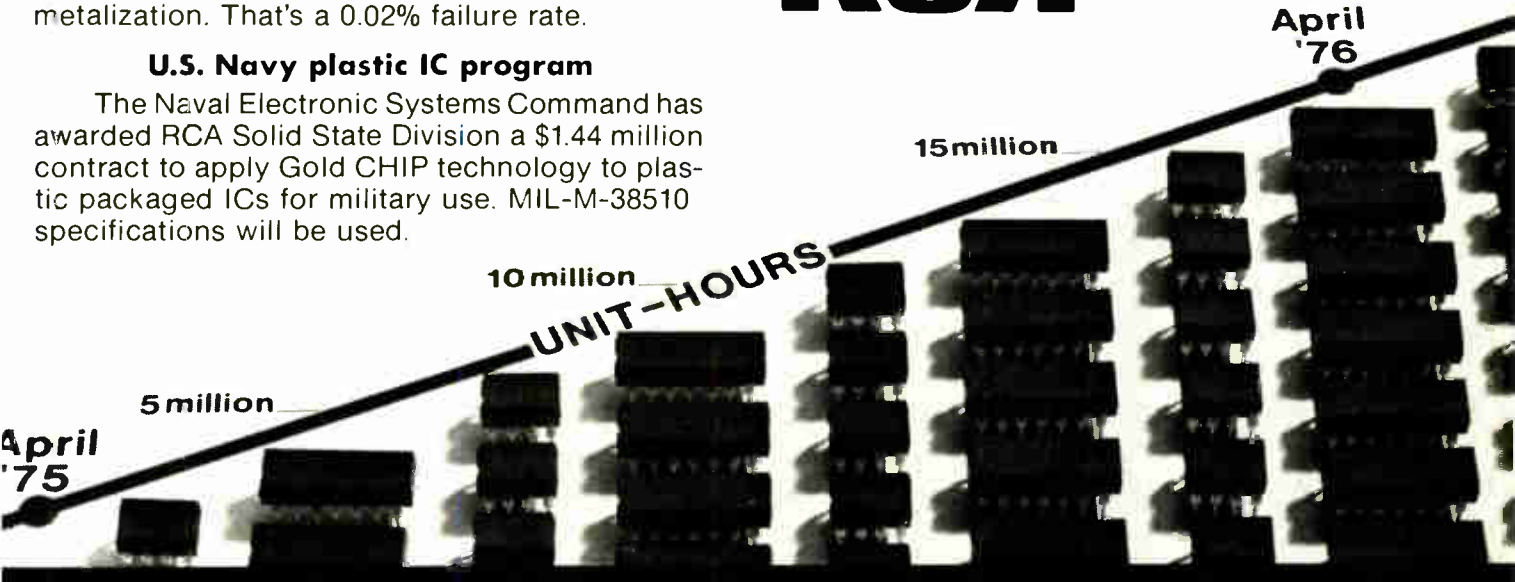
In a continuing program, RCA has run the following tests under industry accepted testing conditions.

- Operating Life: 332 units, 376,500 unit-hours.
- Temperature/Humidity Bias: 314 units, 1,244,000 unit-hours.
- Thermal Fatigue: 30 units, 750,000 unit-cycles.
- Pressure Cooker. 510 units, 92,460 unit-hours.
- Thermal Shock: 673 units, 214,760 unit-cycles.
- Temperature Cycle: 1,630 units, 510,000 unit-cycles.

Results: 1 failure in the pressure cooker test. It was caused by a bond wire break at the frame and was not chip related.

You can buy these Gold CHIP LICs from your local RCA Solid State distributor and evaluate them yourself: CA101AG, CA107G, CA124G, CA139AG, CA139G, CA201AG, CA207G, CA224G, CA239AG, CA239G, CA301AG, CA307G, CA324G, CA339AG, CA339G, CA741CG, CA741G, CA747CG, CA747G, CA748CG, CA748G, CA1458G, CA1558G, CA3401G, CA3724G, CA3725G.

RCA



RCA. Full house in Linear ICs.

Circle 79 on reader service card

Consumer electronics

Play's the thing in home video games

You can't tell the companies without a program as more and more enter $500 million market with LSI and microprocessor-based models

by Gerald M. Walker, Consumer Electronics Editor

Competition to win a position in the electronic-games market for homes and arcades has reached a pitch not seen in consumer electronics since the early days of four-function calculators. The scramble to get part of the action in this lucrative new market, which started in earnest late last year, now involves semiconductor houses, traditional arcade and toy companies, new electronics-oriented firms, Far East assemblers, and a couple of TV manufacturers.

At next month's Consumer Electronics Show in Chicago, a raft of new home-video games will be introduced, and they will be more sophisticated than the original paddle-and-ball-type of games sold thus far. Meanwhile, new coin-operated machines, some controlled by microprocessors, have already begun assaulting the fickle public in arcades around the world.

A bit skeptical about the ability of this growing number of home-games entrepreneurs to actually deliver what they've announced in time for the Christmas selling season, one video-game firm executive says, "Right now, the number of companies that consider themselves in the video-games business is only limited by the number that can get on General Instrument's waiting list. A lot of them are making promises they cannot possibly meet."

Shortage. To date, General Instrument's Microelectronics division in Hicksville, N.Y., is the only semiconductor company that is shipping a dedicated LSI chip for home-video games, and GI's capacity has limited the field. But National Semiconductor, Santa Clara, Calif., and Intermetall GmbH, ITT's subsidiary in West Germany, have both developed game chips, and other semiconductor companies are planning to follow.

Gamesmanship. Magnavox, which introduced home-video games in 1972, added this Odyssey 500 this month. More than 30 companies are now making such games.

Another limitation on the proliferation of video games is the Federal Communications Commission, which requires that these products be certified not to radiate interference when attached to the antenna terminals of television receivers. The FCC has slapped the wrists of a number of would-be games marketers for attempting to sell or even demonstrate nonqualified video games.

A third limitation is the inability of the companies to design appealing games and distribute them to the consumer market. While the coin-op companies do not have the same distribution problem as the consumer-oriented outfits, they do face the pressure of designing new formats with a very short turnaround time.

Success. But despite these limitations, the games market is here to stay: the initial success of the first relatively simple ping-pong-type games indicates that the consumer's taste has been whetted for more of the same. Estimates of the dollar value of the electronic-game business this year vary considerably because no one really knows yet how serious the chip shortage will be.

Sales of at least 2 million and as many as 7 million units are expected for home-video games with a retail value of $250 million to $440 million, depending on whose prediction is correct and how far prices drop this fall. Lows this spring will be in the $60 neighborhood. Worldwide sales of electronic pinball machines and coin-operated video-display games should reach $220 million to $250 million, although the demand for these products is not nearly as

explosive as in the home market. On the other hand, because of the rapid turnover of games in arcades, it's unlikely that this market will be saturated very easily.

Magnavox in Fort Wayne, Ind., whose Odyssey started home video games in 1972, is still the only American television producer to pursue the market. This month, Magnavox introduced three new Odyssey sets in its 1977 model line. The high end of the line, Odyssey 500, shows full-color playing fields and "players" with four games—tennis, hockey, smash (handball), and soccer. There are on-screen digital scoring, automatic serve and ball rebound, plus vertical and horizontal player action, in addition to the English and speed controls used in earlier models.

Choice. European television-set maker Philips, which acquired Magnavox a couple of years ago, introduced a game on the Continent at the beginning of this year. The unit, which contains four ICs, serves up on-screen squash, target shooting, and slalom skiing. Later this year, however, Philips will have another game from Magnavox for the European market. According to the company, some 100,000 home-video game units will be sold in all of Western Europe in 1976.

Atari Inc. of Los Gatos, Calif., whose Pong was successfully transferred from arcade to home use via Sears, Roebuck & Co., plans to unveil the first of a line of new home-video games at the show next month. Allan E. Alcorn, Atari's vice president for R&D, estimates that about 30 companies today have paddle-type games.

By the end of the year, the paddle or racquet types will be giving way to games of aggression—dog fights, tank battles, sea skirmishes, and so on—but the basic technology will still depend on digital n-channel MOS chips like the GI device. At the same time, some companies are getting set to use microprocessors in home games, but others contend that the price is not right yet for the sophisticated devices.

Fairchild's Exetron division, for one, will introduce this year a home-video game built around its F-8 microprocessor. The Santa Clara, Calif., division, which will demonstrate five games at the Consumer Electronics Show, will also display some of the 10 $19 to $25 cartridges that plug into one game console to "program" different games. The games will sell for $100 to $150.

Complexity. And Cardinal Corp. of Brooklyn, N.Y., is using an F-8 programed by second-source Mostek Corp. of Carrollton, Texas, for a chess game. The game, in which the player matches the microcomputer at selected levels of complexity, can be played with a TV display or with a hand-held unit that has only an alphanumeric display.

Executive Games Inc. in Boston is working on a microprocessor-based game for introduction early next year. "We view the market as very exciting," says Peter Stepanek, president of Executive Games, "limited only to the imagination of the individual company."

The arcade and pinball machines, which sell for $1,200 to $3,000, have had an easier transition from basic TTL boards to microprocessors than the home games because of the difference in price and because of the greater emphasis on rapid changes in format. Thus, Bally Corp. and its subsidiary, Midway Manufacturing Corp. in Chicago, have both used microprocessors—the Intel 4004 in Bally Alley, and the Intel 8080 in Gun Fight.

Ramtek Corp. of Sunnyvale, Calif., has just completed a video-display card game in which four players compete against an 8080 microprocessor "dealer." Also, Mirco Inc. of Phoenix, Ariz., is using a Motorola MC6800 in its Spirit of '76 pinball machine.

Microprocessors offer new opportunities to the coin-op companies—first, game controls can be programed and reprogramed quickly when developing the game, and, second, more features can be built into the final product. The most appealing characteristic of the microprocessor for both coin-op and home games is its ability to make the games progressively more difficult as the players become accustomed to the format. This adaptability holds the players' interest longer than games with a fixed level of complexity. □

Government

CoCom list, like subject, is complex

Semiconductors, computers, and laser sections abound with exceptions as list of goods embargoed from East bloc is updated

Exceptions everywhere. That's the rule for new 1976 Coordinating Committee (CoCom) lists of electronics embargoed for export to Communist bloc countries. New lists completed by the British Ministry of Trade and being prepared at the U.S. Department of Commerce are far longer than the amended 1972 lists they will replace—an expansion, most industry officials agree, that reflects the bureaucracy's grasp of the growth of Western technology. Each country's list will be approved by the Coordinating Committee, made up of the North Atlantic Treaty Organization member nations and Japan.

Significantly, sections of the new list devoted to semiconductors and computers that ran for several columns in the 1972 list now take up pages. This reflects the greater knowledge and sophistication of the list makers as well as the growing importance of those high-technology products in the total world trade picture.

Semiconductors, computers and their peripherals, lasers, and a variety of instruments are all categories subject to varying degrees of exception from export controls on the new lists. Importing countries covered by the CoCom controls include Albania, Bulgaria, China, Czechoslovakia, East Germany, Hungary, Mongolia, North Korea, North Vietnam, Poland, Romania, and the USSR.

Limits. Radiation-hardened, ruggedized, or airborne products of any kind are still controlled, of course, including component assemblies, printed-circuit boards, and microcircuits. However, Britain's new and expanded list relaxes the former controls on:

- Discrete component assemblies with maximum densities of 246 per cubic inch.
- Passive networks of encapsulated thick-film microcircuits, and bipolar circuits in T0-5 packages for "use as saturated digital logic elements (except Schottky barrier and emitter-coupled-logic types)" with maximum propagation delays of 15 nanoseconds or more.
- Nonreprogramable p-channel metal-oxide-semiconductor circuits for use in six-function manual calculators or for use as digital shift registers with a 2-megahertz maximum clock rate and no more than 256 bits per package.
- Bipolar memories in packages with maximums of 16 terminals and 64 bits and typical access times that are not less than 50 seconds.

While the British list also contains a variety of other components and circuits designed for such limited civilian applications as use in automobiles, digital watches, cameras, television receivers, stereo, and medical pacemaker systems, the rules make clear—as they have in the past—that no technology transfers that make possible East bloc production or assembly of any of the products will be permitted.

Computers. Relaxation of controls on exports of computers and some production technology other than design has drawn mixed reactions

Lasers don't escape the list

In addition to relaxing some controls on shipments of some solid-state components and computers to Communist bloc nations, the 1976 CoCom list contains some lasers as well. But the applications controls are limited to those designed for use as intrusion-detection alarms; in medical applications; as simple educational devices; for traffic-control and counting systems; environmental pollution measurement; as spectrometers and densitometers; for paper and textile cutting and bonding, or in diamond-drilling and wire-bonding systems.

Exports of lasers and their components not in specific systems are limited to:

- Argon, krypton, and dye lasers with output wavelengths shorter than 0.8 micron, a pulsed output of 0.5 joule, and an average continuous-wave maximum power of 20 watts.
- Helium-cadmium and nitrogen lasers with characteristics the same as those for argon and krypton except for 120 W maximum cw output power.
- Helium-neon with output wavelengths shorter than 0.8 micron.
- Ruby lasers with wavelength and power outputs shorter than 0.8 micron and 2 joules per pulse, respectively.
- Carbon-dioxide lasers in the 9-to-11-micron wavelength range with output maximums of 2 joules per pulse and cw or average power of 1,200 W.
- Neodymium lasers combined with yttrium aluminum garnet or glass with wavelengths of 1.06 microns, pulsed output of 0.5 joule, and maximum rated output power of 10 W cw or average.

Most new instrumentation products are built around custom integrated circuits. Most of them are made by Micro Power Systems.

Our sole business since 1971 has been helping original equipment manufacturers exploit advanced CMOS and Bipolar LSI technology to improve product performance and reduce production costs. We've helped design and produce numerous proprietary LSI circuits for our customers in the fields of instrumentation, digital timekeeping, communications, and medical electronics.

Applications for this type of LSI in industrial instrumentation products have increased dramatically in the past few years. Custom LSI has produced major technical improvements in the products themselves and has enabled many companies to achieve dramatic market advantages.

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- Chemical Monitors
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Our knowledge of the custom LSI approach to instrumentation products can help you to evaluate its potential benefits in your own terms. This can lead to your acquisition of a protectable, fully proprietary circuit. If your need is immediate, we invite you to contact Rich Koury, Manager, or ask for Instrumentation Product Marketing at (408) 247-5350.

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from industry officials who have had an early look at the changes. Several corporate sources say privately that changes permitting exports of some hardware classes without prior military approval—a major delay factor in the U.S.—were encouraging, while others believe they do not go far enough. Most were discouraged by continuation of periodic visitation requirements to a user's installation, even on a relaxed basis. None believes the continuation of user statements guaranteeing end-use for civilian applications only will prove effective because it is too easy to transship or engage in other practices designed to circumvent the regulations.

The new list will permit for the first time exports without prior military approval of computers with these maximum performance specifications (in megabits per second): 60 as the sum of the central processor bus rate plus the total effective bit transfer rate (vs 90 for systems requiring military approval); a CPU processing data rate of 13 (vs 32); internal memory of 4.72 (6.3); for peripherals other than magnetic tapes, total effective bit-transfer rates of 1.6 (8); data-channel or peripheral memory effective bit-transfer rates of 1,900 (3,200); peripheral memory performance factors 64,000 (135,000) as measured by dividing the unit's net capacity by 1.5 of the average access time. No system that is on the roster of approved exports may have more than 12 magnetic tape transports.

Technology. Exports of production technology (except for design) are still severely restricted, however. Specification maximums for such applications include: CPU data handling rates of 2 megabits/second; CPU numerical processing rates of 100,000 Mb/s; available internal memory of 32,768 bits, and peripherals limited to one magnetic tape with 1,600 bits per inch on each of nine tracks with a read/write speed of 25 inches/second; and serially operated cassette/cartridge tape drives with 800 bits per inch per track, and a 6,000-bit-per-second transfer rate.

Computer parts exports will be carefully monitored, the committee promises, with emphasis on controlling such advanced technology components as microprocessors, arithmetic logic units, fixed or alterable storage devices, and programed logic arrays.

For computers to be used for civil communications-switching networks, the CoCom list will permit some exports—with prior military approval of hardware—for use in exchanges not larger than 50,000 lines. For such systems, maximum performance specifications include: a 2,400-b/s total transfer rate for remote terminals interconnected to the computer. For the processor itself, data-signaling-rate maximums are 4,800 b/s for a single circuit; 27,500 b/s for all circuits combined, or 19,200 b/s for all circuits with signaling rates over 1,000 bits. □

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Except us.

You could say the Fluke 8000A is just now getting its legs and becoming the performer we always intended it to be.

It's had to. Because of our foresightedness, a whole new segment of the DVM market emerged. Suddenly, everyone was building a low-cost DVM.

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But they're sort of selective about what they ask you to compare.

Problem is that the average DVM lets you down in one performance area or another.

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It also performs, day after day. We'll guarantee one year of accuracy on all key parameters. Every unit comes with a one-year, no-nonsense warranty. If something does go wrong, we've got over 30 Fluke service centers that'll guarantee quick turnaround on your repairs.

They laughed.

And while those other DVM's have been scurrying to catch the 8000A, we've been improving and adding important, new options. Options that add additional measurement capability to the basic 8000A. There's a low-ohms model with 0.001-ohm resolution. A high current model for measurement up to 20 amps. A milliamp-second model. An analog meter model for peaking and dipping measurements. A high voltage probe for 1 KV to 40 KV measurements, RF probes for ac measurements to 500 MHz, a clamp-on ac current transformer for 2 to 600 A measurements, rack mount kits, test lead kits, dust covers and carrying cases.

So look at everything. Features. Performance. Reliability. Options. Price.

There's a reason the 8000A is the world leader in DVM sales.

And to all those people out there who are claiming this and that about which DVM you should own, ask them why the 8000A leads in sales at $299.*

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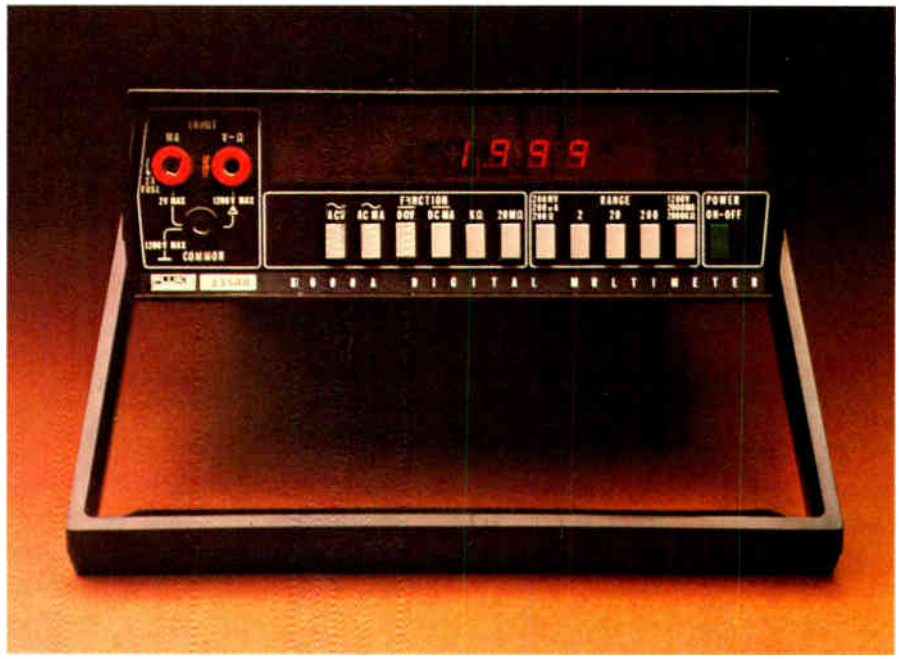

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People

Ferranti's new chief has big partner

Even insiders at Ferranti Ltd., one of Britain's showcase high-technology companies, concede that its products aren't as well known as its name. Producing virtually no consumer goods, the $200 million company is in many ways a custom-systems house. About 50% of its sales are covered by classified military contracts, and a third of the total is earned outside of Great Britain.

But Ferranti has fallen on hard times. In 1974, the family-owned business ran out of cash, mostly because it could not sell transformers. Unable to get bank loans, it turned to the government, which came up with $30 million for half the voting shares and 62.5% of the equity.

The task of turning the company around has fallen to its new managing director, Derek Alun-Jones. To do it, he can call on an impressive range of electronics technology. For the military, this arsenal includes weapons-aiming systems, digital-data transmission, and missile guidance. In avionics, there are a laser ranger and target seeker, inertial-navigation, aircraft-stabilization, and air-traffic-control systems. For industry, the list includes real-time process control, automated drafting gear, and lasers. And its Electronic Components division is building a family of large-scale-integrated products with collector-diffusion-isolation technology.

In one of his first interviews since taking over in December, Alun-Jones discussed Ferranti's problems with *Electronics*. Here are excerpts.

Q. How is the partnership with the government working so far?

A. Very well, I think, in that, so far, they've stuck to their part of the bargain. The liaison with them has been very friendly and reasonably informed.

Q. Has the government aid been enough?

A. Yes, certainly. Our plans for this year, which commenced April 1, are covered by our own resources. As far as we can see, we're all right for cash for this financial year.

Q. What about next year?

A. We shall end the year with some balance. We will use this year to plan on a longer-term basis.

Q. You recently stated that Ferranti had invested some 20 million pounds in areas that were losing money or were barely profitable. What are those areas?

A. Transformers, electronic components, and meters.

Q. Electronic components across the board or in certain areas?

A. I mean our Electronic Components division. Here, we have an area where the whole market has toughened.

Q. Do you expect it to turn profitable with the upturn in the world market?

A. Oh yes, though my chaps have difficulty in telling me when and how much it's going to turn profitable. Certainly, last year, we had a very difficult year in electronics.

Q. What geographical areas do you see as good markets?

A. Ferranti's products tend to be sophisticated, so they tend to be used in areas like the U.S., Europe, and the countries that have the money to be sophisticated in defense: the Middle East, Egypt, and other defense-conscious countries.

Q. Electronics—in the way of avionics, computers, components, and devices—dominates your operations. Will this emphasis on high-technology electronics continue?

A. Yes, they will get stronger. Those are the things we do best. Despite our problems, in many electronics areas we make a good profit.

Q. Will you try to change the percentage of defense business as time goes on?

A. We will try to lower it by raising the activity we do in other fields. We very much value the amount of business we do in the defense area.

Q. Are you working in microprocessors?

A. The microprocessing area is of great interest to us. Development work here [on the F100L] is on a defense contract, fortunately. It's also led us into supporting work. We're very pleased with what we've got. In computers, we're concentrating on two areas—military computers for ships and airborne applications and real-time process control with the Argus minicomputer range. We will stay with that, as we've never been in the business of making Argus computers and flogging them in large numbers. We've concentrated on the systems ability surrounding them, hoping to be in a position to put together the right systems package for the right customer. □

WHY IS EVERYONE FASTIDIOUSLY ACCURATE ON THE BENCH AND SO-SO ACCURATE IN THE FIELD?

Accuracy is needed in the field, also.

Does that come as a startling discovery? Probably not. Most test and measurement people want good accuracy in the field. But there just isn't much to carry out there.

Fortunately, Fluke had the foresight to build the 8800A digital multimeter.

No longer is it necessary to leave accuracy behind when you go into the field.

You can get basic DC accuracy of 0.005% anywhere.

Everywhere. In a clean room. Out doing applications work. Whether you're in communications or plastics. You don't leave accuracy behind on the bench.

And because accuracy in the field is something you shouldn't have to pay extra for, our price is what you'd expect to pay for lab accuracy, alone.

Actually, it's a little less: $985*.

O.K. But you need a lot more than accuracy. What else does this 5½-digit DMM give you for $985?

Great AC measurement performance. The 8800A measures 2 mV to 1200 volts in four ranges. Some 5½-digit DMM's are limited to 700 volts maximum, still others to 500 volts. For DC voltages, the 8800A measures ±1 μvolt to ±1200 volts in five ranges.

There are true 4-wire resistance measurements on all ranges, for low value resistance readings without lead resistance error. Measures 1 milliohm to 20 megohms in six ranges.

Accuracy and resolution to Fluke standards. For 90 days over a temperature range of 18°C to 28°C there's 1 microvolt of DC resolution with 0.1% accuracy. AC resolution is 10 microvolts with 0.01% accuracy. You get the accuracy you paid for under a wide variety of environments. And resistance resolution is 1 milliohm with 0.01% accuracy.

That's not all. The 8800A has a high DC input impedance of 1000 megohms through the 20-volt range. Offset current is less than 15 pA on all ranges. The best overload protection

"Some DMM manufacturers have funny ideas about test and measurement in the field."

in the industry. 10,000 hours MTBF, calculated and demonstrated (absolutely unique among DMM manufacturers). An unusually low 8 watts of power consumption. And a maximum open circuit ohms voltage of 3.3 volts, instead of the commonly offered 9 to 18 volt range that isn't good enough for measuring IC's.

Common mode rejection is better than 120 dB DC to 60 Hz. Normal mode rejection is better than 60 dB at 50 and 60 Hz.

And, remember, all this goes with you into the field. With accessories. High frequency probes. High voltage probe.

It makes sense, doesn't it?

Just because you're going into the field doesn't mean you want to rough it in test and measurement.

So, everything you can get at the bench, in a 5½-digit DMM, we're going to give you in the field. Convenience. Features. Accuracy. And that's why we lead the field.

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Satellites

Seasat to study weather's source

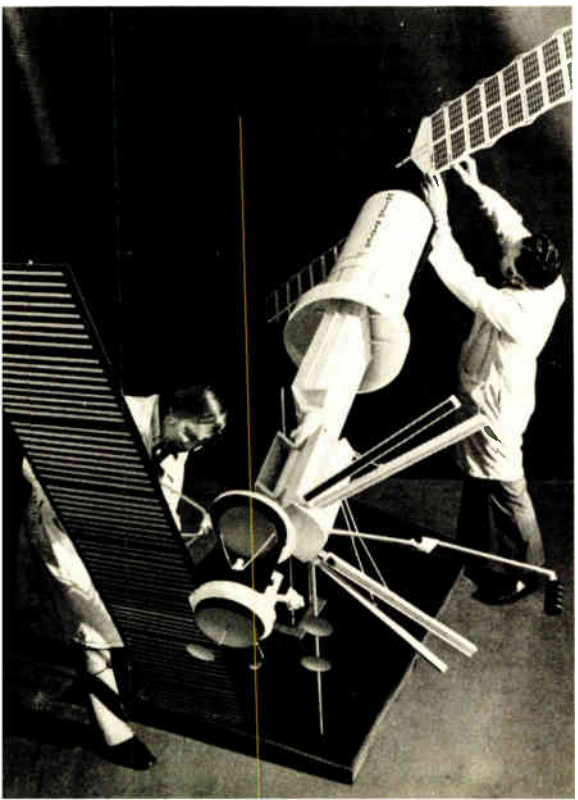
Collection of sensors never before used together in space will focus on waves, tides, surges, currents of the oceans

by Bernard Cole, San Francisco bureau manager

After seven years of planning, work is under way on the first in a family of Seasat global weather and ocean survey satellites whose economic value to the U.S. alone could approach $2 billion by the year 2000.

Being built under a just-approved $25 million contract by Lockheed Missiles and Space Co. in Sunnyvale, Calif., the 4,000-pound Seasat-A will carry an array of advanced microwave, radar, visual, and infrared sensors never before used together in space. Scheduled for launch in 1978, Seasat will serve as the prototype for a global system planned for the mid-1980s.

"As useful as such so-called 'weather satellites' as Nimbus, Tiros, and ITOS have been," says Seasat applications manager William T. Eaton, "the information they provide—basically, clear weather surface temperatures, cloud structures, and gross atmospheric patterns—just is not enough." Not only is a global system of satellites necessary, he says, but its major focus must be the primary weather-making machine, the oceans. In addition, he says, detailed information must be gathered about wave height, direction, and frequency; about ocean tides, surges and currents, and about liquid and gaseous water content in the upper atmosphere, before truly predictive models of the oceans' dynamics can be developed.



Sea look, Engineers at Lockheed Missiles and Space Co. in Sunnyvale, Calif., work on a model of Seasat-A, which is scheduled to be launched in 1978.

Sensors. According to S. W. McCandless Jr. of the National Aeronautics and Space Administration's ocean dynamics program, Seasat-A will be equipped with three types of radar and two different radiometers to make its oceanographic measurements. A key sensor system, he says, will be the so-called side-looking synthetic aperture radar. It will operate in the L band (1.275 gigahertz) and will provide all-weather imagery of ocean waves, ice fields, icebergs, ice leads, and coastal conditions and dynamics to a resolution of 25 meters over a 100-kilometer swath. Previous satellite systems, Eaton says, if they collected such information at all, did so only on a clear-weather basis. Being built by Ball Brothers Inc. and Westinghouse in Baltimore, Md., the radar's only previous nonmilitary use in space was aboard Apollo 17.

Another new system, McCandless says, is the 13.9-to-14.6-GHz radar scatterometer, which measures the signal strength of its returned echoes. "As surface winds increase," Eaton says, "so does surface roughness or chop. The scatterometer measures the signal strength of its returned echoes, and since this increases with the increase in wind-drive waves, this can be directly converted into wind speed and direction." The scatterometer, used previously aboard Skylab, is being built by General Electric Co.'s Valley Forge Space Center and Aerojet General of Azusa, Calif., and will measure wind speeds from 3 to 25 meters per second within 2 m/s and direction within 20°.

Complementing it, says Solvason, is another relatively untried sensor, the compressed pulse radar altimeter, previously used on Skylab and GEOS-C. Being built by the Applied Physics Laboratory at Johns Hopkins University, it will serve two functions. "It will monitor average wave height to within 0.5 to 1 meter along a narrow 2-to-12-kilometer swath by measuring the broadening of the returned echo caused by increased roughness," Eaton says, "as well as measuring to a 10-centimeter precision changes in the ocean geoid due to gravity variations, and tides, surges and currents."

Data processing. Sensor information received by ground stations will then be transmitted to the U.S. Navy's Fleet Numerical Weather Center at Monterey, Calif., where it will be processed and redistributed to the ocean-using community—civilian and military—as weather maps and advisories with less than eight hours' turnaround time. □

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O.K. So why no high cost?

Most testers share one major shortcoming: the cost and complexity of programming. As logic boards become larger and more complex, test engineers anxiously reach for more computer power and more software.

It just isn't necessary.

The fact is that tediously developed, bit-by-bit sequences are now past history. Instead, we provide powerful groups of general-purpose sequences with various duty cycles and frequencies. Boards respond to them. Their mathematical qualities honor the constraints of your circuits and the laws of logic.

Specifically, the 3000 Series Testers have seven classes of signals. Over 350 unique bit streams and their complements are available to exercise the most complex boards.

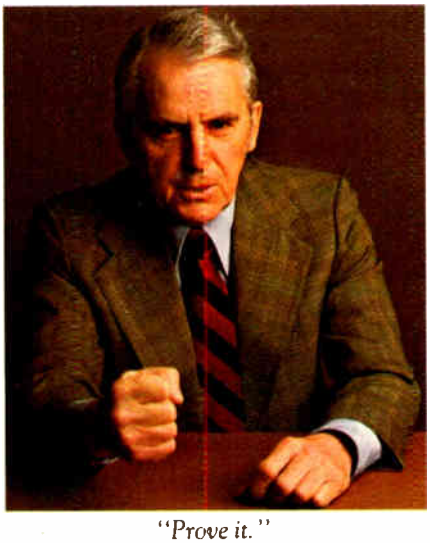
And, where a specific sequence is needed, it is easily added.

The test engineer doesn't program in the conventional sense. He simply develops a test plan which consists of selecting the appropriate stimulus algorithm for each input.

We've pre-programmed the CPU, simplified the peripherals, and eliminated 80% of the programming. That's what keeps the cost down.

The beautiful part is that test confidence ends up higher.

And fault isolation is just as practical as the price. It's hard to imagine



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any other tester making more common sense.

Test program assignments and editing are made on-line by pushbutton. Program debugging is simple. Whenever a pin number is entered, the sequence assignment is displayed. Sequences can be changed simply by depressing the appropriate pushbutton.

Again, there are no assemblers or compilers to fuss with. Highly comprehensive programs are completed in hours, not days or weeks.

And once the test program is entered into memory, you can record it easily on a handy little magnetic credit card that looks exactly like those credit cards in your wallet. The programmed card will function interchangeably with the production Model 3020A, or the field service 3010A.

Maybe we've made our point.

You can get a tester that offers four million tests per second, test sequences to 40 million words, and programmable logic levels without subsidizing a computer center and staff of programmers.

We'll prove it to you in dollars and cents.

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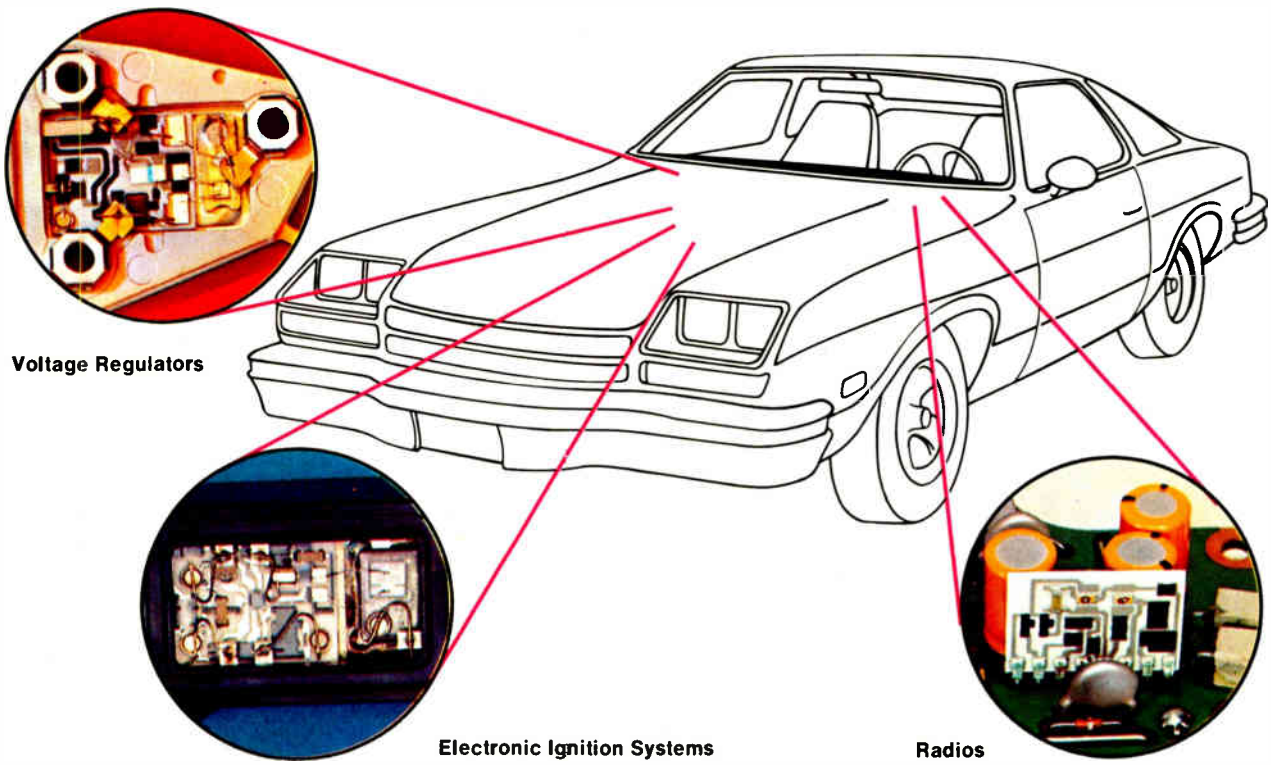

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Distributed processing grows as its hardware and software develop

Large-scale integration and better interconnections of computers benefit both lower-level processing and organized data networks

by Stephen E. Scrupski, *Computers Editor*

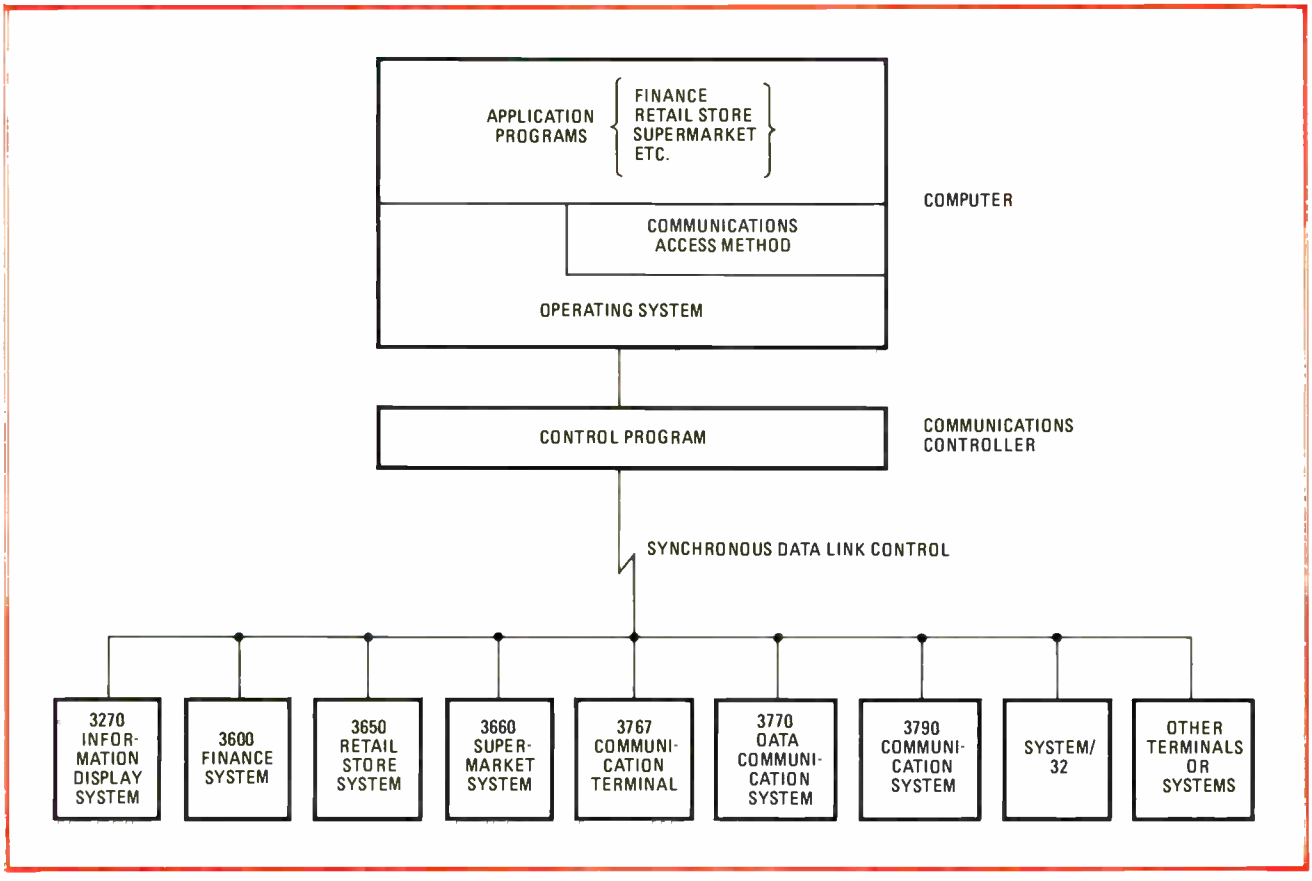
☐ Distributed processing systems are still evolving, so some confusion may exist as to what they are and what they do. But there is no misunderstanding about their potential. "If you're looking for a wave of the future, you must look towards distributed systems," says C. W. Spangle, president of Honeywell Information Systems. There are several trends that back up his prediction.

As central processing and memory hardware have dropped in cost—in large measure because of advances in large-scale integration—it was natural that computer-system designers would look for ways to take advantage of such trends. Also, minicomputer manufacturers, continually improving their products, are now able to offer more capability for the same price. Technology thus is inexorably pushing the manufacturers up into a market area where they will compete with the mainframe makers.

User management, also, is helping the development of distributed systems by decentralizing operations and allowing individual installations or departments to become more self-sufficient both in records keeping and data processing.

Another trend indicating the growth of distributed processing techniques is the increasing presence of

1. Business terminal. The Control Data Cyber 18-10 operates as a small, stand-alone computer and as an intelligent terminal connected to a computer network. The unit also can emulate IBM 2780 and 3780 terminals, allowing it to be connected to those types of systems.



2. Network architecture. IBM's new System Network Architecture covers the interconnection of several different types of terminal systems. Communication is through the company's SDLC protocol. A central 370 computer can run applications programs to support the terminals.

many small computers in one organization. How can their aggregate power be made available to all the users? Might users be connected into some network to allow them to multiply the processing power available through their individual minicomputers?

Although hardware has been making big jumps in performance, the necessary software is evolving only slowly. "A number of companies have combined limited local processing with remote-batch and data-inquiry capabilities," Spangle says. "But when you talk about completely distributed systems—systems with processing and information storage resident within the various operating components of an organization and with each application program accessible by programs at other sites—you are talking about things that are still largely experimental."

Thus, the problem with distributed processing, is, first of all, to define it. According to Neil Gorchow, Sperry Univac vice president for product strategy and requirements, distributed processing means whatever you want it to mean. "Are we talking about distributing the functions that the computer system performs into the auxiliary elements, or are we talking about distributing the processing of data back toward the source where the data is generated? The latter is my definition of distributed processing. Where I capture the data, I also begin to process it and then forward the results to some central source."

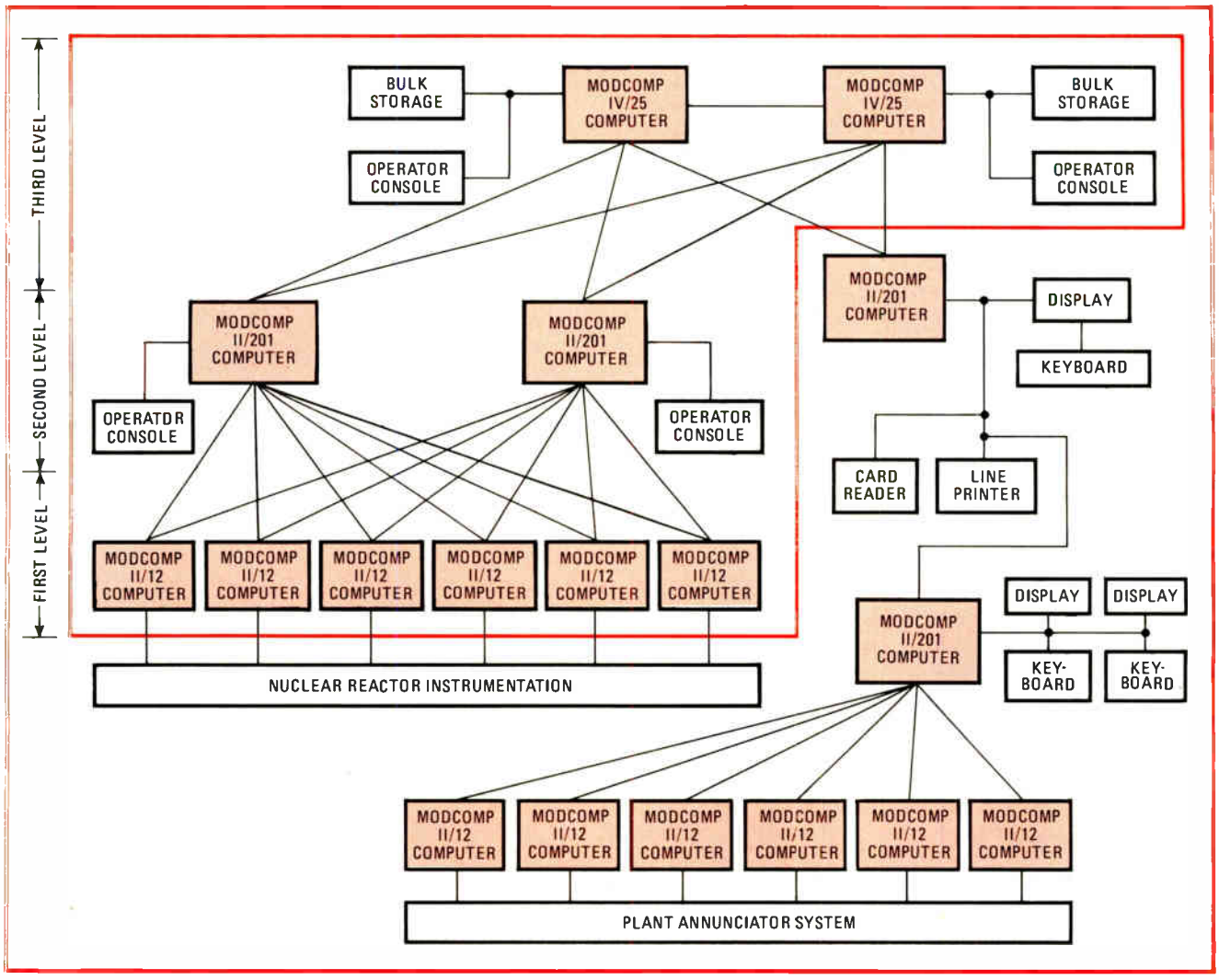
As Spangle points out, two types of computer networks are laying claims to the name of distributed processing. Remote locations are being equipped with lower-level processing systems that perform the functions needed there, sending only important results back to headquarters. In this category—by far the more prevalent today because of rapidly decreasing processor and memory costs—are the intelligent terminal systems offered by such manufacturers as Datapoint and Sycor. They can be used for order entry and preliminary processing of other transactions.

The other type is one in which network users have full access to all of its scattered resources. The Government's Arpanet [*Electronics*, May 2, 1974, p. 98] is the best example of this type—anyone connected can use the computing power available anywhere else in the network.

Software is the problem

However, the actual processing hardware does not impose as significant problems as does the software necessary to run the network. Individual computers installed at network nodes generally represent a variety of standard units and have their own operating systems and applications programs. The problem is to overlay some high-level network software that allows any one computer automatic access to the resources elsewhere in the network.

One way to view the intelligent terminals in the first type, in typical hierarchical applications, is as somewhat



3. Industrial network. Modular Computer Systems recently installed a network to monitor the operations of an atomic power plant. At the lowest level, Modcomp II/12 computers process data from sensors and pass it along. Modcomp IV/25 computers control the system.

schizophrenic. While they do act as computers when reducing raw input data, they usually become more like terminals when the central computer demands their attention, no matter how intelligent they may be when operating on their own. This ability to operate concurrently is an important factor in judging the operation of a network.

As an example, consider a recently installed system for Globe-Union Inc., a Milwaukee, Wis., manufacturer of batteries and electronic components. The company uses Datapoint dual, floppy-disk, intelligent terminals in its order-entry processes in each of 11 plants throughout the U.S. Previously, operators at local plants used teletypewriters to enter orders to the home office, keying information directly into the network from purchase orders. This involved considerable expense in tracking down errors on the purchase orders and operator errors.

The Diskette 1100 unit comprises a small computer, a video display screen for data entry, and local data storage using floppy disks capable of holding 256,000 characters of information each. The computers are connected through communications links to a Honeywell 6000 computer in the company's headquarters. The remote units in the plants process orders for the many types of batteries made by the company.

Globe-Union's private-label customers send purchase orders to the nearest plant, usually by mail. Operators enter onto the terminals data about the customer, billing address, battery part-number, and quantity ordered. Automatic error-checks signal if an invalid battery number or an erroneous customer number is entered. Once in the system, the purchase-order data triggers a process in the local plant to fulfill the order, while the home-office computer is alerted that the order has been received. When shipment has been made, the home-office computer generates the necessary customer invoice.

Another example is a system recently installed by Data General Corp. for a Canadian distributor of heavy construction equipment, Finnings Tractor Co., Vancouver. Salesman can get on-line responses to questions about the availability and location of particular types of equipment. The system uses a central Eclipse C-300 to store the inventory of equipment—about 250,000 different line items—including locations of available equipment. There are 25 branch offices, each equipped with

Nova 3 minicomputers running cathode-ray-tube displays. They also act as intelligent terminals, storing the local inventories.

IBM's SNA

Even in IBM's new System Network Architecture (Fig. 2) in which the central 370 computer controls many different types of intelligent terminals as well as a System 32 computer, only the 370 can always act as a computer at all times. Even the S/32 must interrupt its operation to service the 370.

The firm introduced the new system to establish a standard way of connecting all its different terminal models to a central computer. It doubtless also moved in order to counteract increasing competition from minicomputer manufacturers and intelligent-terminal producers, who have been making their products compatible with the 370 computer. Other mainframe manufacturers also are developing their own network architectures for their products.

The IBM system is, first of all, a definition of a network structure, not a product. It defines the functions that various parts of the network will do and how programs will be loaded from the central processor into the remote distributed-network elements. It also defines how the distributed elements will get access to the central processor and extract the data they need to do their jobs.

It also creates a standard that will help combine previously diverse networks. Large users, for example, often have various terminals connected into different special-purpose networks. They must live with the inefficiencies rising from the inability of one network to talk with another. Each terminal must be totally dedicated to its own network—but with System Network Architecture, one terminal can service any network.

The system divides network functions into discrete types and defines protocols and formats for communication between parts of the network. Products developed by IBM for use in the networks embody combinations of hardware and programing whose designs are based on the architecture.

The company also has developed a concept, called the Distributed Intelligence System, for interconnecting System 7 computers to a central 370 in industrial applications. The individual S/7 computers can gain access to the data files and the peripherals available at the central 370 site. Different S/7 computers can pass data from one to the other, and programs can be loaded and executed from one computer to another. The programer can use high-level language such as Fortran or PL/1 on the central computer and the system without regard to characteristics of individual computers.

The mini makers

Minicomputer manufacturers view distributed processing as a major opportunity to compete with the mainframe manufacturers. Of course, in order to compete with large computers, anyone making small computers must convince customers to break up their processing requirements into smaller blocks that could be satisfied by smaller computers. And the manufacturers must develop the necessary software that will support the networks.

Both Digital Equipment Corp. and Modular Computer Systems, for example, have developed network software concepts that allow them to tie their minicomputers together. DEC's Decnet allows interconnection of all its computer types, and Modcomp's Maxnet similarly covers interconnection of the full range of its computers, albeit one that spans a somewhat narrower range in performance.

Announced about a year ago, Decnet is installed in networks with as few as two machines and as many as 12, according to DEC's Nathan Teichholtz, software product manager, networks and communications, while some future installations may involve about 40 computers. "In general, Decnet is quite different from the typical kinds of networks that most people are familiar with because it really is a computer network," he says. "It's a way of interconnecting many independent computers to solve system problems, as opposed to trying to do it all on one machine or hooking lots of terminals to a single computer—which is the typical kind of network that people have talked about."

The problems in such a network involve compatibility between software of heterogeneous types of machines, Teichholtz says. "We think that one of the strengths of Decnet is that it covers many different series of heterogeneous hardware and software architectures. The goal is to be able to interconnect them quite freely."

Maxnet is a software operating system residing in each computer in the network that handles all communications between computers. The host computer, generally more powerful than the satellite, has, say, floating-point hardware, more memory, and more peripherals. Thus the host usually does the report-generation and file-management tasks, while satellites perform local data acquisition and process control and do some processing of data before sending it to the host.

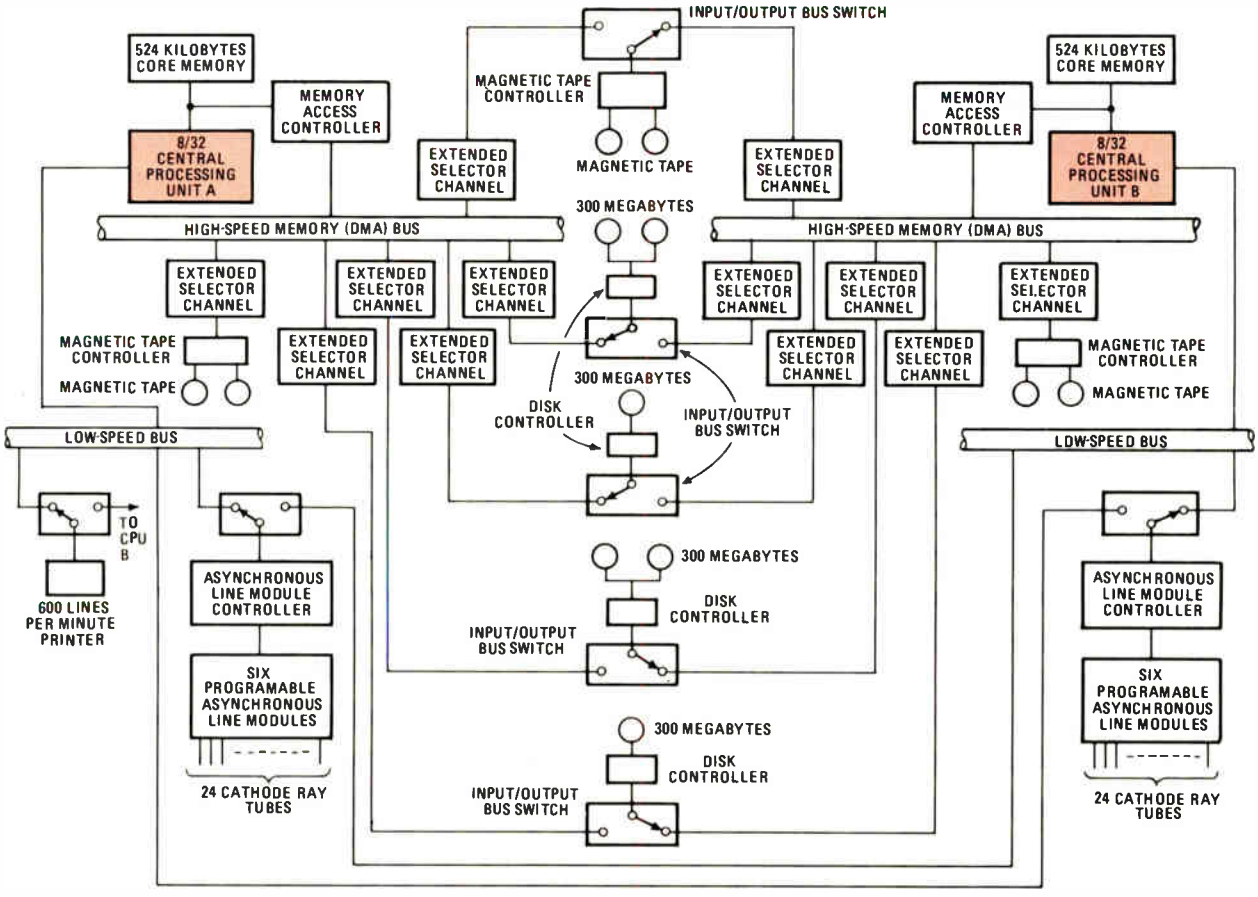
Users can direct the network operation with programs written in Fortran. From the host computer, they can do compilation, assembly, and debugging of programs for all the computers in the network. A host computer can load a program into the memory of a satellite via the direct-memory-access channel while the satellite is performing its own tasks. Maxnet also enables each computer in the network to control tasks in others and to use local or remote peripherals.

One example of a Maxnet installation is in an atomic-power generation plant (Fig. 3). Modcomp II/12 computers are placed close to the points of data generation and perform detailed control jobs while larger Modcomp II/201 computers are working to monitor these lower-level computers.

Such transfer of software and remote access to peripherals is one of the hallmarks of true distributed systems. Hewlett-Packard's disk-based 9700 distributed system central computer, for example, can support a network of lower-cost satellite computers and can also communicate with a central 370 computer and with other 9700s.

With a variety of software running on the satellites,

First steps in decentralized processing



Although not a distributed processing system according to the definitions in the accompanying article, the approach taken by Citibank, New York, to decentralize its processing of stock transactions serves as a good example of the trend. The company had used an IBM 370/158 computer running almost full-time to handle the transactions. With a new system based on the Interdata 8/32 computers, this computing power has been distributed across five smaller systems of the type shown above.

Information on transactions is entered via the cathode-ray tube terminals. The processors check and update the stored records, making sure that the seller actually does own the shares, that his account is reduced by the amount of the sale, and that the buyer's account is credited. The transactions also are checked to make sure that stolen securities are not involved. Some transactions from outside accounts also are entered via magnetic tape.

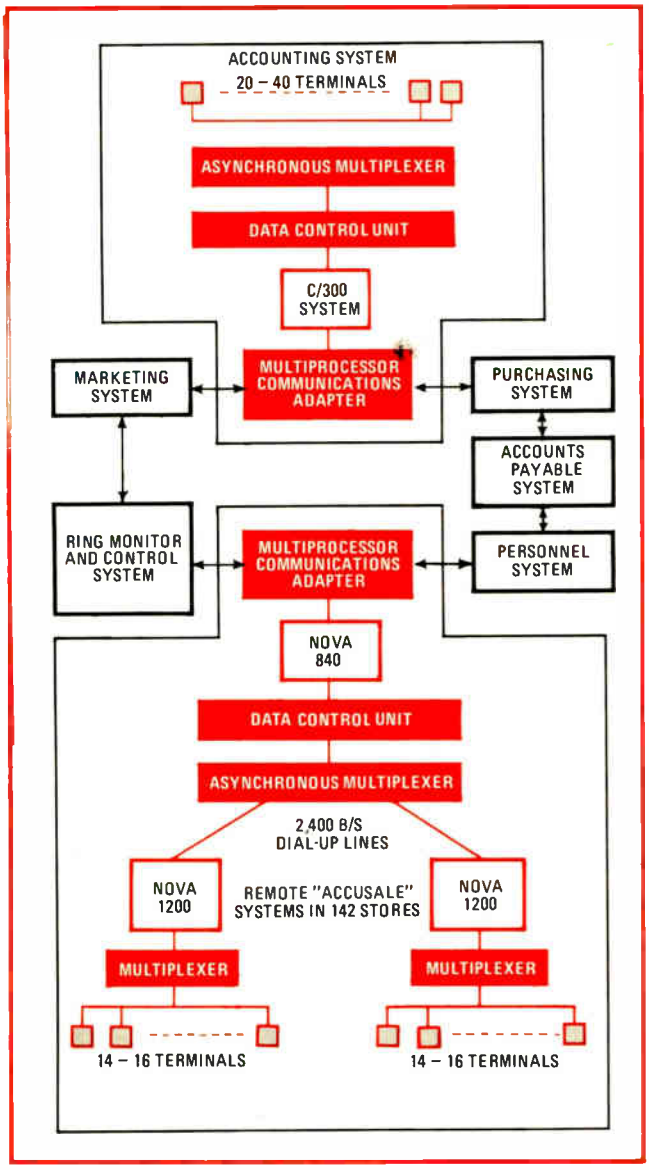
Note that the system operates essentially in a stand-alone mode with a minimum of interprocessor communication. Information can be swapped between processors via the magnetic-tape units, but such cases would be unusual. With more communications capability between the processors, this system could be classified as true distributed processing.

the 9700 can perform such functions as remote-file access, program-to-program communication, and downlink loading of programs. It also allows program-development from low-cost satellites using the facilities of the disk-based central computer. And, with a map of the satellite features in central storage, a program can be written for all satellites and automatically matched to the facilities available at each. Peripherals also can be shared, so a satellite can send data directly to a central line printer, for example.

A ring-structure system is being installed by Data General at Lowe's Companies Inc., North Wilkesboro, N.C., a retail hardware chain. When completed, a series of Eclipse C-300s will be connected in the ring, and each will control many terminals (Fig. 4). Information can be passed between the different data bases serving each major department—accounts payable, personnel, marketing, accounting, and purchasing.

Microprocessors and protocols

The heavy emphasis on software does not mean that hardware developments have come to a standstill. Large-scale integration, which is at the heart of the development of cheaper computing power, is also being applied to microprogramable processors that will allow more universal interconnections of various computers. These permit conversion of communications line protocols and emulation of other processors built into termi-



4. Retail ring. Data General is installing a ring-structure network to process transactions for a retail chain. Each system in the network is identical to the accounting system shown in detail. The structure allows each system access to records of any other department.

nals that already are compatible with the network.

Digital Equipment Corp., for example, uses a communications protocol called DDCMP (Digital Data Communications Message Protocol), which incorporates error detection and allows retransmission when errors occur. In present systems, the central processor, under program control, assembles messages to fit the protocol. But with the DMC-11, a new high-speed microprocessor with a programable read-only control memory and a small random-access memory for information needed to process messages, will perform this function, thereby relieving the PDP-11 program of these details.

The microprocessor uses medium-scale integrated components and has a 300-nanosecond cycle time with 8-bit data paths and 16-bit microinstructions. "There were not any high-speed commercial microprocessors available when we started the design," says Anthony G. Lauck, communications hardware product manager for DEC.

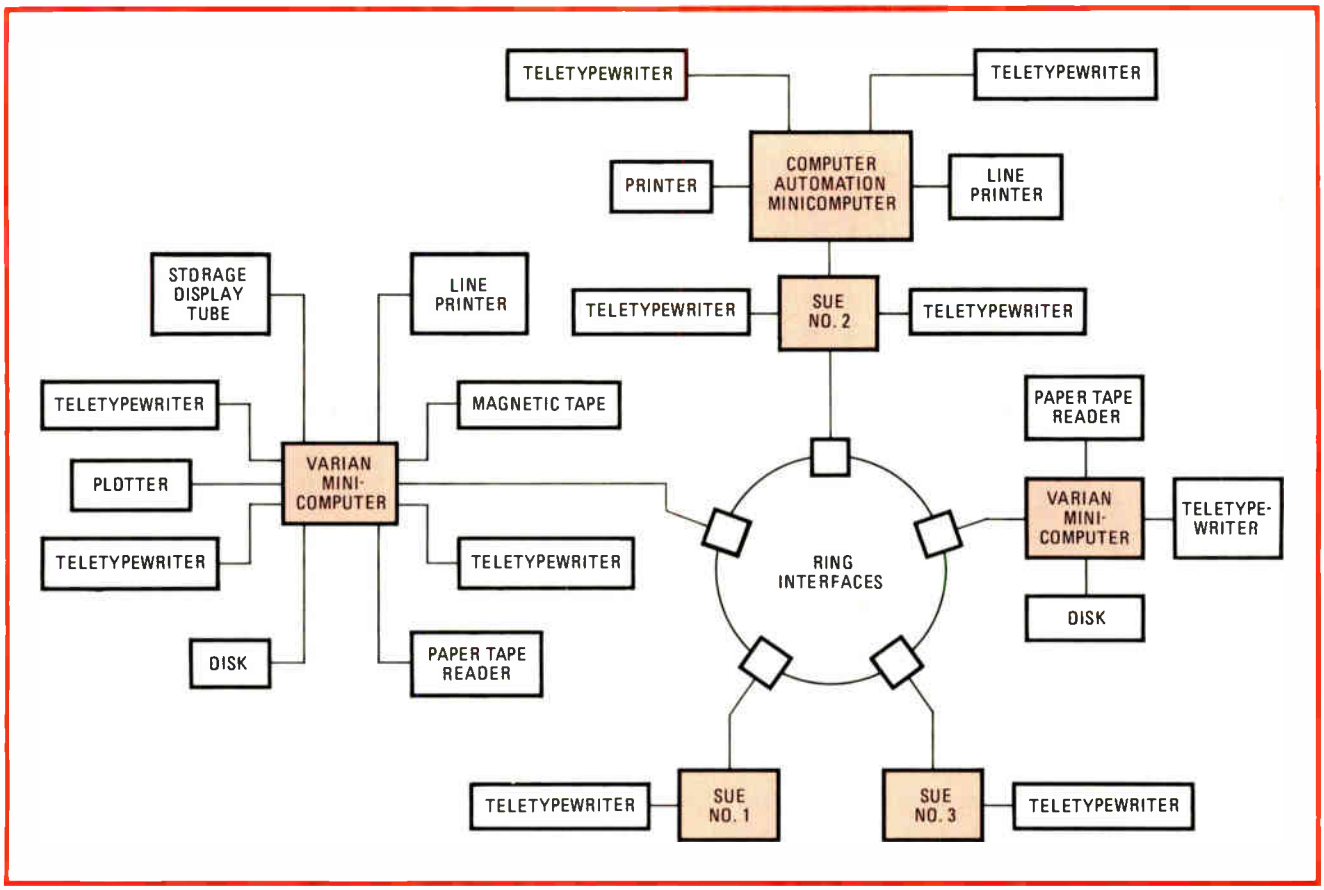
"There were some bit-slice parts available, but by the time we got through, we would have used as much space and spent as much money as in the MSI design that we came up with. We see the DMC-11 improving the performance of Decnet substantially, giving us the ability to run up to 1 megabit per second over local coaxial cable." The previous maximum speed, he notes, was about 50 kilobaud.

While DEC developed its own protocol, some minicomputer companies are following IBM's lead. Late last year, General Automation announced a hardware and software package for its computer-network architecture based on IBM's synchronous-data-link-control (SDLC) protocol. It is building hardware to interface its SPC-16 and its successors, the Solution Series—GA-16/110, /220, /330, and /440—to a computer network. The controllers, multiplexers, and associated software allow assembly of many different networks, covering remote microcomputer-based terminal controllers, satellite minicomputers or remote data concentrators, redundant multiprocessor modules tying together several minicomputers at the central computer level, clusters of multiprocessor modules for distributed data-base management, and multiple clusters for full data communications networks. All communicate through the SDLC protocol. And, when a new function must be added to a system, users need not rewrite the central-computer operating system. Rather they could simply add a new dedicated processor by plugging it into the network.

Distributed processing also will have an impact on organizations with many different minicomputers already in place. For example, at the University of Arizona in Tucson, many research laboratories have their own minicomputers. According to David Clark, director of the university's computer center, the goal is to interconnect these computers to his center to allow the laboratories to expand their processing capabilities.

"We're barely sticking our toe in the water at this point," Clark says, "but we are going to be heavily involved in distributed processing." He says the network will be based on the Decnet protocol. "We have a DEC System 10 computer—probably one of the largest installations of that kind in existence—and we have a CDC 6400 in the same room. These two are linked together, and next we're going to form a triangular link, hooking in a PDP-11/40 to serve as a communications interface for both of them."

Clark says there are between 60 and 80 minicomputers of all varieties on campus. "Our view is that the demand for computing services cannot be met by just an exponential growth in giant machines. And we also intend to connect in the Arizona State University in Tempe, which has a Sperry Univac 1110 machine, via a Decnet-like protocol and also the Northern Arizona University in Flagstaff, which has an XDS Sigma 6 that will be linked into the system, not long after that. Any terminal that could get into our center could then get into one of the other centers. This concept supports task-to-task communications, so a task running on any



5. Distributed computing system. Ring network at the University of California, Irvine, interconnects minicomputers for full access to one another. Messages are passed between computers—Lockheed Sue, Varian 620, or Computer Automation LSI-2 units.

computer could establish communication with a task running on any other computer.

"For example, in one lab, a researcher is doing cancer-cell research using a microscope with a digitizer to digitize the light patterns for a PDP-11/45. He has programs that process those digitized representations of the cancer cells and do pattern recognition in order to automate the process of cancer detection.

"He feels there are not enough doctors in the world to analyze all the slides that could be taken. He has very large statistical programs, and as his experiments proceed, he has to trek back and forth to the computer center bringing his data and running it on the CDC 6400 to guide him in what to do next. He's probably our next candidate for linking in, because if we can get his PDP-11 talking to the computer center it can speed up his work, giving instant access to the large machine from his machine while doing his pattern recognition."

Such systems, with already-installed computers that will be interconnected, offer the challenge of developing network software that makes use of software facilities at each computer. However, if system software is designed from the ground up with operating systems specifically for each node, then the system may have more flexibility. This is what David Farber did with the distributed computer system in place at the University of California at Irvine.

The system is a collection of minicomputers (Fig. 5) connected to a digital communications ring, which serves as a unidirectional information path operating at 2.3 megabits/second. Control of the ring is distributed among interfaces, which connect the computers to the ring. The structure allows incremental growth of the system, since new computers can be added simply by adding another interface unit.

Messages from one computer to another are addressed to a program or task that is resident on a computer connected to the ring. The messages are addressed by name, and there's no need to know where in the system they reside. As the message arrives, each interface compares the program name with a list of all those that are active in the attached computer. If there is a match, the interface copies the message into memory.

Whether or not the addressed process is present, the interface allows the message to travel on around the ring, until it arrives back at the interface for the originating processor. There it is removed from the ring.

Each processor on the ring has a resident software system called the nucleus, which provides facilities for the scheduling of processes and the transmission and reception of messages. Other system functions, such as resource allocation, device input/output, and file-system services, are provided by processes executed in the overall system. Because the nucleus is the only software absolutely bound to a particular processor, all other system services may be executed by any machine in the ring and can be accessed from any user via the message system. □

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16-bit processor performs like minicomputer

Fast device features memory-to-memory architecture plus large system capability

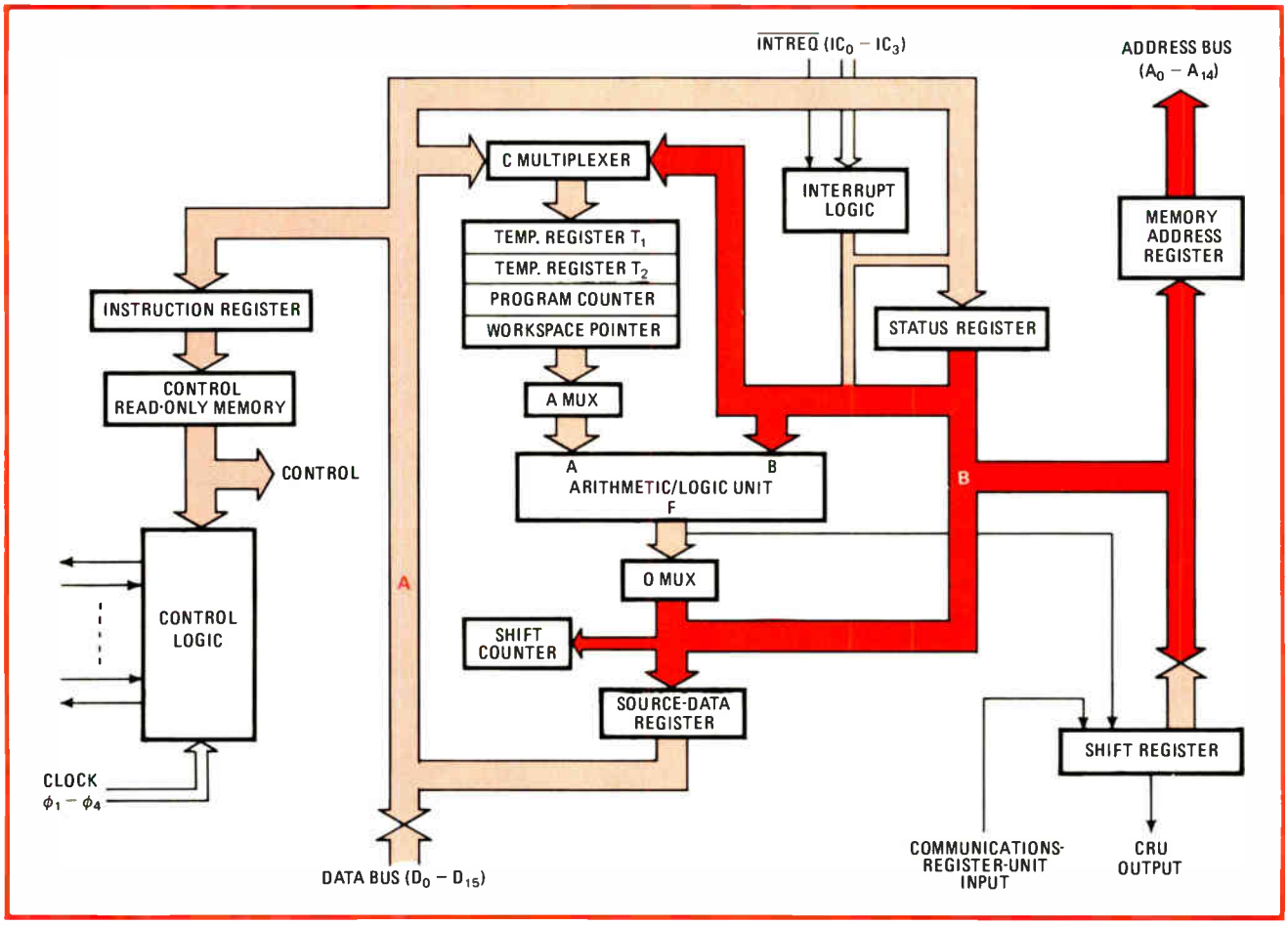
by Alan Lofthus and Deene Ogden,
Texas Instruments Inc., Dallas

☐ While most 8-bit microprocessors can be used for peripheral controllers and small-to-medium data handling systems, their processing and data-acquisition capabilities often face the system designer with unsatisfactory alternatives. For larger configurations, which accommodate big blocks of memory or handle fast, high-precision data, the designer has to push the 8-bit system beyond its most comfortable performance level or else turn to full-blown general-purpose minicomputers that could well represent an expensive overkill.

The new TMS 9900 microprocessor changes all that by offering data-processing performance and 16-bit precision of a minicomputer at a microprocessor-system cost. It can be used even in highly dedicated cost-sensitive applications. In addition, the 9900 allows the user a natural upward growth, since it is a member of a software-compatible family of computers that includes the microprocessor itself, the 990/4 microcomputer, and the 990/10 minicomputer.

Of the single-chip, 16-bit processors available, only the 9900 offers 3-megahertz cycle times and the minicomputer-type architecture that makes the central processing unit extremely efficient. Its 16-bit words can reach large blocks of external memory two bytes at a time and can easily accommodate the needed 8-, 12-, 14-, and 16-bit converter resolutions.

Unlike the 16-bit chips built with the p-channel,



1. Big chip. An LSI version of a minicomputer CPU, the 9900 handles addresses on the 15-bit address bus (labeled B) and data on the 16-bit data bus (labeled A). Interrupts are handled on the interrupt request line and four code lines; I/Os by the communications register unit.

metal-oxide-semiconductor method, the new device uses n-channel silicon-gate technology. This accounts for its high speed and results in transistor-transistor-logic input and output levels that work directly with standard memory and I/O packages. No special memories or chips for system interfacing are needed.

Many features

The chip has full 16-bit capability on both address and data buses. Since both are full-capability parallel busses, access to 16-bit words is in one fast cycle.

There are no general-purpose memory registers in the central processing unit. All data goes directly from memory to the chip's arithmetic/logic unit or to special-purpose registers for interrupts, data status, etc. and then back to memory again. Forgoing on-chip, general-purpose registers gives extremely efficient data transfer and makes room for sixteen 16-bit general purpose registers in memory that greatly add to the CPU's capability and flexibility. Since all data processing resides in external RAMs, register capacity is not limited by the processor's on-chip register data. And putting all data in memory saves time during interrupts or subroutines since no CPU register data must be saved.

The interrupt capability has 17 vectored interrupts: two predetermined and 15 determined by the system designer in software. The device is almost as flexible as a minicomputer for general-purpose data-processing jobs.

Separate, nonmultiplexed data-, address-, and I/O-bus structures mean that no external multiplexers are needed to distinguish bus use. Moreover, the chip is fully compatible with all data inputs, outputs, and controls operable from standard TTL signals. Thus, it can operate with all standard RAMs, read-only memories; I/Os, and peripheral TTL circuits. Its 16-bit competitors need special peripherals.

Many of the set of 69, 16-bit instructions are two-operand instructions containing source- and destination-operand address information in one line of code. An example of the savings here is that the STORE and LOAD commands of other machines become simply MOVE in the 9900. The instructions are further enhanced by the seven addressing modes available for use on random-memory data, or formatted memory data such as character strings or tables.

In short, the 9900 is particularly well suited for interrupt-driven, real-time applications with large memory requirements where fast processing is required. Its 3-MHz instruction cycle, together with its powerful instruction set, gives the designer a true third-generation microprocessor for today's designs, especially in high-speed data-handling and process control applications.

The 9900's architecture

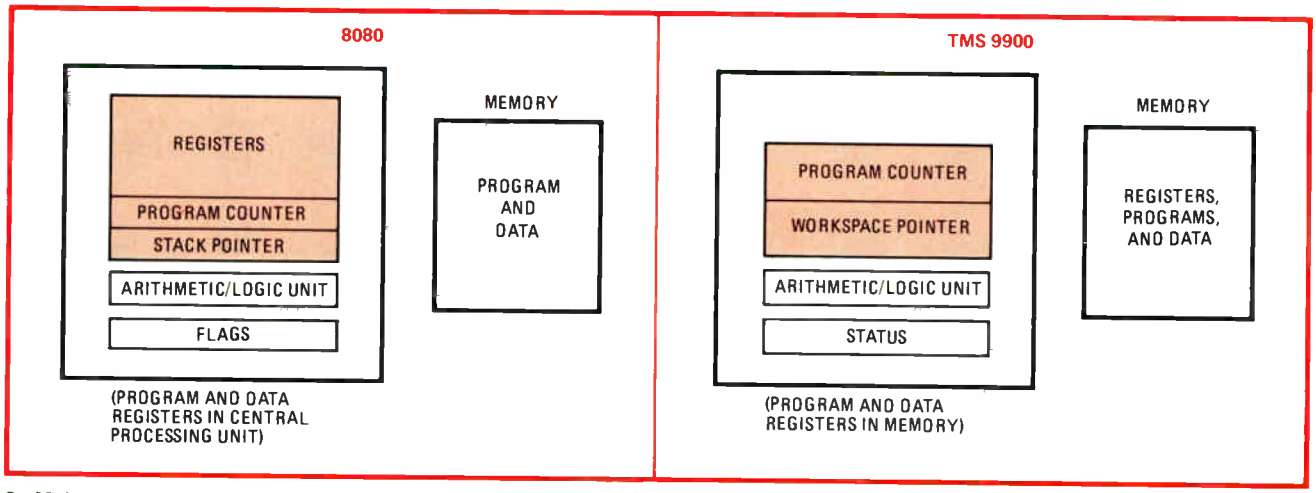
The configuration of the chip (Fig. 1) is basically a large-scale integration of a minicomputer CPU. The memory addresses (upper right) are applied to the 15-bit address bus B by the memory address register, while the 16-bit data bus A (left) serves as the memory data input and output. The interrupt interface consists of an interrupt request line, INTREQ, and four interrupt code lines, IC_0 to IC_3.

The input/output interface is usually accomplished through serial I/O ports designated as the communications register unit, or CRU, (lower right), which ties all I/O circuits implemented in this manner to a general-purpose on-chip shift register for control by the chip. The remaining miscellaneous control clocks and power signals (lower left) complete the functional elements.

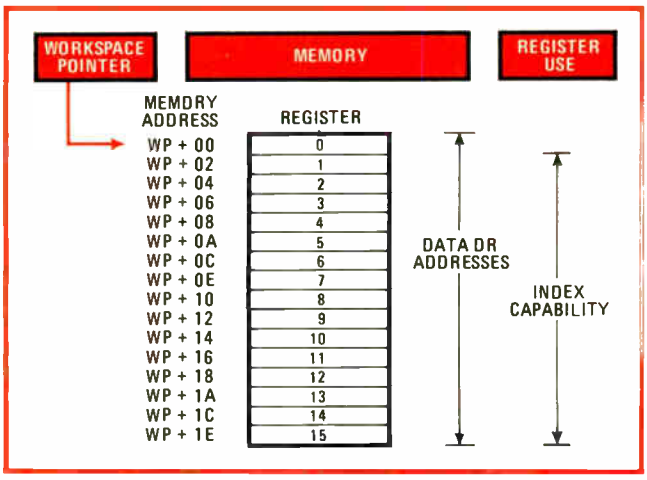
The heart of the 9900 is the arithmetic/logic unit. During any machine cycle, it can receive one of two input signals on one of the two independent buses. The input on data bus A comes from the four-tiered, 4-by-16-bit register file with a program counter keeping track of the instruction sequence, a workspace pointer keeping track of external memory spaces, and two temporary registers, T_1 and T_2, used for short-time storage during instruction execution.

The second input to the ALU is the B bus, which can be driven by such various working registers as the source-data register, shift register, and status register. The bus also goes to the register file through multiplexers A and C, which jump the instruction in progress during interrupt operation.

The ALU output F, through the D multiplexer, also



2. Makes the difference. While the 8-bit 8080 microprocessor reaches external memory with a conventional, stack architecture, the 9900 uses external memory for program and data spaces, as well as general-purpose registers organized as a 16-by-16 register file.



3. Pointers. The workspace pointer automatically generates memory addresses. Here it points to the first workspace register. The CPU reaches any register within the active register field by doubling the register number and adding it to the pointer.

drives the B bus and, for example, can feed either the shift counter, used with the shift register during shift, multiply, divide, and CPU instructions, or the source-data register, which is used to drive the data bus output lines, D_0 through D_{15}.

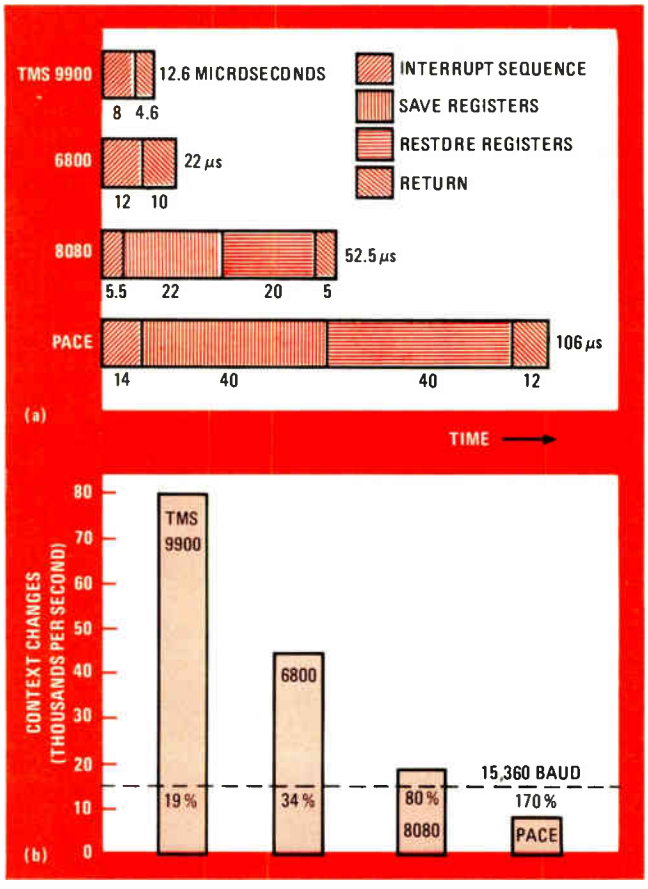
How it works

An instruction execution consists of four sequences that occur in the control ROM of the chip. The first sequence is the instruction-acquisition phase, in which the value of the program counter in the register file is passed through the ALU, the D multiplexer, and into the memory address register. During a memory-read cycle, the instruction moves from the data bus to the instruction register, which then initiates the remaining three sequences: source-operand derivation, destination-operand derivation, and execution.

The two derivations are control-ROM sequences that acquire instruction operands based on the type of instruction and the addressing mode. The operand addresses are generated from the values in the workspace pointer, along with the contents of the incoming instruction, while the source data, destination data, and destination address are stored in the source-data registers, T_1 and T_2. The instruction is executed using the source and destination data, and the result is stored in the external memory location specified by the destination address.

During execution, the LOAD and INTREQ inputs are checked to determine if an interrupt is pending. If INTREQ is active, then a 4-bit code is generated on the interrupt code lines and compared to the appropriate status-register data to determine whether the interrupt has sufficient priority to be accepted. If it is accepted, a vector address, generated in the ALU by the interrupt logic, goes to the memory-address register to initiate the interrupt sequence. If no enabled interrupts are active, the program counter is incremented by two to point to the next instruction, and the instruction acquisition sequence is initiated again.

How the 9900 machine architecture compares with the popular 8080 8-bit microprocessor is shown in Fig.



4. Low overhead. The 9900 keeps the interrupt overhead low (a) compared to other designs. Even for applications requiring a very high level of interrupt capability—above the line in (b)—the 9900 has over 80% of its processing time left over for useful routines.

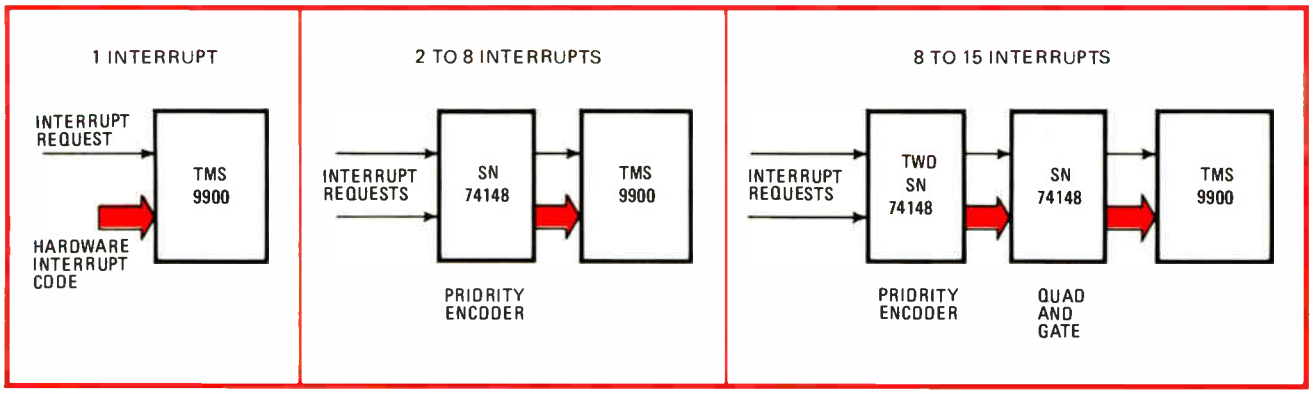
2. The 8080 employs a conventional stack architecture with a register file, program counter, stack pointer, ALU, and flag register. The program and data spaces reside in external memory. The 9900's CPU consists of the program counter, workspace pointer (or register pointer), ALU, and status register, which is similar to the 8080 flag register. The new device's external memory provides program and data spaces and general-purpose data registers organized as a 16-by-16 register file.

Big jobs

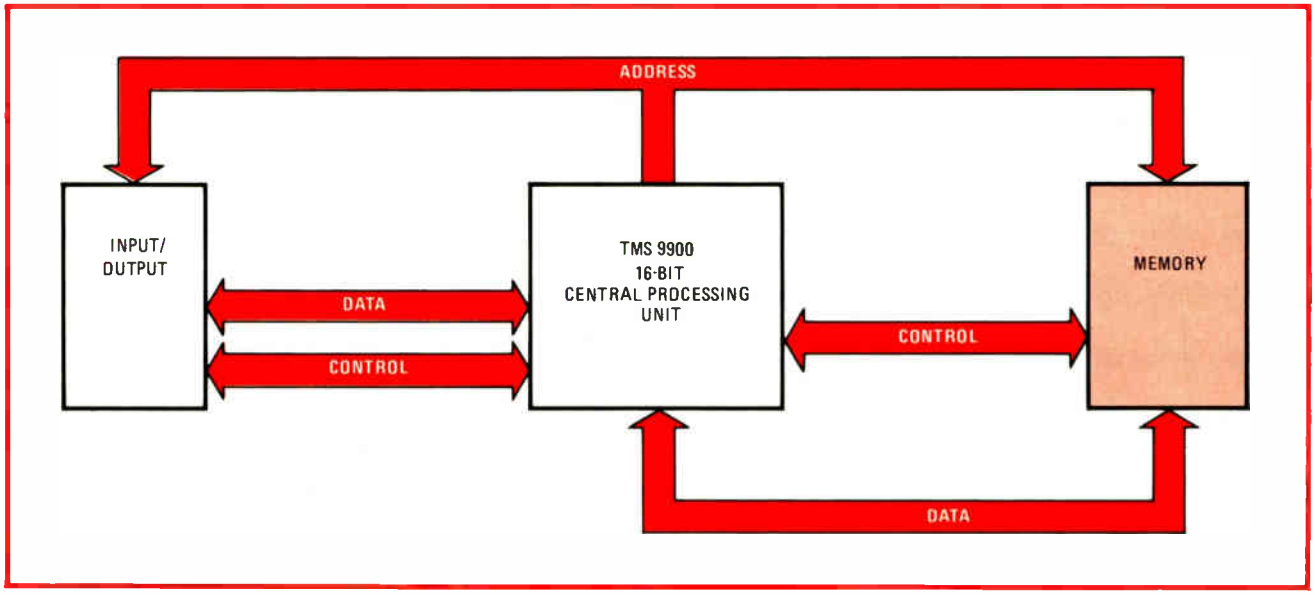
For the big jobs, the memory-oriented 9900 architecture has significant advantages. Since the register file resides in main memory, the number of workspace registers is limited only by memory size. Thus it can handle a large quantity of data unlike the 8080, which handles only what the on-chip register file can accommodate.

The architecture of the 9900 also allows the programer access to three internal registers: the program counter, workspace pointer, and the status register. Thus, the fact that the data registers are located in memory is completely transparent to the user. A programer, for example, can specify any register, and the device generates the actual memory address with the workspace pointer, as shown in Fig. 3.

Memory access is organized so that all 16-bit memory addresses specify the location of one byte of data. Thus,



5. It's easy. Although the 9900 has a powerful interrupt capability, it's easy to work it. One interrupt requires no external hardware. Less than eight require one priority encoder, while eight to fifteen interrupts need only an additional quad AND package.



6. System bus. The system bus is simplicity itself. For memory there are completely separate address, control, and data lines. For I/O there are separate control and data lines. Moreover, all standard memory and I/O packages can be accommodated without interfaces.

the memory space for a system is 65,536 bytes, organized as 32,768 by 16 words.

Since each access to memory results in a 16-bit word, or two 8-bit bytes, the memory address bus requires only 15 bits specifying 32-k words. The 16th, least significant, bit is maintained inside the chip's working registers and specifies the byte which the CPU must use during instruction execution. Note that, during byte operations, the integrity of the unused byte is maintained, but, at the completion of the instruction, the two bytes merge and return to memory. This means that the instructions automatically control operations.

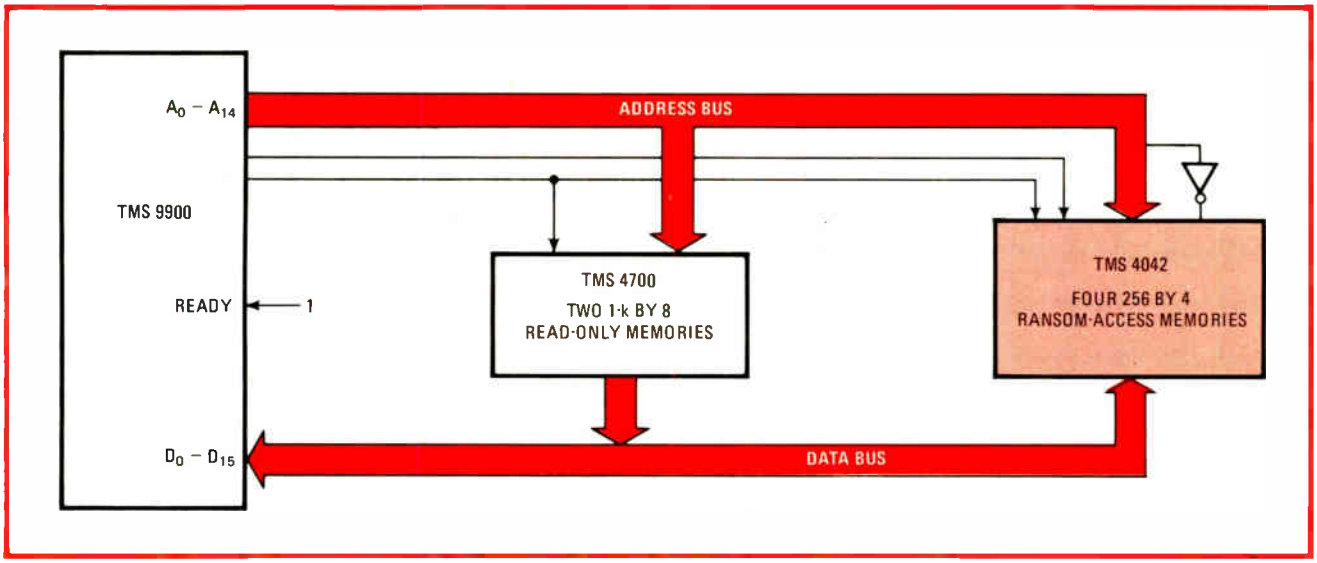
Handling context switches

The memory-to-memory organization handles context switches efficiently and rapidly. In standard minicomputer language, a context switch is a program-environment change that occurs as the result of an interrupt, a subroutine call, or a special software "trap" instruction referred to as an extended operation.

During interrupts, the exchange of data in the active registers proceeds very smoothly. The contents of the program counter, workspace register, and status register of program A are all automatically stored in registers 13, 14, and 15, respectively, of the B workspace register. Then the CPU obtains the locations of this register file and of the interrupt subroutine from the 2-word vector in lower memory space reserved for that interrupt. The return instruction moves the three A program linkages back into the processor, returning it to program A.

Figure 4a shows the effects of this typical operation on interrupt overhead for each of four microprocessors. In most processors, this overhead time consists of four sequences: CPU interrupt sequence (done automatically by its hardware); storage of the interrupted data in the CPU registers, called save registers, (done by instructions at the beginning of the interrupt subroutine); restore registers (done by instructions at the end of the interrupt subroutine), and return instructions. Since all the 9900's operations reside in external memory, there is no on-chip active register data to save or to restore. This cuts the total interrupt overhead time to only 12.6 microseconds, or ½ to 1/10 that of other popular designs.

Figure 4b shows why this speed becomes important to the system. Clearly, the 9900 can efficiently handle interrupts with the greatest percentage of processing



7. Getting ready. For small memory systems, say, 1,024 words of read-only memory and 256 bits of random-access memory, the ready line on the 9900 CPU can be tied high so that gates or buffers are not needed on the control, address, or data lines.

Pitting the 9900 against the competition

A benchmark test, pitting the 9900 against the 16-bit PACE system and the 8-bit 8080 and 6800 systems, compared performance on the execution of instructions. Six programs were used, with comparisons made in program memory requirements, measured in bytes, assembler states or lines of code, and execution times.

Results for the separate programs were added together (bottom, left), showing that the 9900 saved at least 20% on program memory requirements, used at most 56% as many assembler statements, and executed instructions at least 42% faster.

The input/output handler program is an interrupt-driven routine that brings in a character from a modem, tests for an end-of-line character, outputs the character on a cathode-ray-tube terminal, and returns control to the main program.

The character-search routine searches a table of 40 characters anywhere in the memory for a specific character. It generates the address of the matched character, or, upon failure, a zero address.

The computer-go-to routine tests a control byte that has one true bit. That bit's position determines which of eight table vectors controls transfer.

The vector-addition routine adds two N-dimensional vectors from anywhere in memory to generate a third N-dimensional vector. Both 8- and 16-bit precision routines are provided. N was 20 in the test.

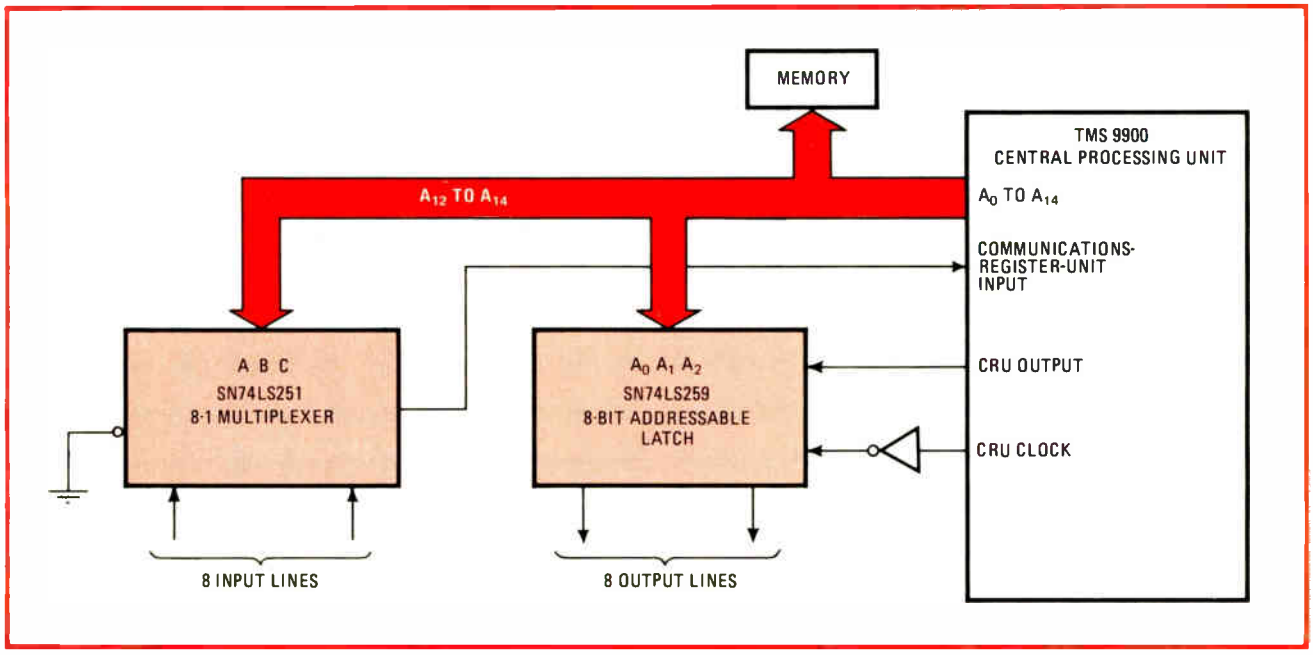
The shift-right-5-bits routine shifts a 16-bit word right by 5 places, with zero filling on the left.

The move-block routine moves a block of 64 characters to another location. Both start and destination blocks can be anywhere within memory.

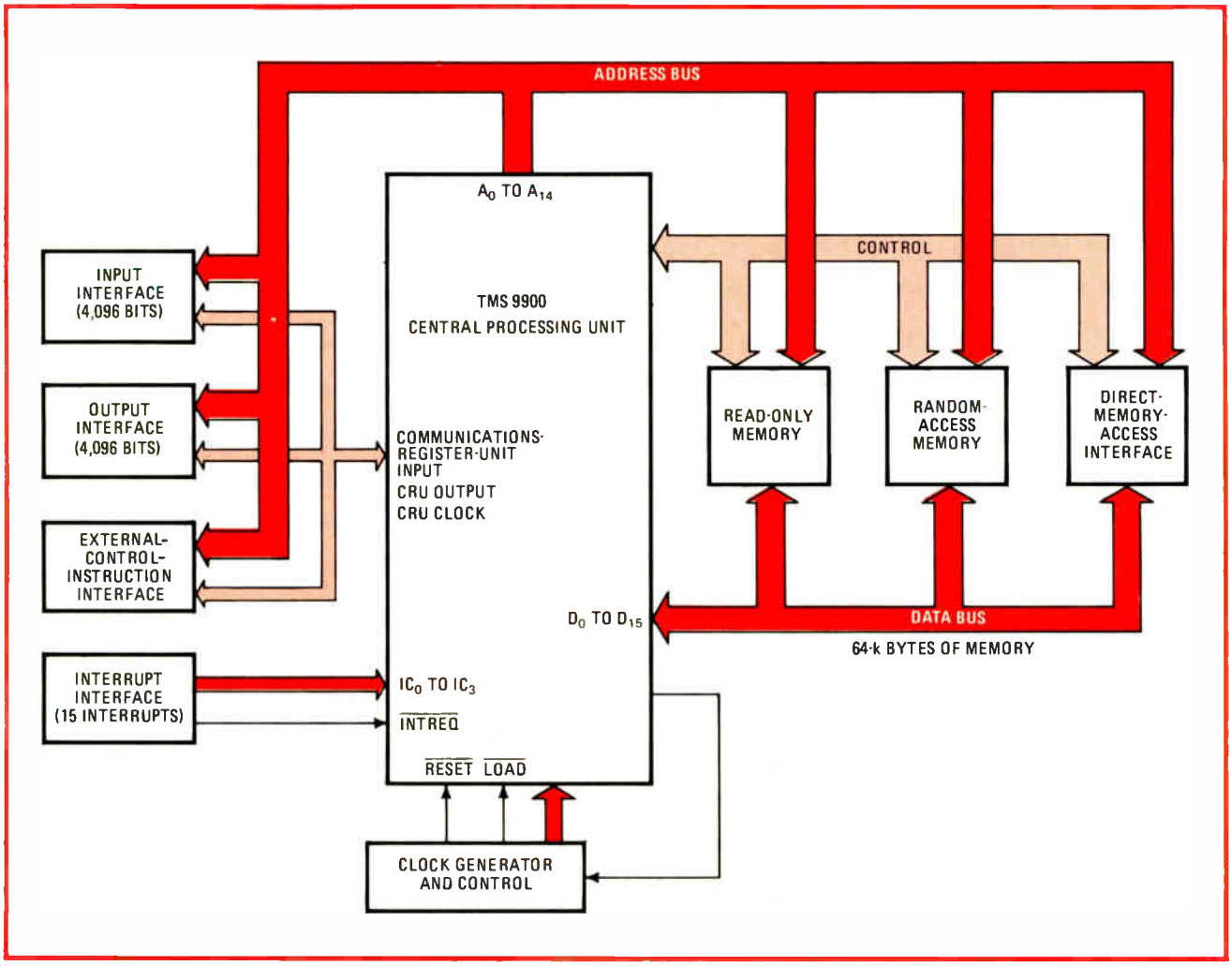
Also shown (below right) are the 9900's execution times for sample instructions. Although a simple register-to-register add is slower than with some current microprocessors, the device's ability becomes clear in the more advanced instructions, such as indexed-to-indirect add, multiply, and divide. All of these require many instructions in other processors for the equivalent function, while they require only a single instruction with the 9900.

	Program memory requirements (bytes)				Assembler statements				Execution time (microseconds)			
	9900	PACE	8080	6800	9900	PACE	8080	6800	9900	PACE	8080	6800
Input/output handler	24	38	28	17	9	14	17	7	71	154	79	49
Character search	22	24	20	18	8	10	9	8	661	1636	760	808
Computer go to	12	12	17	14	5	5	11	8	98	352	145	145
Vector addition: $A_N \leftarrow B_N = C_N$ (16)	20	30	29	46	5	14	20	22	537	2098	1098	1866
Vector addition: $A_N \rightarrow B_N = C_N$ (8)	20	32	23	40	5	15	14	22	537	2108	738	936
Shift right 5 bits	10	6	19	20	3	3	12	9	22	56	137	81
Move block	14	18	16	34	4	9	9	16	537	1750	1262	2246
Totals	122	160	152	189	39	70	92	92	2464	8154	4219	6131

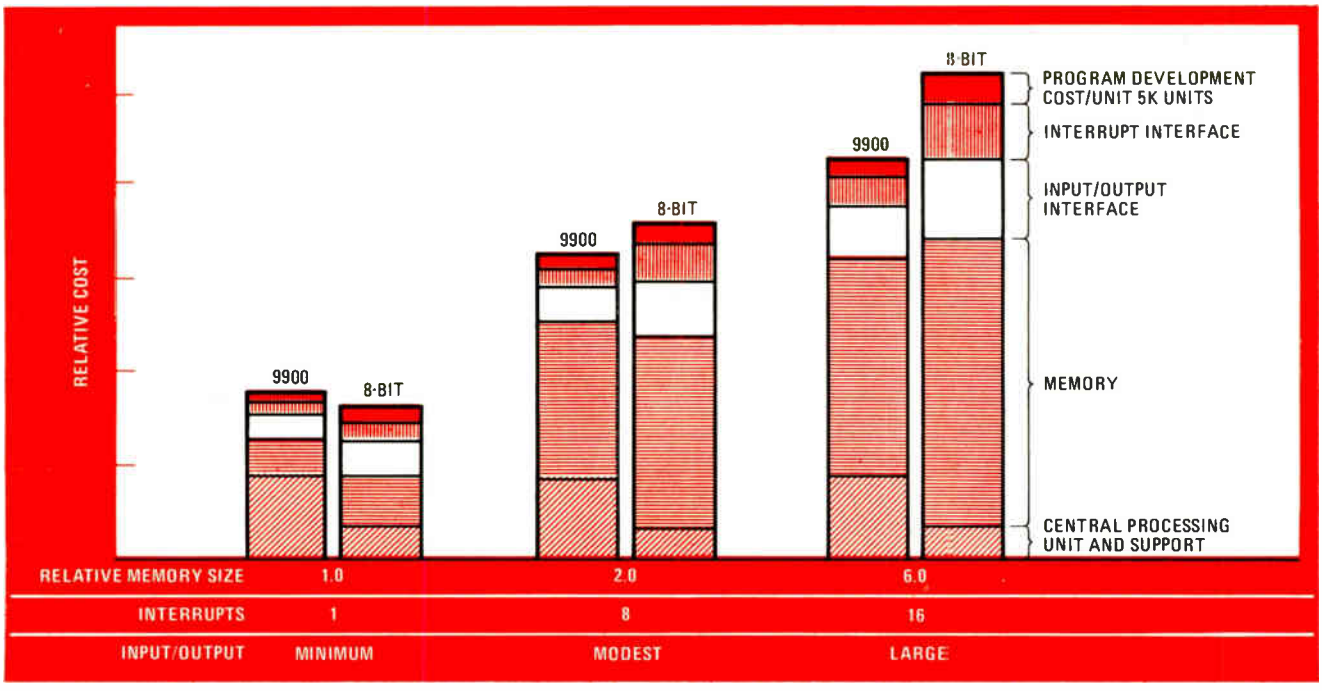
Instruction	Execution time (microseconds) (Clock rate is 3 MHz)
Branch	
Register to register	2.67
Add (words/bytes)	
Reg. to reg.	4.67
Indirect to indexed	8.67
Multiply	
Reg. to reg.	17.33
Divide	
Reg. to reg.	41.33
Shift (left/right)	
1 bit	4.67
8 8 bits	9.33
Move data (words/bytes)	
Reg. to reg.	4.67
Reg. to directory/index	7.33
Load communications register unit (reg. to CRU)	
8 bits	12
16 bits	17.33
Store CRU (CRU to reg.)	
8 bits	14.67
16 bits	20



8. The interface. The special communications-register-unit interface port gives interface flexibility. The configuration for an 8-bit parallel I/O transfer requires only two standard TTL packages, compared to the LSI interface chips with most other processors.



9. The system. The 9900 CPU can handle a powerful minicomputer-type system configuration. Here 64-bytes of RAM and maximum I/O capability are accommodated, yet the entire system has only nine circuit blocks, including direct memory access.



10. Value. For large configurations, although the CPU costs may be higher for the 9900 than for the 8080, the 9900 system costs considerably less thanks to the efficiency with which it handles large amounts of memory, I/O, and interrupts.

time remaining. As an example, the dotted line indicates a very high interrupt rate, where 16 cathode-ray tubes are performing data concentration at 9600 baud. Even in this application, the chip has over 80% of the processing time left to perform useful routines.

Taking interrupts in stride

The simple, cost-effective interrupt structure, (Fig. 5) includes 17 vectored interrupts arranged in priority. There are two zero-level, nonmaskable interrupts for handling the reset and load functions. The rest are available for external use. For single-interrupt applications, no external hardware is needed, and the interrupt request signal is directly connected to the CPU. For systems with two to eight interrupts, a single SN74148 priority encoder is needed, and for more than eight, two SN74148s plus a SN7408 gate package are needed.

The last 4 bits of the chip's status register provide a code that constitutes a masking level for interrupt operation. The CPU uses this mask, which is under program control. If the level is at, say, 8, the program allows interrupt levels 0 through 8 and disallows 9 through 15.

Then, if level 5 is requested, the 9900 will start the interrupt sequence at the completion of the instruction being executed. It will automatically move the mask to level 4, one step below. This effectively masks out lower interrupts and allows higher ones. During the return instruction, the previous status-register value changes the mask level back to 8. This sequence, which continues until all interrupts are processed, allows fully nested interrupts with no polling.

The 9900 microcomputer system

The key to the simplicity of a 9900 computer system (Fig. 6) is the completely separate address, control, and data lines to the memory, as well as the separate control and data lines to the I/O devices. This interfacing is simpler than with the 8-bit systems that have shared busses.

Included among the control signals are READY and WAIT, so that mixed memory speeds are allowed. For example, if the access time of the memory is 500 nanoseconds or less, the ready line can be tied to logic high, and the processor will never have to wait for the memory. Moreover, in a small memory system such as a 1,024-word ROM and a 256-word RAM (Fig. 7), the ready line can also be tied high, and neither gates nor buffers are needed on any input lines.

Three methods of I/O interface capability exist. In addition to the DMA conditions mentioned above, there are what is called memory-mapped I/O capability, which is similar to other microprocessors, and the CRU interface port, unique with the 9900.

This CRU structure makes it extremely easy to interface with I/Os. It can directly address up to 4,096 each of input and output bits and handles data transfers over serial I/O lines. Thus it is a simple, easily expandable, nonmultiplexed interface that hooks up directly with most types of I/O devices. Moreover, with special CRU instructions, it is possible to manipulate a single bit or multiple bit transfers through the port.

The interface logic required for, say, an 8-bit parallel I/O transfer (Fig. 8) is very simple, utilizing standard, low-cost TTL packages. Comparable interfacing for other microprocessors often requires special MOS-LSI circuits, which are more expensive.

Figure 9 shows the entire system capability of the 9900, and Fig. 10 shows how it compares in cost with typical 8-bit systems. Although the CPU costs may be greater, the savings in memory, I/O, and interrupt-interface circuitry on the system level can be significant, compared to a typical 8-bit system. Of course, the larger the memory system required, the greater the savings. □

Adjustable pulse generator features rate alarm

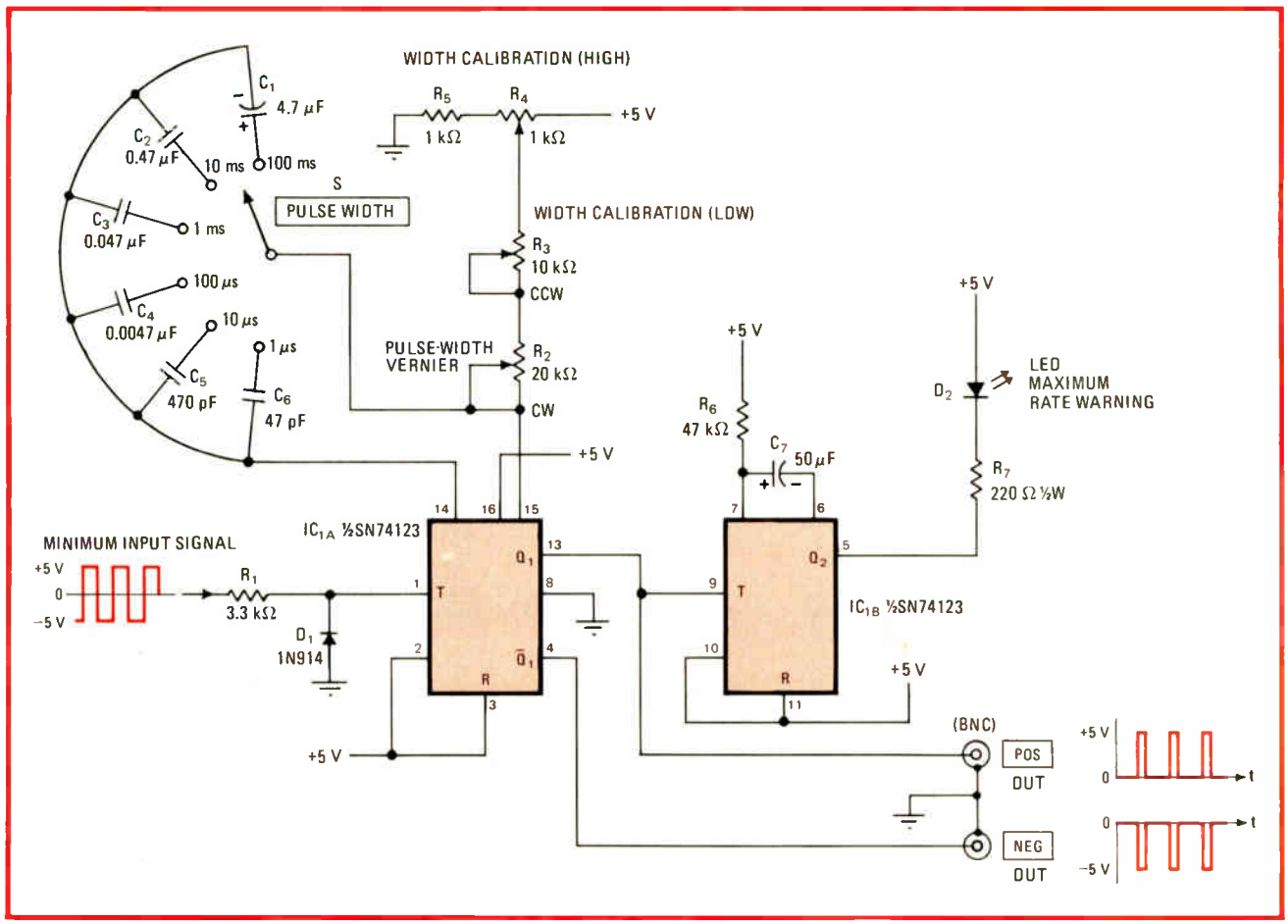
by Frank N. Cicchiello
Geometric Data Corp., Wayne, Pa.

A TTL dual monostable multivibrator integrated circuit driven by a clock emits pulses of either polarity with widths adjustable in six decade ranges from 100 nanoseconds to 100 milliseconds. Output rise and fall times of the pulses are 15 ns or less, and the frequency can be greater than 10 megahertz. The most novel feature of the generator, however, is a maximum-pulse-rate indicator light that switches on if the clock rate is increased so that it is no longer compatible with the pulse width; that is, if the clock period is equal to or less than the pulse width.

Each negative-going transition of the clock signal applied to resistor R_1 causes one pulse to be generated by the one-shot multivibrator, IC_{1A}. Pulse width is determined by the circuit time-constant R_PC_P, where C_P is any capacitor from C_1 to C_6, and R_P is the sum of R_2 through R_5. Positive-going output pulses are available from IC_{1A}'s Q output, and negative-going ones from its $\overline{Q}$ output.

If the rate of the incoming clock signal is so high that its period is less than the desired pulse width, IC_{1A} is retriggered during its pulse-forming time (this type of one-shot multivibrator is retriggerable at any point in its operating cycle). Retriggering keeps the output of IC_{1A}, which is connected to the input of the second one-shot circuit, IC_{1B}, constantly at +5 volts. If IC_{1B} is untriggered for a time equal to its time-out period (approximately 2 seconds for listed values of R_6 and C_7), the output of IC_{1B} switches to ground level at Q_2, and the light-emitting diode lights.

The circuit includes potentiometers for vernier adjustment of pulse width and for calibration. The procedure is as follows:



Fast and narrow. Adjustable-width pulses down to 100 nanoseconds are produced at rates to 10 megahertz by this TTL circuit, based on a single dual-monostable integrated circuit driven by any suitable clock. If the input clock rate is raised so high (or the output pulse width is made so small) that the width exceeds the period, Q_2 goes low and lights the warning LED.

1. Adjust input clock frequency to 500 Hz.
2. Set switch S to 1-ms position.
3. Set R_3 to midrange.
4. Set R_2 to full clockwise (cw) position.
5. Adjust R_4 for 1-ms output-pulse width.
6. Set R_2 to full counter clockwise (ccw) position.
7. Adjust R_3 for 100-microsecond output-pulse width.

Repeat steps 4–7 until the rotation of R_2 from full counterclockwise to full clockwise changes the width of the output pulse from 100 μs to 1 ms.

The warning indicator can be checked by switching switch S to the 10-ms position. The indicator will light until the output pulse width is less than 1 ms.

Any function generator can provide a suitable clock signal. If a bipolar generator is used, diode D_1 eliminates negative pulses. □

Shift register with feedback generates white noise

by Marc Damashek
Clarke School for the Deaf, Northampton, Mass.

A shift register with linear feedback generates a pseudorandom sequence of pulses that can be used without digital-to-analog conversion or audio processing as extremely high-quality audio white noise. The output from the register, fed directly to an audio amplifier, produces a power spectrum that is flat to within ±1 decibel over the entire audio range.

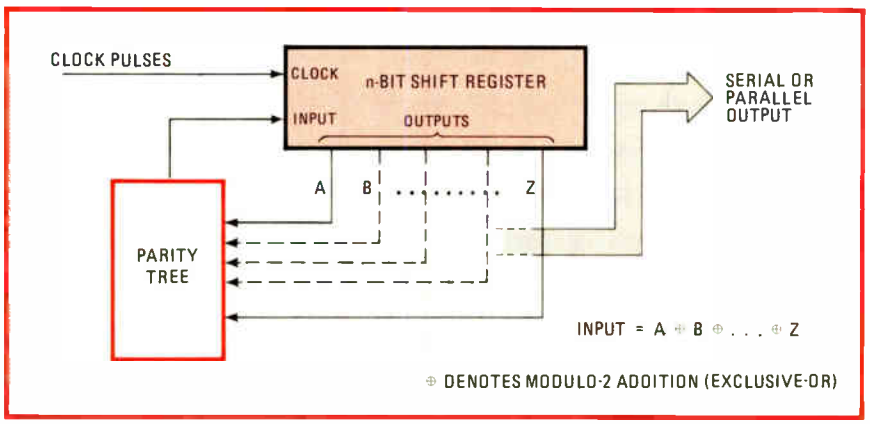
The operating principles of a linear-feedback shift register (LFSR) are illustrated in Fig. 1. The input to the first stage of an n-bit register is determined at each clock pulse by the exclusive-OR (parity) function of some output taps of the register. Choosing these taps is the crucial step in constructing a LFSR that performs as required.

For an n-bit shift register, taps can be chosen so that the register cycles through $2^n - 1$ different states before repeating any previous state. All possible n-bit words are generated except the word containing only 0s [*Electronics*, Nov. 27, 1975, p. 104]. In addition, with the use of only two taps, some shift-register lengths can produce these maximal-length sequences. A partial list of such registers is given in the table, which is excerpted from "Shift Register Sequences," by S. Golomb (Holden-Day Inc., San Francisco, 1967). As the table shows, even shift registers that are only moderately long can produce astronomically long sequences.

An appropriate clock and a sufficiently long register generate a flat power spectrum of audio white noise, using the digital bit stream itself as the noise source. Fig-

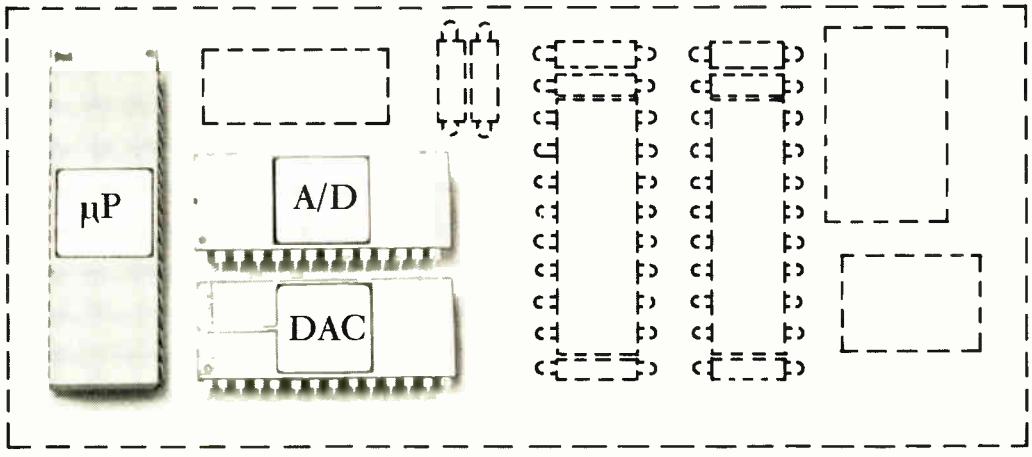
MAXIMUM-LENGTH LINEAR-FEEDBACK SHIFT REGISTERS THAT REQUIRE ONLY TWO FEEDBACK TAPS

No. of stages	Stages at which taps are placed	Sequence length	Duration of sequence using 250-kHz clock
7	1, 7 or 3, 7	127	0.51 ms
9	4, 9	511	2.0 ms
10	3, 10	1,023	4.1 ms
11	2, 11	2,047	8.2 ms
15	1, 15 or 4, 15 or 7, 15	32,767	131 ms
17	3, 17 or 5, 17 or 6, 17	131,071	0.52 s
18	7, 18	262,143	1.0 s
20	3, 20	1,048,575	4.2 s
21	2, 21	2,097,151	8.4 s
22	1, 22	4,194,303	17 s
23	5, 23 or 9, 23	8,388,607	34 s
25	3, 25 or 7, 25	33,554,431	2.2 m
28	3, 28 or 9, 28 or 13, 28	268,435,455	18 m
29	2, 29	536,870,911	36 m
31	3, 31 or 6, 31 or 7, 31 or 13, 31	2,147,483,647	2.4 h
33	13, 33	8,589,934,591	9.5 h
35	2, 35	34,359,738,367	1.6 d
36	11, 36	68,719,476,735	3.2 d
39	4, 39 or 8, 39 or 14, 39	5.5×10^{11}	25 d
41	3, 41 or 20, 41	2.2×10^{12}	102 d



1. Pseudorandom pulses . . . In this linear-feedback shift register, some of the output ports are connected back to the input through an exclusive-OR circuit. Depending upon which output taps are fed back, a nonrepeating sequence of any length up to $2^n - 1$ binary words can be generated.

A lot of microprocessor users wish their analog interface problems would go away.



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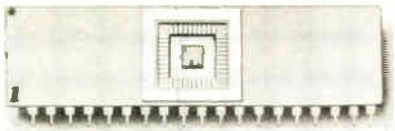

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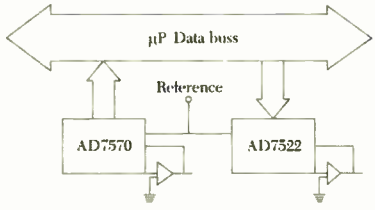

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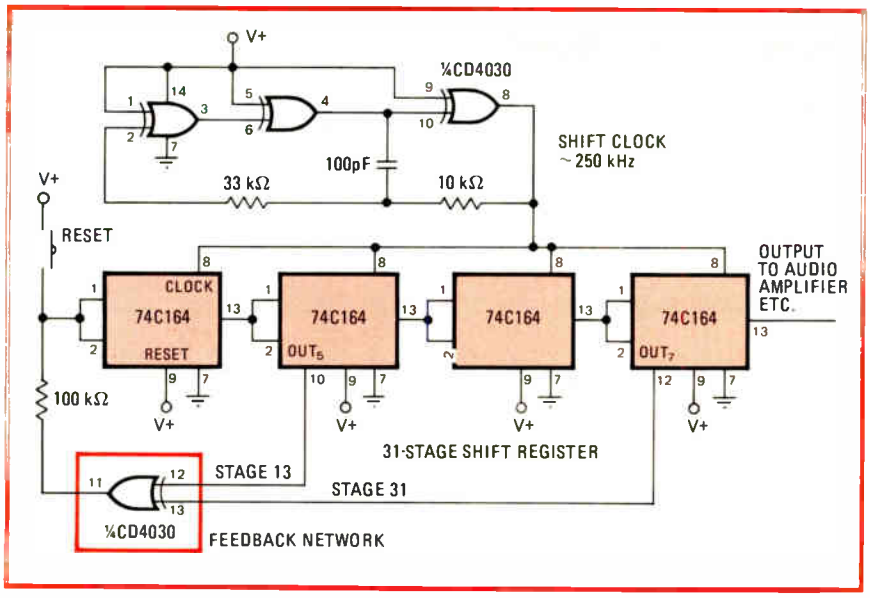
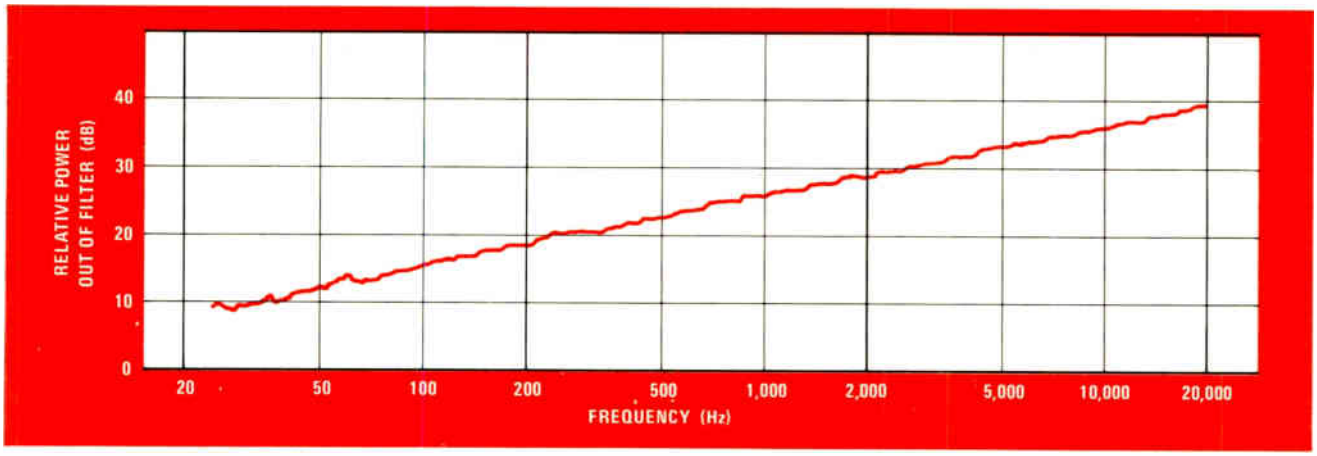


2. . . . generate noise . . . This 31-stage linear-feedback shift register is arranged to produce a maximum-length pseudorandom bit sequence by connection of stages 13 and 31 back to input. Output bit stream, which can be taken from any port, constitutes a white-noise source.



3. . . . like this. The output power spectrum of the circuit in Fig. 2, measured directly at the output of stage 31, slopes upward because filter bandwidth is proportional to frequency. The slope of 3 dB/octave indicates white noise. Reference level (0 dB) was chosen arbitrarily.

ure 2 shows a 31-stage LFSR, with taps at stages 13 and 31 and a shift clock running at 250 kilohertz.

Any shift register that provides access to the required feedback bits will serve. For instance, two CD4006s might have been used instead of the 74C164s. With only three ICs, these shift registers can give access to bits 13 and 31. For a white-noise generator in audio applications, the component values are noncritical. The reset button ensures that at least a single 1 is initially in the shift register, but the manual button can be replaced by a more elaborate initialization circuit if desirable.

The audio-power spectrum from the circuit in Fig. 2, measured directly at the output of stage 31, is shown in Fig. 3. A series of ⅓-octave filters measures the spectrum. The curve is inclined upward at a rate of 3 decibels per octave, matching the increasing bandwidth of the filters. The deviation from a straight line inclined 3 dB/octave is less than 1 dB over the frequency interval from 25 Hz to 20 kHz. The largest deviation occurs at the power-line frequency of 60 Hz. The table shows that the string produced by this register is longer than 2 billion bits and, at a 250-kHz clock rate, will take more than two hours to repeat.

The LFSR pulse sequences are also used for error-correcting codes, spread-spectrum techniques [*Electronics*, May 29, 1975, p. 127], and other random-selection processes. In a maximum-length LFSR n bits long, the bit string produced is statistically identical to $2^n - 1$ flips of an ideal coin (one with precisely equal probabilities of landing heads or tails). Thus, for example, a 17-stage LFSR can generate the equivalent of 131,071 coin-flips. Any stage of the register may provide the output, since every bit is eventually shifted the entire length of the register.

Such a device could be useful for producing uncorrelated stimuli in a psychophysical experiment, because it could easily determine which of two possible stimuli to present to a test subject. It can do so with an undiscernible, yet repeatable, pattern so that a second test subject could be given the same sequence of stimuli. If the bit string from the 31-stage register in Fig. 2 were used for test stimuli with an average interval between stimuli of 5 seconds, it would not repeat for 340 years. □

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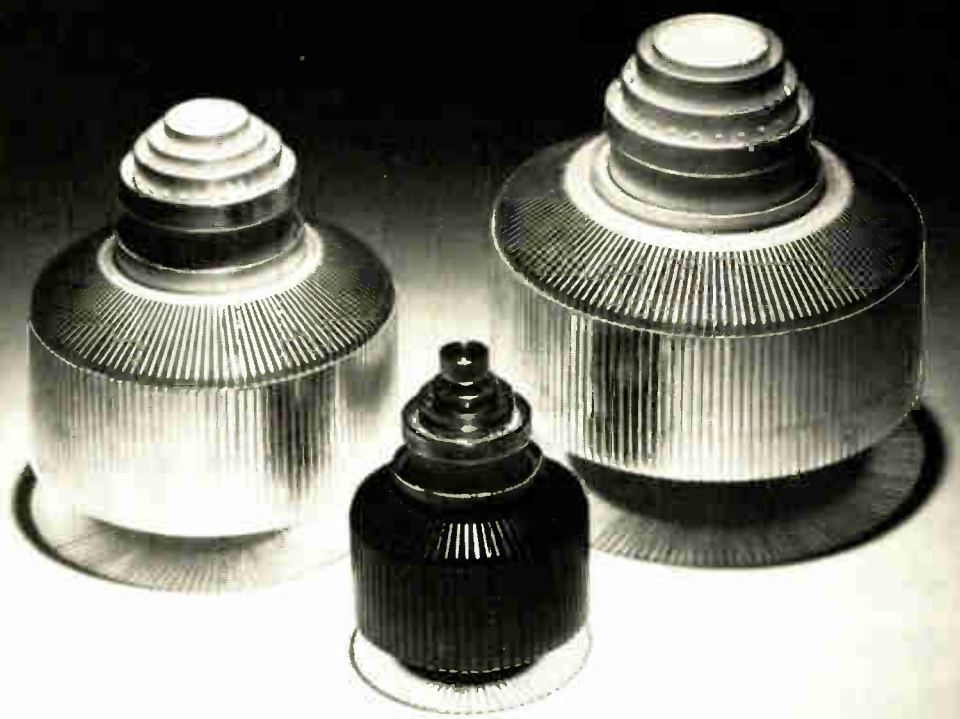
TH 371	10 kW	30 kW	TH 18117



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Design worksheet can generate least-part system, best addressing

by Ray M. Vasquez, *Motorola Semiconductor Products Inc., Phoenix, Ariz.*

☐ When the time comes to figure out the interconnections in the design of a microprocessor system, design engineers frequently resort to trial and error. But such a technique affords little chance of generating a minimum-part system and of avoiding redundant addresses to devices. A more methodical approach with a system-layout worksheet in the form of Fig. 1 will surmount these problems.

Basically, the sheet allows a designer to list all devices by type and to allocate memory positions. Although this procedure was developed for systems based on the MC6800 microprocessor, it is readily adaptable to the design layout of any microprocessor.

The power and usefulness of this tool can be illustrated best by working out an example designed around the 6800 series of devices. Such an example will become clearer by reviewing the characteristics of the various integrated circuits of the series, setting general rules for the placement of control functions in memory locations, and illustrating the interconnections of the devices in a one-of-each system.

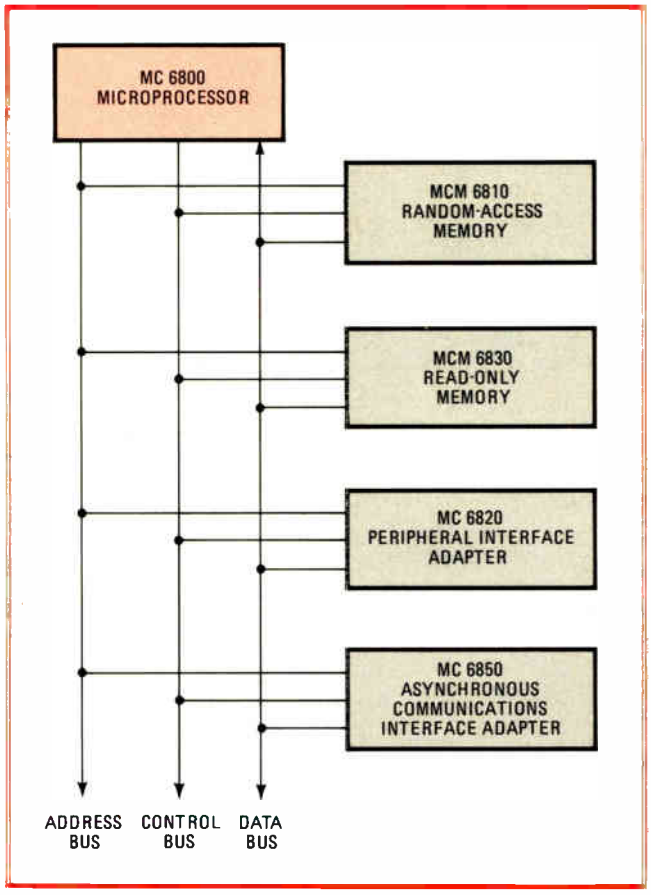
Family of ICs

The family consists of the microprocessor, read-only memory, random-access memory, peripheral interface adapter, and asynchronous communications interface adapter. These ICs are linked by the processor's address, control, and data busses (Fig. 2). As well as specifying

	MICROPROCESSOR ADDRESS LINES ($A_0 - A_{15}$)																ADDRESS	
Device	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	From	To
FIRST RAM	$\overline{C}_{S5}$	$\overline{C}_{S9}$						$\overline{C}_{S2}$	$\overline{C}_{S1}$	X	X	X	X	X	X	X	0000	007F
SECOND RAM	$\overline{C}_{S5}$	$\overline{C}_{S9}$						$\overline{C}_{S1}$	C_{S0}	X	X	X	X	X	X	X	0080	00FF
THIRD RAM	$\overline{C}_{S5}$	$\overline{C}_{S9}$						C_{S0}	$\overline{C}_{S1}$	X	X	X	X	X	X	X	0100	017F
FIRST ROM	C_{S1}				$\overline{C}_{S3}$	C_{S2}	X	X	X	X	X	X	X	X	X	X	8400	87FF
SECOND ROM	C_{S1}				C_{S3}	$\overline{C}_{S2}$	X	X	X	X	X	X	X	X	X	X	8800	8BFF
THIRD ROM	C_{S1}				C_{S3}	C_{S2}	X	X	X	X	X	X	X	X	X	X	8C00	8FFF
FIRST PIA	$\overline{C}_{S2}$	C_{S1}												C_{S0}	R_{S1}	R_{S0}	4004	4007
SECOND PIA	$\overline{C}_{S2}$	C_{S1}											C_{S0}		R_{S1}	R_{S0}	4008	400B
THIRD PIA	$\overline{C}_{S2}$	C_{S1}										C_{S0}			R_{S1}	R_{S0}	4010	4013
ACIA	$\overline{C}_{S2}$	C_{S1}									C_{S0}					R_{S0}	4020	4021

X = Wired connection C_S = Chip select R_S = Register select

1. System layout. This system-layout worksheet is for a 3-RAM, 3-ROM, 3-PIA, 1-ACIA microprocessor system. The tabular form can be used for an optimum assignment of device addresses in memory and also as the starting point for the complete system wiring diagram.



2. The family. The MC6800 microprocessor is tied to its peripheral ICs through address, control, and data busses.

memory, the address bus specifies input/output devices through the PIA and ACIA. Through connections to selected address lines, the PIA and ACIA are allocated areas of memory. Thus, the user may converse with them, selecting one of several of the devices by using a memory address.

Pin assignments for the devices are shown in Fig. 3. The MC6800 is a monolithic, 8-bit microprocessor forming the central control function for the family. Like the other family members, it is compatible with transistor-transistor logic and requires only 5 volts. The MC6810 RAM has a byte-organized memory of 128 by 8 bits. The MC6820 PIA can interface the processor to byte-oriented peripherals through two 8-bit, bidirectional, peripheral data busses and four control lines.

Program storage is provided by the MCM6830, a ROM of 1,024 by 8 bits, which is mask-programable and byte-organized. The MC6850 ACIA provides interfacing of serial, asynchronous communications to the data bus.

Direct addressing

One of the microprocessor's seven modes of addressing is of particular interest in a system layout: the direct mode, in which the source instruction is converted into two bytes of machine code. Since 8 bits can address only memory locations 0 through 255, access to locations 256 through 65,535 is by the extended mode of addressing, using an extra byte of code. Therefore, it is preferable to use the direct-address mode when possible.

To provide this, it is necessary to assign addresses at locations 0 through 255 to the RAM. This establishes the first requirement of the system, that RAM addresses should be placed in the lowest memory location.

The next step is to examine the system for any similar constraints on the assignment of ROM addresses. (All addresses are in hexadecimal notation, which is illustrated in the table on page 114.)

In a typical application, the peripheral devices may interrupt the microprocessor with requests for service or acknowledgements of services performed earlier. An interrupt sequence can be initiated by applying the proper control signal to any of the three hardware interrupts, reset ($\overline{RES}$), nonmaskable interrupt ($\overline{NMI}$), and interrupt request ($\overline{IRQ}$), or by using the software interrupt (SWI).

If the interrupt is maskable, the processor will test its interrupt mask bit once it has finished its current instruction. If the interrupt mask is not set or if an $\overline{NMI}$ is received, the processor will store the contents of its programable registers in the RAM.

In any event, after the interrupt bit has been set, it obtains the address of the interrupt input, which falls in the address range shown in hexadecimal notation in Fig. 4. The interrupt vectors' high address range of FFF4 to FFF8 must be stored in the upper memory location of the ROM. This establishes the second system requirement: that ROM addresses should be placed in the highest memory location.

Locating I/O

Since the upper and lower memory locations have been assigned, the middle memory locations are left for the input/outputs. This assignment is implemented by tapping off the processor's busses in such a way that it references "memory" addresses for the PIA and ACIA.

To make a functioning system, the starting point is a straightforward connection of the data bus, the address bus, and the control bus of Fig. 2. The eight bus lines D_0 through D_7 on the microprocessor are connected to the D_0 through D_7 pins on every device used.

Through the wiring of the address bus, each device gets its own address. For the RAMs, the easiest selection of a particular location is realized by connecting pins A_0 through A_6 to address lines A_0 through A_6, and for the ROM, by connecting A_0 through A_9 to lines A_0 through A_9. For the PIA, wire pins $\overline{RS_0}$ and $\overline{RS_1}$ to address lines A_0 and A_1, respectively, and connect the ACIA by pin R_S to address line A_0. This allows selection of any internal memory location in the devices.

Next, arrange the upper address line to discriminate one type of device from another. For example, when the RAM is addressed, the ROM and the input/outputs should be disabled. Similarly, selecting the I/Os should disable the RAM and the ROM. Connecting the upper line to the various positive or negative chip-select pins on a particular device will permit this discrimination to be made.

To select one device among the many of its type, the middle-order address lines are connected to the chip-select pins, which permits discrimination in a manner similar to the selection of one particular type. Any

unused chip-select pins are connected to the appropriate +5-volt or ground level to minimize noise.

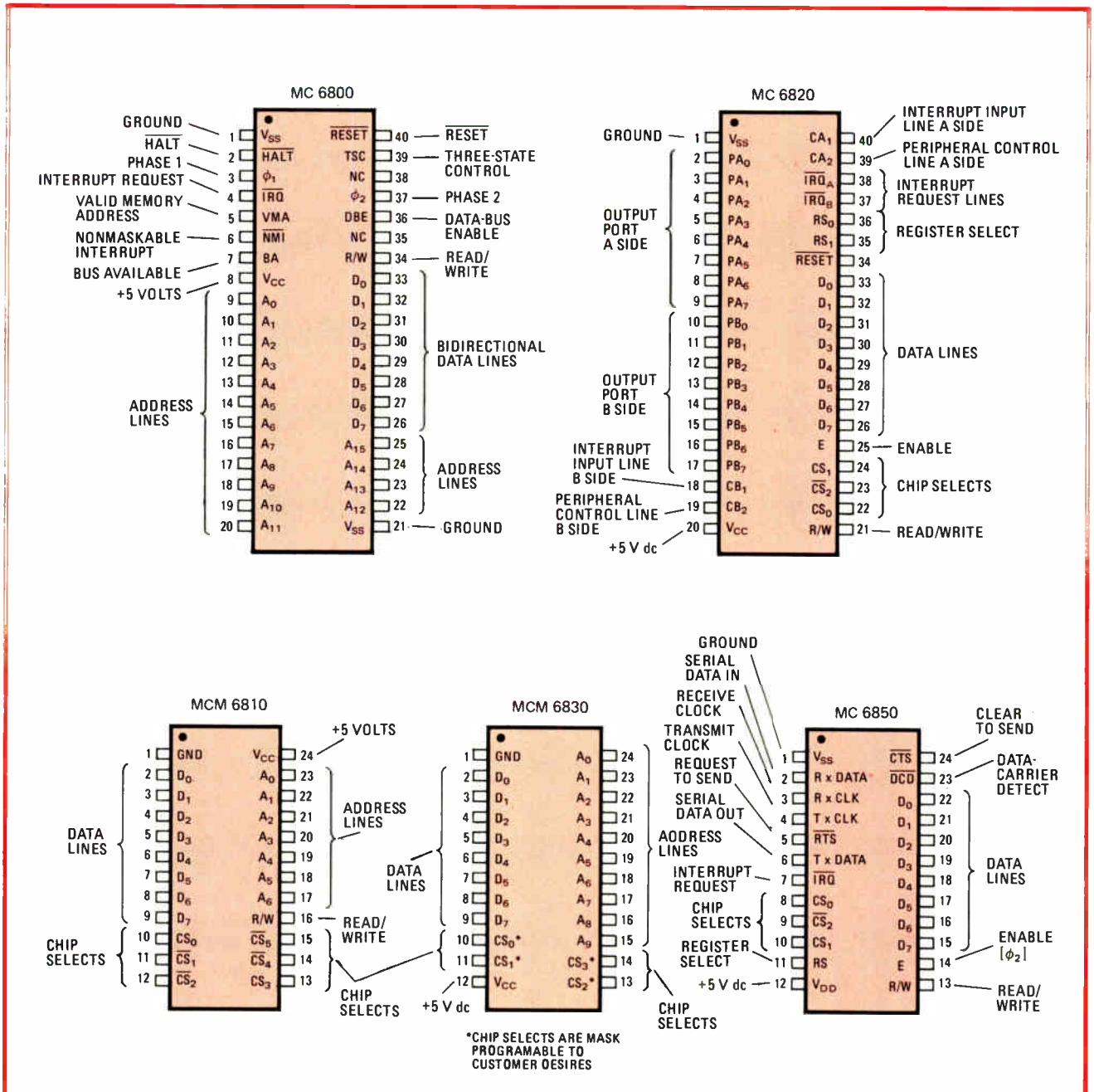
System control

Once the address bus is wired, the control bus is connected. Its lines are interrupt request ($\overline{IRQ}$), restart ($\overline{RES}$), clock phase 2 (ϕ_2), read/write (R/W), and valid memory address (VMA). The $\overline{RES}$ is generated externally, and should be connected to the $\overline{RES}$ pins of the microprocessor and the peripheral interface adapter.

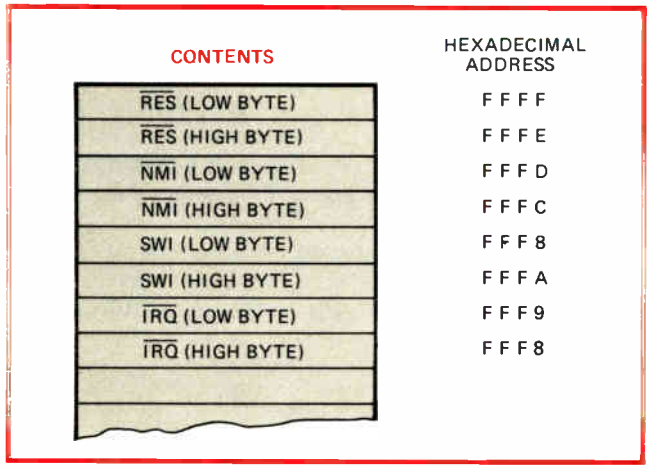
All the $\overline{IRQ}$ lines should be wired together and connected to the $\overline{IRQ}$ pin on the processor. Since the peripheral ICs have no internal pull-ups and the processor has a high internal impedance pull-up, an external, 3-kilohm resistor to +5 V is recommended.

The symbol ϕ_2 stands for a system synchronization signal. It should be used to restrict data on the data bus only during ϕ_2 for devices that can be written into. Therefore it should be wired to a chip-select pin on the RAM or the E enable line on the PIA and ACIA.

The R/W line is connected to the R/W pins on the RAM and the input/outputs. VMA, the logic 1 signal that tells all external devices there is a valid memory address on the address bus, should be used to prevent



3. Pinouts. Pin assignments for the MC6800 microprocessor, MCM6810 RAM, MCM6830 ROM, MC6820 PIA, and MC6850 ACIA show the points that are tied to the address, control, and data busses, chip-select pins, and control signals for hardware and software interrupts.



4. Interrupt vectors. In a 6800 system, interrupt commands are permanently stored in eight locations in a ROM and are called forth with these addresses on the microprocessor address bus. They are not necessarily the same as the ROM addresses.

HEXADECIMAL TO BINARY CONVERSION

Hexadecimal	8	4	2	1
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
A	1	0	1	0
B	1	0	1	1
C	1	1	0	0
D	1	1	0	1
E	1	1	1	0
F	1	1	1	1

	A_{15}	A_{14}	A_{13}	A_{12}	A_{11}	A_{10}	A_9	A_8	A_7	A_6	A_5	A_4	A_3	A_2	A_1	A_0
Microprocessor address = FFF8	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0
Actual logic on address	C_S	NC	NC	NC	C_S	C_S	1	1	1	1	1	1	1	0	0	0
ROM address = 8FF8	1	0	0	0	1	1	1	1	1	1	1	1	1	0	0	0

C_S = Logic 1 NC = No connection

5. Interrupt addressing. Under the conditions shown, which correspond to the wiring of the third ROM in the system-layout sheet previously described, an interrupt address of FFF8 on the microprocessor address bus can select a ROM with an address location of 8FF8.

improper addressing of devices. This helps prevent destruction of data in the system. However, it only is necessary to use the signal to protect the PIA and the ACIA. During internal operations, the microprocessor sets the R/W line to the read state, which protects the RAM. The data in the ROM can't be overwritten, so there's no need to protect it. The VMA is connected to a chip-select pin, but if there is none available, it may be ANDed with an address line going to one and to its ANDed output.

System design

Now that the ground rules of a general system have been developed, the use of the worksheet can be illustrated with a more complex example. Since the maximum number of peripheral ICs that be connected to the microprocessor's busses without external buffering is 10, the example will have three RAMs, three ROMs, three PIAs, and one ACIA.

The example will demonstrate how the system-layout worksheet can systematically generate the information that will allow the system designer to:

- Connect the data bus to all devices.
- Connect all internal addresses on devices to appropriate address lines of the processor.
- Use upper-order address lines to select one type of device and exclude the others.
- Use middle-order address lines to select one device of a group.
- Connect the control bus lines.

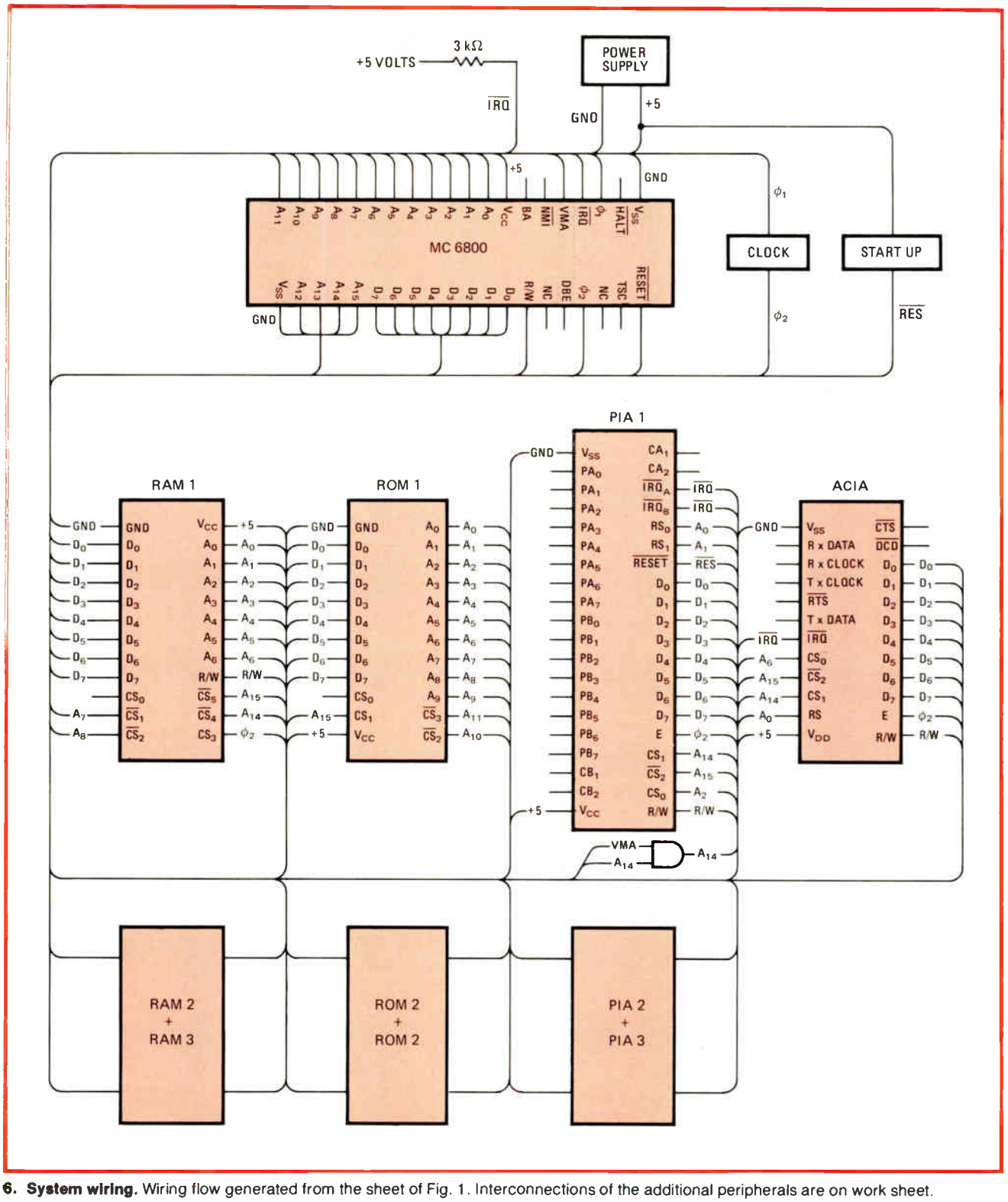
In developing this system's worksheet (Fig. 1), the first task is to list all the devices in the device column, grouping them by type. Next, list the connections of the internal addresses, remembering the constraints on memory locations and the address assignments developed in the discussion of the one-of-each system.

The next task is selection of one type of device to the exclusion of the others. The starting point is to connect a chip-select pin (Cs) to address line A_{15} of the microprocessor, thereby selecting the ROM function and disabling the others. To separate the RAM from the input/outputs, A_{14} is connected to various chip-select pins as shown on the worksheet.

Device selection.

The next step is distinguishing an individual device from the others of its type. For the RAMs and ROMs, it is necessary to use two address lines in order to select one out of the three devices of each type. A combination of A_7 and A_8 will accomplish this for the RAMs, and A_{10} and A_{11} will do the job for the ROMs. Distinguishing among the four input/outputs can be accomplished with the last available Cs pins on these devices, connecting them to different address lines as shown.

The next task is to allocate each device's addresses for use in software. The first RAM is activated when A_{15}, A_{14}, A_8, and A_7 are at logic 0. Lines A_0 to A_6 will go from all 0s to all 1s, so the addresses assigned to this device are from 0000 to 007F in hexadecimal notation. Using the same procedure, the addresses of all the other devices may be determined, as shown on the right side of the worksheet. It can be seen that some parts can have several enabling addresses. This poses no problem,



6. System wiring. Wiring flow generated from the sheet of Fig. 1. Interconnections of the additional peripherals are on work sheet.

since the user controls what addresses will be used when he sets up programs in the software.

The final task is to check the microprocessor's acquisition of the interrupt vectors, which have the address range of FFF8 through FFFF shown in Fig. 4. The worksheet shows that the upper eight memory locations of the third ROM, 8FF8 through 8FFF, are for storage of these vectors. The addresses of the two devices do not correspond, but the correct logic conditions are available to select the vectors' memory locations. For example, FFF8 on the microprocessor's address bus is equivalent to 8FF8 on the RAM (Fig. 5), due to the wiring of the bus and the chip-select pins.

With the information from the worksheet on the address bus and the relatively simple system connections for the data and control busses, it is possible to generate the complete wiring diagram of Fig. 6. Since all the chip selects on the PIAs and the ACIA have been used, it is necessary to AND the VMA with one of the address lines, as discussed. And the impossibility of overwriting data in the ROMs means that address lines with no synchronization signals are used. □

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Two tandem pulse generators provide waveform flexibility

by Sandford Jacobson
Cober Electronics Inc., Stamford, Conn.

Whether in testing components like pulse transformers or in studying how bipolar molecules behave in chemical birefringence and similar phenomena, it's necessary to use trains of bipolar pulses, with both positive and negative polarities relative to ground. The quickest and most economical method of generating these pulse sequences is by connecting two standard pulse generators in tandem, with opposite polarities.

The tandem generators can also be connected with like polarities to double the pulse width and thus double the average power delivered to a load. Series and parallel arrangements are also possible, giving twice the voltage or twice the current of a single unit.

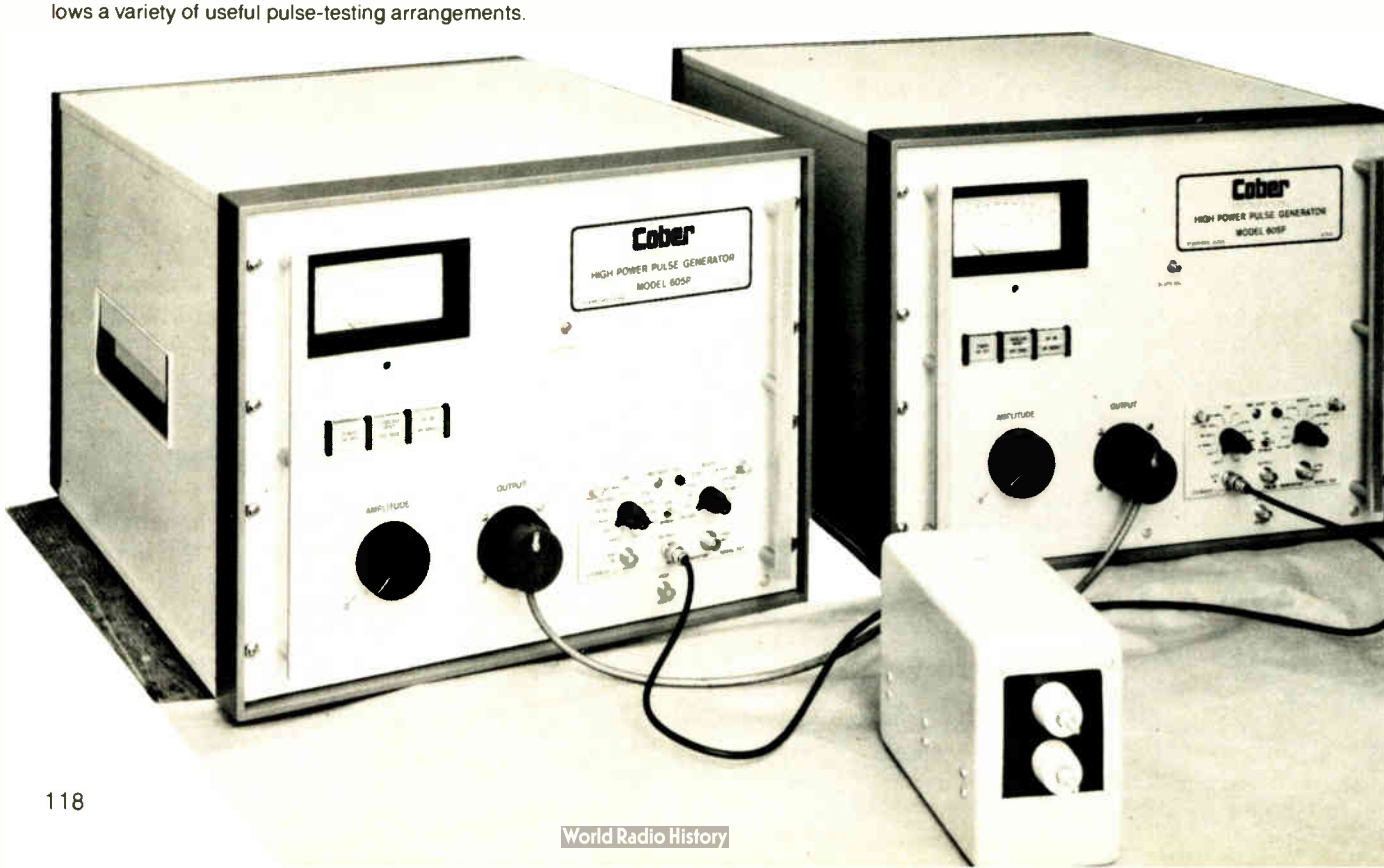
A pair of standard 10-volt generators, such as the Datapulse 101 or the Tektronix 114, can be used to generate bipolar waveforms at low voltages. For high-voltage/high-power requirements, Cober 605-P pulse generators are excellent.

In setting them up, it is better not to use pulse transformers but to employ generators capable of providing both positive and negative outputs, or to select one generator with a positive output and the other with a negative output. Reversing pulse polarity with a transformer degrades the pulse shape, so that the waveforms are not symmetrical.

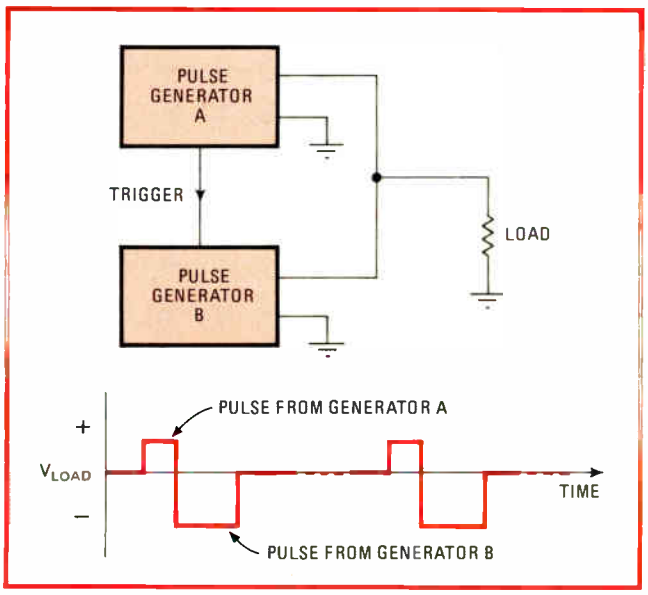
This technique for generating bipolar pulses is illustrated in Fig. 1. One generator determines the polarity, amplitude, and width of the first pulse. The other, triggered from the back edge of the first output pulse, provides the reverse-polarity pulse with its own amplitude and width. The pulse rate is determined by the first generator.

In practice, this general technique is somewhat tempered by the internal impedance of the particular generators used. The maximum outputs are obtained when the pulse generators have high internal impedance during their off stage and provide low internal impedance during their on stage. In this way, the loading effect of one generator upon the other is minimized, and maximum energy is developed across the load. The 605-P, with essentially infinite output impedance in the off state, can provide bipolar pulses of up to 2,200 volts and 11 amperes peak; each generator can produce a pulse from 50 nanoseconds to 3 milliseconds long at a duty rate of 1.5%. Figure 2 shows two of these generators applying a bipolar pulse train to a pulse transformer.

If the two generators are set so that both deliver the same polarity, and the second is triggered by the first, the output to the load is a single pulse that lasts twice as long—up to 6 milliseconds at 3% duty factor.



1. Bipolar testing. Two high-power pulse generators are connected to test a pulse transformer with pulses of alternating polarity. Tandem, series, and parallel connection of pairs of generators allows a variety of useful pulse-testing arrangements.



2. Tandem cycle. Here two pulse generators are connected so that the second is triggered by the falling edge from the first. If the two have opposite polarities, as shown, the resulting pulse train is bipolar. If the two have the same polarity, the pulse length is doubled.

If the two generators are set so that both deliver the same polarity and are triggered simultaneously, the output to the load is then a single pulse with current capability up to 22 A. And if the two generators are connected in series and triggered simultaneously, the output voltage may be as high as 4,400 V. The voltage isolation of the upper generator, which is not grounded, must be sufficient to withstand the sum of the voltages of the series pair.

For many applications, the two pulse generators need not be identical or of the same manufacture to be operated in these various modes. Thus, complicated waveforms can be achieved without any degradation of rise time or fall time by the hookup of pulse generators for series, parallel, or tandem operation. □

Digital-testing glossary reflects industry usage

Robert E. Anderson
Omnicomp Inc., Phoenix, Ariz.

Digital testing of integrated circuits and printed-circuit boards applies a wide range of programing, testing, and troubleshooting techniques. A lot of new terminology has evolved to describe many of these techniques. The definitions given in the following glossary are consistent with typical use of this terminology in industry.

Types of testing

Functional: verifies correct logical operation.

Parametric: verifies analog parameters within specified tolerances.

Static: test rate is slow, relative to the operating frequency.

Dynamic: test rate (or timing resolution) is comparable to the operating frequency (or period).

Truth-table: static functional testing.

Clock-rate: dynamic functional testing.

Dc: static parametric testing.

Ac: dynamic parametric testing.

Testing terminology and techniques

Algorithmic pattern generation: real-time generation of input test patterns during test execution according to specified procedures, formulas, or algorithms. Also refers to procedures or algorithms used in automatic-test-generation software for specific fault sets.

Automatic test generation (ATG), automatic-test-pattern generation (ATPG): calculation of a specific set of input test patterns with a computer program providing algorithmic and heuristic routines.

Bidirectional I/O pins: pins that function for both input and output.

Comparison testing: real-time comparison between the actual output responses of the device under test and those of a known-good reference device when the same input stimulus patterns are applied to both devices in parallel.

Comprehensiveness: the percentage of the faults in a specific fault set that can be detected by means of a fault program.

Control points or pins: input pins provided for testing or fault-isolation purposes that can control the state of internal memory elements.

Device model, circuit model: a set of data that logically describes the correct operation of a device or circuit.

Digital IC (SSI, MSI, LSI): digital integrated circuit, a monolithic group of logic elements. May be small-scale integration (e.g., gates, flip-flops, latches); medium-scale integration (e.g., decoders, adders, counters); large-scale integration (e.g., memories, microprocessors).

Digital signature: a numerical representation of a set of logic states, typically used to describe the logic-state history at one DUT output pin during the complete test program.

DUT, UUT, MUT: device, unit, or module under test.

Emulation: the use of hardware or software to generate in real-time the expected correct output responses for comparison to the DUT.

Equivalent faults: two or more faults that cause the same output responses and that cannot be isolated from the board output pins and internal nodes being monitored by the tester.

Fault defect: an anomaly that prevents the correct operation of the device. "Defect" and "fault" are often used interchangeably, although "fault" is the theoretical or practical result of a physical "defect."

Fault dictionary: a set of fault signatures, each of which indicates the probable faults that could cause the error message matching the signature.

Fault isolation: determining the cause of a test failure,

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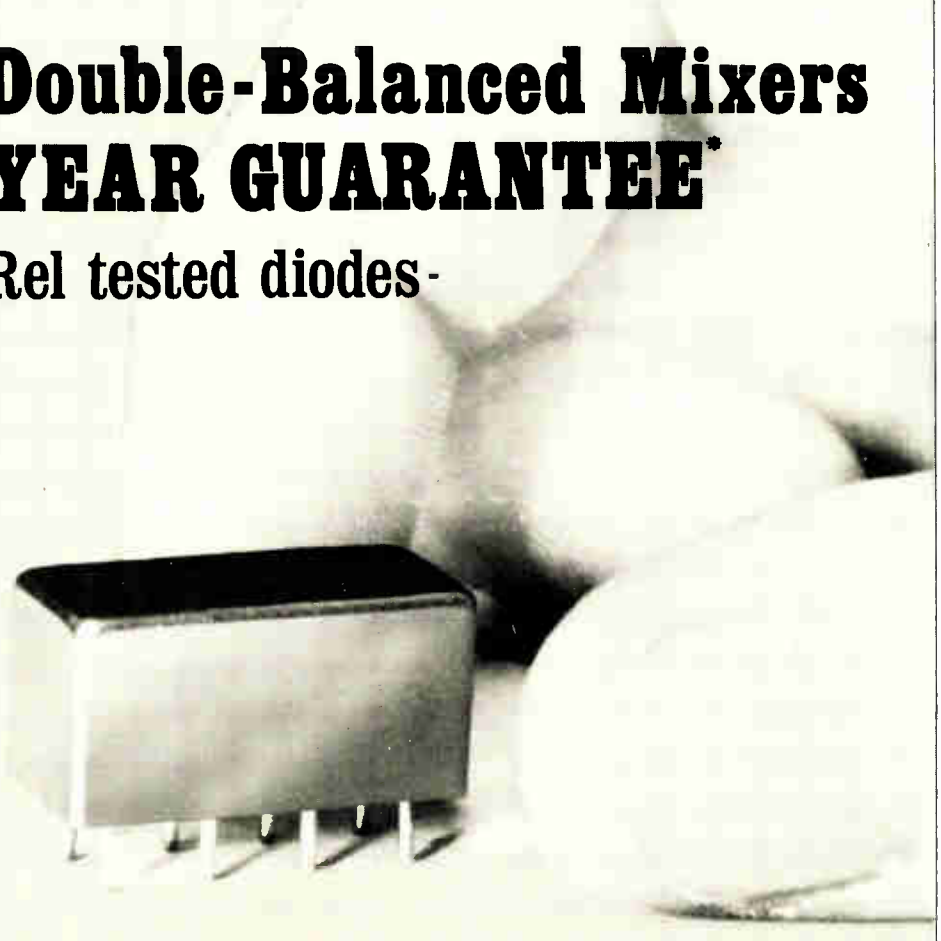

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Conversion loss (dB)			
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Total range		6.5	8.5
Isolation (dB)		**Typ.**	**Min.**
Lower band edge to	LO-RF	50	35
one decade higher	LO-RF	45	30
Mid range	LO-RF	45	30
	LO-IF	40	25
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typically by identifying a defective component or process failure on a board.

Fault-isolation resolution: the average number of components to which a fault can be isolated.

Fault model: a set of data that logically describes the operation of a device or circuit containing one or more faults.

Fault set: a group of all faults of specific types.

Fault signature: a particular output response or set of responses generated when a test program is executed on a device containing a fault. A typical fault signature consists of the incorrect output-pin numbers and the test step number at which a test program first detects a fault.

Forward-trace, Reverse-trace: particular algorithms used by automatic-test-generation software.

Functional board tester: a tester that verifies the correct logical operation of a logic board by applying test patterns at the board-edge connector. The output responses usually are monitored at the connector, although some test points may be used.

Gray-code test patterns: A sequence of input patterns in which only one input pin changes state at each test step.

Guided probe, guided clip: a fault-isolation technique in which the test system automatically displays the next mode or IC that the operator should probe or clip. The system leads the operator along a path back from a faulty output pin to the location of the fault. A software algorithm uses stored interconnection information and expected responses at each node to determine the next node to be probed.

In-circuit tester, bed-of-nails tester, in-situ tester: a tester that checks the individual components on a board using a fixture that provides access to each node of each component. Used to test for short and open circuits on bare boards, correct values of analog components (using a guarding technique), and correct functions of individual ICs (using a pulsing technique).

Indeterminate (X) state: the unknown logic state of a memory element caused by critical races or oscillations, or existing after power is applied and before initialization. Some simulators can model indeterminate states and typically assign an X to indicate an indeterminate state.

Initialization: applying input patterns to a logic circuit so that all internal memory elements achieve a known logic state.

Input pins: the terminals of the device to which input logic signals may be applied.

Input/output pins, I/O pins: the set of input pins and output pins on the device.

Input-stimulus pattern, input pattern, input-test vector: the set of logic states applied to the DUT input pins during a particular time period.

Interface adaptor, device adaptor: a unit that provides a mechanical and electrical interconnection between the tester and the device under test may include special stimulus, measurement, load, and switching circuitry unique to a device or family of devices, but is not provided in the tester.

Internal node: a junction between internal logic elements within an IC.

Known-good device, known-good board: a reference device or board that is presumed to function correctly.

Logic circuit, logic board, logic-circuit board: an assembly containing a group of interconnected digital ICs.

Logic element: a unit that performs a basic logical function (e.g., a single OR gate).

Logic states, logic signals: the binary (1 or 0) values at the nodes of logic elements and ICs at a particular time.

Manual analysis, manual test programing: the generation of input and output test patterns by a test engineer or technicians who studies the function or structure of a logic circuit.

Node: a junction between interconnected ICs on a logic board.

Output pins: the terminals of the device at which its output logic signals may be obtained.

Output response pattern, output pattern, output test vector: the set of logic states produced at the output pins of the device under test during a particular time period.

Pseudorandom patterns: a repeatable sequence of input test patterns that appears statistically random.

Signature-testing: comparison of the actual output digital signatures, such as transition counts, with the expected correct signatures recorded from a known-good device.

Simulation, digital simulation: modeling of the operation of a logic circuit by a computer program containing device models and topology information about their interconnections.

Skew: the time difference between the logic-state changes on different input pins within a particular test pattern.

Stuck-at-1, stuck-at-0: a particular fault model in which a faulty node remains at a logical 1 or 0 state, regardless of the inputs applied.

Stored-response testing: comparison of the actual output responses of the DUT with the expected correct output responses stored within the tester. The expected correct responses can be recorded from a known-good device or determined by manual analysis or software simulation. Stored-response testing often implies storage of the actual logic states, although such digital signatures as transition counts could be the stored responses.

Test pattern, test step, test vector: the input and output patterns valid during a particular time period.

Test points or pins: output pins provided for testing or fault-isolation purposes that can monitor the nodal responses.

Test program: a particular group of test sequences or test patterns.

Test sequence: a group of test steps or test patterns.

Transition counts: a particular digital signature used in logic-board testing.

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Engineer's newsletter

Designation points the way toward IC standardization

At last, official help has arrived for the harrassed circuit designer trying to beat the specsmanship game played by some IC manufacturers: a new two-level 12-digit designation system for microelectronic devices. Developed by the Joint Electron Devices Engineering Council for Solid State Products, the new system's first level classifies devices according to manufacturers' published data sheets.

The optional second level is the key because it lists devices based on data format precisely defined, developed, and controlled by the industry. If enough suppliers participate, it could lead to some measure of device standardization and interchangeability. The system is described in EIA standard RS-428, priced at $1.50, and Jedec Publication No. 93, priced at $4. Both are available from the Standards Sales Office, EIA, together with a free Index of EIA and Jedec Standards and Engineering Publications.

Oven indicates how mounted parts can withstand heat

To help predict early component failures or derate components that run hot, equipment designers often need to know how components on a printed-circuit board will react to high temperatures. An accessory to the Inspect system, made by Vanzetti Infrared & Computer Systems, Canton, Mass., could ease the problem. The new accessory is an environmental oven that fits in the target area of the Inspect system. **The automatic test system develops an infrared signature for each part.**

The oven is energized by using a feedthrough connector, and its top side is transparent to IR radiation. The pc board is placed in the oven and scanned; the system then plots and prints out individual component temperatures as they rise. The operator can set the temperature in the oven to any level above room ambient, up to 100°C. **Component temperatures can be measured either in absolute values, or as gradients above oven ambients.**

Magnetic ink flows through needles to mark IC chips

A new magnetic ink is just right for marking IC chips after wafer sawing. This ink, made of a magnetic liquid called Ferrofluid, overcomes the big headache of older magnetic inks—their large particles clog the fine inking needles needed for chip marking. But the Ferrofluid ink—originally developed for magnetic rotary seals—has nonsettling microscopic particles that pass cleanly through even the finest syringe needles. **For details, write to Dexter Howe, product manager, Ferrofluidics Corp., 144 Middlesex Turnpike, Burlington, Mass. 01803.**

Radio reference adds optical data for communications

Designers who've grown up on the ITT "Reference Data for Radio Engineers" will want to check out the new edition of their old friend. Reflecting the new interest in optical communications, the reference book, which is packed full of design information dear to the hearts of radio engineers, has been beefed up with two new chapters on optoelectronics and optical communications. **Included are fresh data on optical transmission, fiber optics, detectors, sources, modulation techniques, and so on.** The 48-chapter tome, published by Howard W. Sams and Co., is now available in all the technical-book stores.

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Networking of computers and data security highlight NCC

Optimism prevails at show that boasts 300 exhibitors and 126 technical sessions, 'something for everyone'

by Stephen E. Scrupski, *Computers Editor*

☐ The National Computer Conference precedes the Democratic National Convention in New York by about a month. And, with business conditions steadily improving, "Happy Days Are Here Again" could just as well be the conference theme song. About 300 exhibitors will be showing their wares at the New York Coliseum for four days, starting June 7.

Conference chairman Carl Hammer, senior scientist with Sperry Univac, is similarly bullish on attendance—he expects a crowd of 50,000 computer designers and users. And program chairman Stanley Winkler, of IBM Corp., says there will be something for everybody in his 126 technical sessions, which will be covered in a 1,124-page proceedings to be distributed at the conference.

In the exhibit area, 930 booths will take up the first three floors of the Coliseum (Nepcon, the National Packaging and Production Conference, will be running simultaneously on the fourth floor). Visitors may view the latest equipment from such manufacturers as IBM, which will be showing a variety of terminals—including the 3660 supermarket system and 3600 financial system—that demonstrate the use of SDLC (synchronous data-link control communications protocol and the new SNA (systems network architecture). Sperry Univac is presenting a new line of intelligent terminals, and Data General is demonstrating its new microprocessor-based MicroNova minicomputer. In addition, many exhibitors are expected to accept the invitation to connect their terminals into the Telenet network for a special demonstration. Visitors will be invited to actually operate the various terminals, which are connected to timesharing organizations over the packet-switched network.

The technical sessions, to be held in the New York Hilton and the Americana Hotel, one block west on 52nd Street, have been organized into special-interest "tracks," to minimize those frustrating overlaps where two simultaneous sessions tantalize the visitor with papers on related topics. Of interest to designers will be the sessions on storage systems, computer security, networks, modular computer design, and microprocessors.

Talk about storage

The economics of charge-coupled-device memories will be analyzed in the session on storage systems, which is chaired by John C. Davis of the Department of Defense, Fort Meade, Md. The cost of running a CCD-memory system for one year could in some cases equal its initial cost—a dubious state of affairs, maintains S. L. Rege of Burroughs Corp., Piscataway, N.J.

Rege notes that CCDs can be designed to operate in

three different states, each of which is characterized by a different frequency: the access state, when data is being read from or written into the chip; the idle state, when the chip is doing nothing, and the refresh state, when data is being refreshed. By choosing combinations of the three frequencies to be equal or unequal, the chip can be operated in five different modes.

Rege shows that the best mode of operation is when the access and refresh frequencies are equal, but the idle frequency differs. Criteria include power dissipation, which influences the cost of maintaining the memory, access and service times, interface requirements, and control complexity.

Other speakers, including Peter Schneider of Siemens AG, Munich, Germany, also cover CCDs. Schneider points out that his paper on increasing the performance of multilevel storage hierarchies describes how to make them cheaper to build. At present, a three-level storage system, consisting of cache, page buffer, and CCD, when used with a transfer-on-demand strategy, has about twice the access time of a two-level (cache-and-buffer) system.

But with a method called working-set restoration, it can be equally as fast. When the working set of pages from the next program to be run is loaded into the buffer during execution of the acttive program, only the access time to the two-level system becomes visible. The main advantage, however, according to Schneider, is reducing the cost, since such a three-level system can use a large CCD main memory that's only a quarter to a half the cost of its MOS equivalent.

Also concerned with multilevel storage, Murray Edelberg and L. Robert Schissler of Sperry Research Center, Sudbury, Mass., describe an "intelligent memory." As one component of a storage hierarchy, it offers performance gains ranging from one to three orders of magnitude over random-access memories at comparable prices. The memory, formed of circulating serial-storage loops and distributed-processing logic, can dynamically vary its loop size to accommodate varying data requirements. Besides storing information, it handles off-line sort processing, associative searching, updating, and retrieval. Several memory configurations, which trade performance for economy and use CCDs or magnetic bubbles, are possible.

Finally, after studying the "Results of Added Memory," D.S. Hubbert, Reliance Electric, Cleveland, Ohio, and D.C. Harder, CRU Inc., Cleveland, conclude that, though system performance is improved, several factors delay the benefit to the user. They describe how an IBM 370/158 computer in a teleprocessing system had its memory increased from 2 megabytes to 3 megabytes in order to improve system response time and make better use of system components. In a combined batch and processing shop, they found, response time was indeed cut from 20 to 5 seconds, but the intricacies of large-volume batch production, issuance of time commitments to users, and training problems have retarded exploitation of the new facilities. The authors

The intelligentsia. NCC exhibits will abound with new intelligent terminals, such as Sperry Univac's Universal Terminal System 700. The UTS 700, based on the 8080 microprocessor, supports card readers, punches, line printers, floppy disks, and disk cartridges.

suggest some form of scheduling for production, based on either a software or hardware monitor.

A question of security

Since computer fraud is on the rise, several sessions are devoted to data security in general and cryptography in particular. From Donald Heaton, Collins Radio Co., Richardson, Texas, comes a paper on a new MOS-LSI chip that enciphers and deciphers data in accordance with the National Bureau of Standards' proposed cryptographic standard. The chip, mounted in a 40-pin package, takes in a 64-bit block, 8 bits at a time, which it reassembles into a 64-bit word in its input buffer and then passes over a path 64 bits wide to the encryption-algorithm section.

Finally, the word exits through the output buffer, 8 bits at a time. Since the chip can handle data at a rate of 1.6 megabits per second, it takes about 40 microseconds to process all 64 bits. Heaton says the device is aimed at such commercial applications as banking and point-of-sale terminals. For those systems that must have physical separation between cipher-key paths and normal data paths, the key can be entered 8 bits at a time and stored in 56-bit registers.

The key to a code can all too easily fall into the wrong hands. But in multi-user cryptography, suggests Martin Hellman of Stanford University, a key could be replaced altogether by an unforgeable, message-dependent signature. In the paper he coauthors, Hellman describes how a user can code his unique signature into all his messages so that the person receiving them can identify their source with certainty but cannot, by comparing two messages, decode the signature for himself—its message dependence keeps it opaque to him and hence unforgeable. Hellman foresees uses for the technique in signing contracts and in customers' buy and sell orders for stocks.

What's new in network design?

Of major concern to designers of a computer network is the operating system—the software that pulls the network together and allows even the unsophisticated user to perform standard jobs without understanding the process in detail. At the session on this subject, chairman Stephen Kimbleton, computer scientist at the National Bureau of Standards, Gaithersburg, Md., plans to lead off with an overview. The early Arpanet, he points out, was built by scientists and engineers well versed in scientific calculations and thus able to adjust for differing data protocols. But users of commercial networks, being less expert in computer techniques, will have to be provided with automatic translators.

Following Kimbleton's paper, Nan Shu of IBM, San Jose, Calif., will cover the problem of transmitting business records, with their highly structured information, between computers that have different input-data requirements. James White of Stanford Research Institute will then present a technique by which a computer at one node can automatically call up a computer at another remote node and get it to perform a subroutine as if it were in the same location. The user could do this himself, by opening up the communications path, sending the data, and then telling the remote computer what to do with the data. But for true network operation, such functions should be performed automatically. White says he has demonstrated with a prototype system, based on a single computer, that such automatic operation is possible. His system sends information out to a buffer and takes it back in as if it were coming from a second, remote source.

Packet-radio and satellite networks get a session of their own. The chairman is Frank Kuo, presently on leave of absence from the University of Hawaii and serving in the Department of Defense as assistant director of telecommunications. Kuo also is a coauthor of a paper from the group at that university working on the Aloha packet-radio network. The paper will discuss the user's problems of splitting capacity in a network that has both a satellite link and a ground link. The satellite component offers large bandwidth at low cost but long delays, while the ground component has high cost per unit-bandwidth but less delay. Thus, for a fixed budget and a fixed amount of data, the user must allocate the capacity between the two links appropriately.

Another packet network, which has been in operation for about two years at Xerox Corp.'s Palo Alto Research Center, will be described by Robert Metcalfe, director of technical planning at Transaction Technology Inc., Los Angeles. Though called Ethernet, after the substance that was once believed to carry radio waves, the network in fact uses coaxial cable rather than radio. But the name is at least partly justified by the fact that the network was substantially modeled after the Aloha system. The cable, between 1 and 2 kilometers long, carries information at about 3 megabits per second between upwards of 100 computers of varying types, including about 30 Data General Nova 800s. Metcalfe says that Xerox personnel now regularly use the network for many office functions, like text manipulation and printing, while programers also use it for program develop-

ment. Many of the computers are, in fact, personal units on the users' desktops. Metcalfe also says that a "gateway" has been installed to give a user at his desk full access to the facilities of Arpanet.

Efforts to build a gateway between the Arpanet and another packet-switched network, such as one that uses a communications satellite, are also preoccupying Bolt Beranek, and Newman Inc., says the Cambridge, Mass., firm's Virginia Strazisar. With such a gateway, the user on one network could gain full access to the distributed computing power of the other network. BBN now is operating a gateway that interconnects the Arpanet with a simulation of a packet-radio network at Stanford. For developmental purposes, Strazisar says, BBN simulated the Stanford network with cables, but the gateway could easily be installed for actual work at Stanford.

At the session on modular computer design, Jack Dennis of the Massachusetts Institute of Technology, Cambridge, Mass., will discuss a pet idea of his—the design of computers to achieve a modular structure of software. Today, he says, systems can be put together out of minicomputers or microcomputers in such a way that the programing job can be separated into subtasks, which yield independent modules that run on the individual hardware modules. Computer systems implemented in this way are certain to have greater performance and reliability, at least for the near term, than systems based on conventional large-scale processors.

In another paper, Hanan Potash, staff member at Technology Marketing Inc., Costa Mesa, Calif., will describe how he moves from his logical concept of a hardware computer module to its final physical realization. As an example of his approach, he'll use a Systems Engineering Laboratories SEL-32 computer, for which his company provided the blueprint and he was the prime design engineer.

In a minor key

Microprocessors are receiving less attention than at past conferences—only two sessions directly concern them. One is a general panel on microprocessor systems, and the other has three papers that cover software, support tools, and a bowling-alley scoring system.

In the first of these papers, Richard Sell, Motorola Data Products, Carol Stream, Ill., will concentrate on the importance of human engineering in software design—usually the main design job with a microprocessor, he points out. If the system involves a user keyboard, for example, it's up to the designer to decide which of the many ways available to perform a given function will be easiest for the user. Such human engineering for software differs from human engineering for hardware, which relates to matching the hardware to physical operations.

The one paper on microprocessor applications covers an automatic scoring system for bowling built by AMF Inc., Stamford, Conn. The system, described by AMF's Reg Kaenel, uses the Motorola M6800 microprocessor and displays on two CRTs such information as the names of the upcoming bowlers, the lane side on which each is to bowl, the full frame-by-frame bowling score, and the final score, including the handicap, for each bowler. The microprocessor also drives a thermal printer for permanent records. The system uses the M6800 with three peripheral interface adapters, one asynchronous communications interface adapter, and five read-only memories, each of which holds 2,048 8-bit words. □

Figures, fees, and phones

This year's National Computer Conference, June 7 to 10, in New York City intends "to provide the computer specialist, user, or data-processing manager with an intensive program aimed at increasing professional skills and enhancing the cost-effective utilization of computer power." To reach that objective, the program committee has scheduled a series of eight professional-development seminars in addition to 126 technical sessions. The seminars will cover such topics as computer networks, design of on-line systems, micrographics in data processing, and structured design.

There are about 50% more technical sessions than the 85 offered last year at Anaheim, Calif. The 930 booths this year represent 114 more than last year, and the 300 exhibits are 31 more than last year. What's more, the attendance is expected to hit 50,000, compared with the 33,000 to 34,000 last year.

The advance full-conference registration fee, which includes a copy of the proceedings, is $60, but advance registration for any single day of the conference, including exhibits, is $25. To obtain additional information on the conference, write '76 NCC, c/o Afips, 210 Summit Ave., Montvale, N. J. 07645, or telephone (201) 391-9810.

Take a close look at the

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Range	Accuracy	Input Impedance	Resolution	Max Cont Overload
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1V	0.3%±1 Digit	10Mohm	1 mV	250V
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100V	0.5%±1 Digit	10Mohm	100 mV	1000V
1000V	0.5%±1 Digit	10Mohm	1 V	1000V
AC Volts			**Frequency Range**	**Max Overload**
1V	0.7%±2 Digits	10 Mohm/40pF	20Hz-1kHz	200V
10V	1.0%±2 Digits	10 Mohm/40pF	20Hz-1kHz	500V
100V	1.0%±2 Digits	10 Mohm/40pF	20Hz-1kHz	500V
1000V	1.0%±2 Digits	10 Mohm/40pF	20Hz-1kHz	500V
DC Current			**Resolution**	
1mA	0.5%±1 Digit	1 Kohm	1 μA	1A (Fused)
10mA	0.5%±1 Digit	100 ohm	10 μA	1A (Fused)
100mA	0.5%±1 Digit	10 ohm	100 μA	1A (Fused)
1000mA	1.0%±1 Digit	1 ohm	1 mA	1A (Fused)
AC Current			**Frequency Range**	
1mA	1.0%±2 Digits		20Hz-1kHz	1A (Fused)
10mA	1.0%±2 Digits		20Hz-1kHz	1A (Fused)
100mA	1.0%±2 Digits		20Hz-1kHz	1A (Fused)
1000mA	1.5%±2 Digits		20Hz-1kHz	1A (Fused)

Resistance		Measuring Current
1K	1.0%±1 Digit	1 mA
10K	1.0%±1 Digit	100 μA
100K	1.0%±1 Digit	10 μA
1000K	1.0%±1 Digit	1 μA
10,000K	5.0%±1 Digit	1 μA

OPERATION

Power:
Internal battery or AC-DC converter. (Converter can charge battery.)

Input Terminals:
A positive voltage to the red terminal with respect to the black one will give a positive reading.

Function
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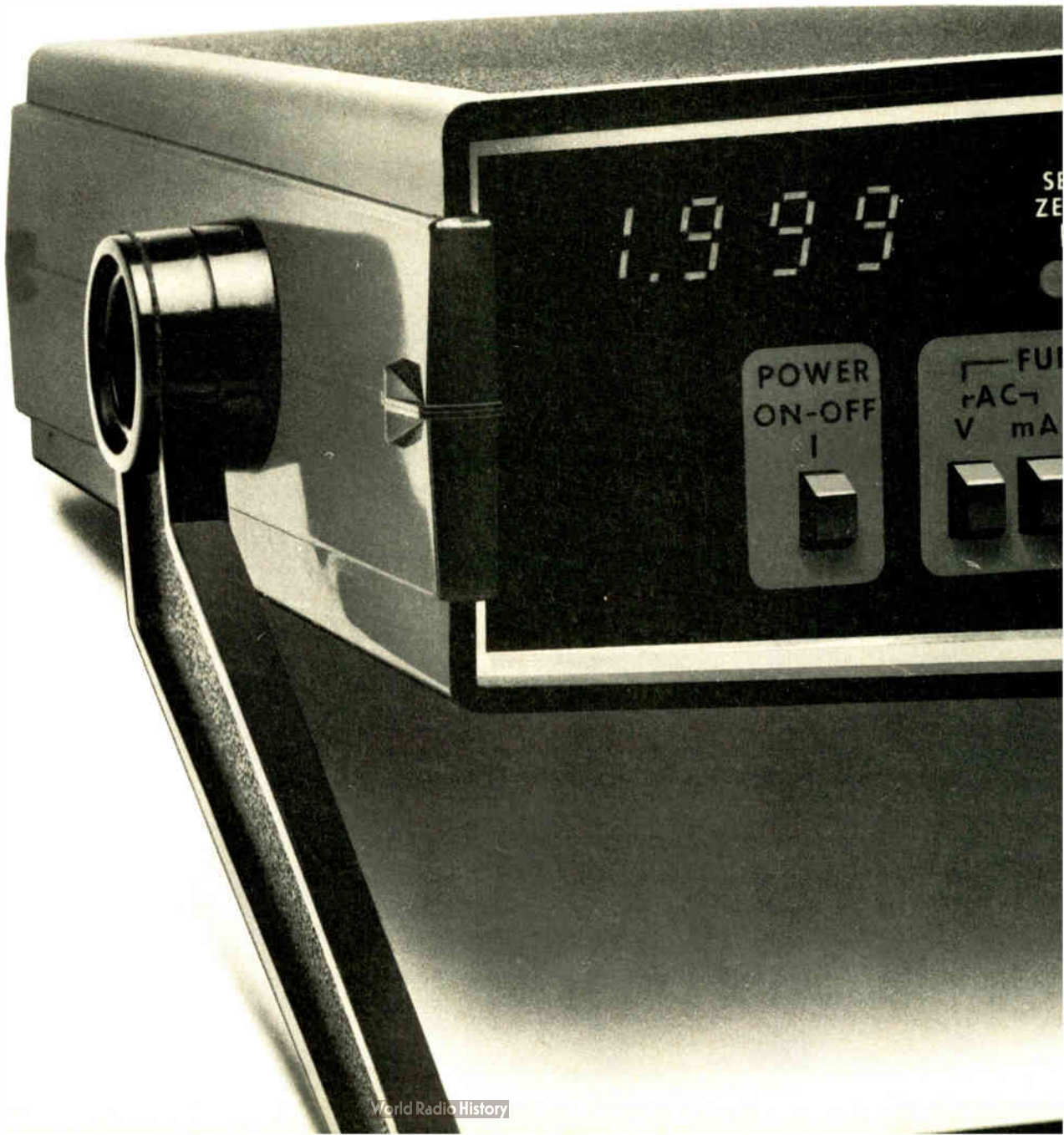
The four range multipliers 1, 10, 100 and 1000 are selected by pressing the appropriate button—the decimal point will be automatically positioned. In the 10,000K resistance range, all the range buttons are released.



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Power Consumption:
100 mA approximately

Size:

Height	3.4"	8.64cm
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Double-density diskette, auto-loader make debut

Since flexible disks entered the data-processing market a few years ago, improvements have come along at a rapid pace. Examples include double-density recording techniques for more data on a disk and better ways to transfer data from disk to a system memory. Two products from General Systems International Inc. continue this trend.

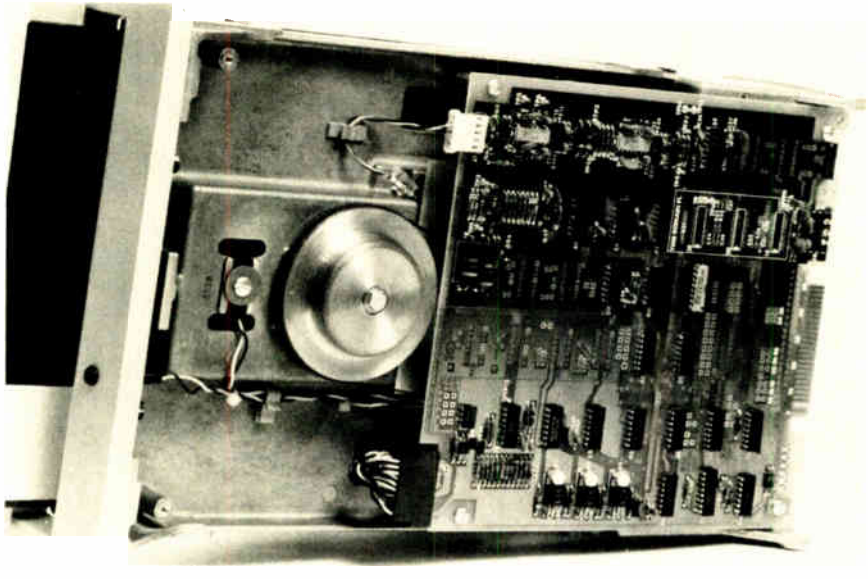
Designed to operate either in tandem or as stand-alone units, they are a flexible-disk drive designed for both double-density and single density recording and a random-access loader that automates the transfer of data from standard diskettes to the user's system memory.

In double-density applications, the GSI-110 flexible-disk drive accommodates up to 6.4 megabits of data on one side of any standard diskette. It may be adapted to either modified frequency-modulation encoding or the less efficient modified-squared frequency modulation used by older controllers. Single-density recording provides up to 3.2 megabits of data storage. Although designed for double-density operation, its single-density feature allows those with older controllers to use it while upgrading.

The GSI random-access unit automatically loads and unloads up to 32 standard diskettes from an attached positioning magazine into the model 110 flexible-disk drive. It has a maximum capacity of 1,024 megabits of data from the 32 diskettes. After the diskettes are loaded into the disk drive, total time for transfer of data to a system memory for each diskette can be as short as 2.5 seconds, with the average being 3.9 s. Under direction of the system controller, diskettes may be selected randomly from the magazine and rearranged after unloading, as necessary. The random-access loader, which fits into a standard 19-inch rack, measures 25.6 by 15.4 by 17.7 inches. The magazines are enclosed to protect the diskettes.

Price of the disk drive is $500 in quantities of 100, and delivery time is 30 days. The loader, which sells for $3,000 for single units, will be available in the third quarter.

General Systems International Inc., 1440 Allec St., Anaheim, Calif. 92805. Phone (714) 956-7183 [363]



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Formatter shapes up tape signals

A tape-controlled formatter developed by Datum Inc. provides complete operating, formatting, and control signals between industry-standard tape drives and all major minicomputer models. The model 5191 is called a quad-density controller because it handles up to four separate tape densities at the same

time. It offers individually driven ports for four transports in any combination of seven or nine tracks, nonreturn-to-zero (NRZ) or phase-encoded data density from 200 to 600 bits per inch, and tape speed from 12.5 to 200 in. per second.

The quad-density unit consists of two circuit boards. One interfaces with different computer families, and the other provides formatting logic for tape drivers compatible with ANSI and IBM formats. In contrast to conventional controllers that use daisy chain, or serial, output, the Datum model 5191 has separate, parallel outputs for each drive. Parallel operation allows a mix of different tapes on one formatter. Data densities are individually software-controlled or switch-selectable from the front panel. Power, selection, parity, and density are displayed.

In operation, the unit's NRZ section generates and checks error-detecting codes, and the phase-encoded section contains logic for function-generating. Timing restrictions on data transfers are eliminated by 64-byte write/read buffers. A quartz crystal oscillator is the timing reference.

The model 5191 measures 3.5 in. high by 17.2 in. wide and 17.79 in. deep. Power required is 105 to 230 volts at 47 to 400 hertz. Unit prices start at $5,400 and vary with minicomputer and cabling options. Delivery time is 30 days.

Datum Inc., Peripheral Products Division, 1363 S. State College Blvd., Anaheim, Calif. 92806 Phone (714) 533-6333 [364]

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Bipolar MPU is heart of minicomputer

The Harris Computer Systems division will introduce a high-performance, medium-scale addition to its line of Slash computers. The new computer, which contains bipolar microprocessor circuits and MOS memory, is software-compatible with other Slash computers already in the field. The new Slash 6 computer, aimed at real-time applications, fits between the company's recently-introduced Slash 7 Super-Mini and the Slash 4.

The Slash 6 is designed around a high-performance, 4-bit, bipolar microprocessor. Direct-memory-access channels accommodate high-speed devices, such as disks and magnetic tape equipment, and a programed input/output channel handles lower-speed devices. The I/O structure permits the sharing of peripherals in multiple central-processing-unit configurations.

An optional scientific-arithmetic unit is offered for high-speed floating-point operations. Its instruction set includes double-precision, square root, and inverse arithmetic functions, in addition to floating-point-to-integer and integer-to-floating-point conversion.

The MOS memory is made up of 4-kilobit RAM chips, which permit packaging of 48 kilobytes on a single printed-circuit board. The memory is expandable in 48-kilobyte increments to a maximum of 768 kilobytes. Single-bit error correction by means of a 5-bit code is standard for the MOS memory, and battery backup is optional.

Software includes the disk monitor system, which offers a concurrent foreground/background capability, and three other operating systems: disk, tape, and resident. The other elements of the software system include six languages, six support systems, a system utility package and, optionally, three remote-job-entry support packages. In addition, OEM users may develop their own dedicated application software.

The Slash 6 with 48 kilobytes of MOS memory is priced at about $14,500.

The new computer is expected to be ready for deliveries in August.

Harris Corp., Computer Systems Division, 1200 Gateway Drive, Fort Lauderdale, Fla. 33309 [367]

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Monitor catches power glitches

Fast transients, line surges, dips and anomalies on critical mainlines supplying power to sensitive electronics equipment are virtually everyday events. In complex computer installations, particularly, it is important to rapidly determine if data inconsistencies (glitches) were caused by external power disturbances or were due to some internal malfunction in the computer.

To serve the needs of computer customers in particular, Programmed Power Inc. is introducing its model 3500 automatic power-line-disturbance monitor. It incorporates line-monitoring and a capability for detecting the direction

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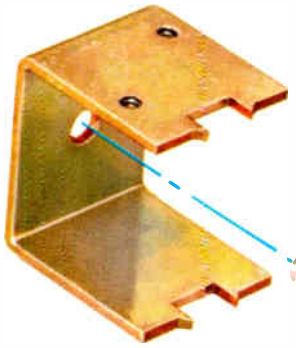


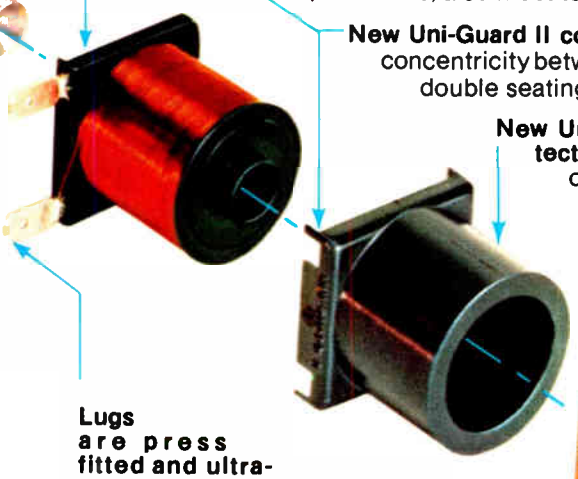
New Uni-Guard II molded bobbin and coil covers are Valox® 420 SE-O... to meet or surpass all U/L and CSA component recognition requirements; also meet tough U/L flammability spec 94V-0.

New Uni-Guard II construction minimizes wear by holding concentricity between plug and plunger... and minimizes double seating.

New Uni-Guard II coil cover gives snug, protecting fit, yet leaves space for addition of thermal cutouts or diodes.

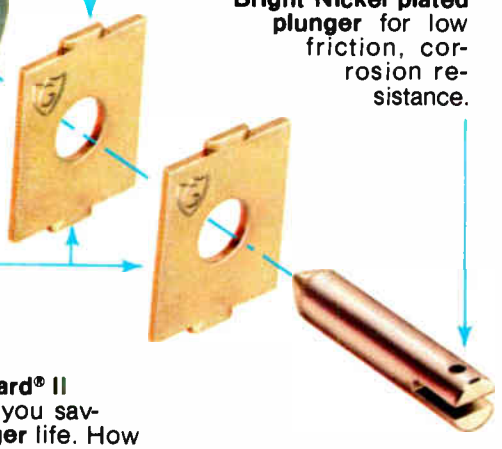
Dual endplates on model shown improve mechanical strength and magnetic efficiency.

Bright Nickel plated plunger for low friction, corrosion resistance.



Lugs are press fitted and ultrasonically welded to bobbin to withstand eight pound pull test.

Endplates are swage formed and staked to field piece to provide continuous magnetic flux field for most efficient operation.



Only Guardian solenoids have new Uni-Guard® II molded bobbin and coil covers that give you savings of up to 25%... with at least 25% **longer** life. How long? Up to 5 million operations. This new construction is now available on nearly all Guardian box frame and U-frame solenoids. Including pull type, push type and solenoid switches. All have .187" or .110" QC lug or solder lug termination for easier, faster, less expensive installation. And Guardian has more types available from stock than anyone else.

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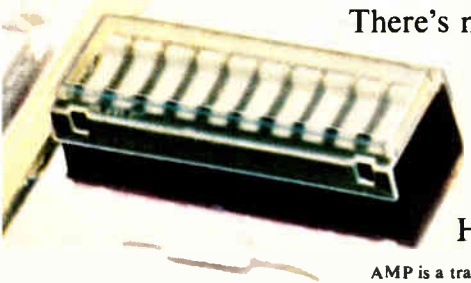

There's nothing quite like new AMP LED DIP switches. For more details on them, or the new AMP low-profile DIP switches, call (717) 564-0100. Or write AMP Incorporated, Harrisburg, PA 17105.

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Circle 134 on reader service card

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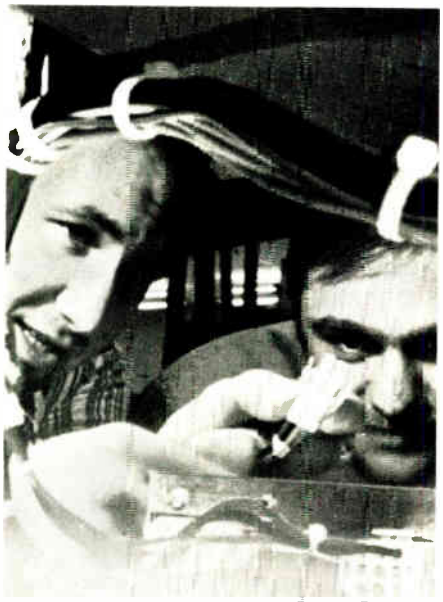


of transients as in the form's earlier systems—the model 3200 and 3400 families. It also has automatic operation, a wide test range, and fast operation.

According to president Lee Cooper, the 3500 automatically monitors standard single-phase and three-phase ac power mains covering 50 to 600 volts ac for overvoltage, undervoltage, and fast transients or spikes. When connected for three-phase monitoring, each is monitored individually, and data on each disturbance is recorded by hard-copy printout.

Time-of-day information with one-second resolution is also printed out to correlate the time of line disturbances and equipment malfunctions. Printouts occur when any disturbance is detected and when overvoltages and undervoltages terminate. Special printouts are available on command from the user.

A front-panel digital voltmeter display is used to set voltage levels. A digital memory accumulates the number of disturbances per phase to ensure against loss of data during any printout cycle. An uninterruptible power supply is standard to keep the model 3500 alive and monitoring at all times, including complete blackouts.

Threshold-level settings and other status data are recorded in black printouts, and disturbance data is printed in red. A visual and audible alarm is activated on the detection of any disturbance. Maximum voltage deviations for overvoltages and undervoltages and peak transient voltages are detected and recorded in the printout.

Options include frequency error detection for 50/60 hertz and 400/415/441 Hz, transient-direction detection, transient duration, dc voltage monitoring, binary-coded-decimal output terminal, external alarm terminal, and rack-mounting hardware. Price is $3,800 to $4,000 for the basic configuration.

Programmed Power Inc., 141 Jefferson Dr., Menlo Park, Calif. 94025 [365]

NCC NCC NCC NCC NCC NCC NCC NCC NCC NCC NCC NCC NCC NCC

OCR wand reads alphanumerics

A hand-held wand optically recognizes characters for direct digital input to data-processing systems of readable information such as routing slips, point-of-sale merchandise, and process-control forms. The system reads a total of 26 characters: 10 alphabetic characters, 10 numbers, and six special characters of the OCR-A code. As an option, the wand can also handle 24-character OCR-B subset-1 (ECMA-11, 1971). And it can be supplied with parallel or EIA RS232C interfaces.

The wand, which contains a self-scanned photo-diode array and a preamplifier, delivers an analog signal to its supplementary electronics module. The electronics module converts the inputs to digital form by means of custom MOS circuitry and a Fairchild F-8 microprocessor.

The MOS logic recognizes the characters, and the F-8 performs the last few steps of the conversion process. Although the F-8's programmability allows some customization for individual users, its primary benefit is going to be one of cost, say the

developers of the new system.

The wand does not have to be in continuous contact with the paper, since its depth of field is about ⅛ inch. It can be swept in either direction across the paper at speeds of 3 to 12 inches per second. As for accuracy, not more than 0.01% of undetected errors have been observed in scanning media with a wide range of print quality, according to the developers.

Recognition Products Inc., P.O. Box 5569, Dallas, Texas 75222 [361]

NCC NCC NCC NCC NCC NCC NCC NCC NCC NCC NCC NCC NCC NCC

Memory units have 280-ns access

National Semiconductor's Memory Systems division will introduce two semiconductor memory units. A single printed-circuit board, type NS3000-1, holds 16,384 words of 20 bits each and a four-board system, type NS3, holds up to 128,000 22-bit words. Each of the four boards contains 32 kilowords. Both systems are based on 4-kilobit random-access memory chips.

A timing and control board, together with an optional custom interface circuit and a special-features board complete the multiboard system. The special-features board offers such enhancements as error check and correction, double-word structure, and generation and checking of parities.

Access time for both the single board and the multiboard systems is 280 nanoseconds, and read or write cycle-time is 430 ns. The read/modify/write cycle is 610 ns. All boards measure 11.75 by 15.40 inches.

Price of the 16-kiloword board is $1,050, and of the 128-kiloword system, $11,000, including chassis and power supply.

National Semiconductor Memory Systems Division, 2900 Semiconductor Dr., Santa Clara, Calif. 95051 [368]

NCC NCC NCC NCC NCC NCC NCC NCC NCC NCC NCC NCC NCC NCC

Portable terminal boasts big screen

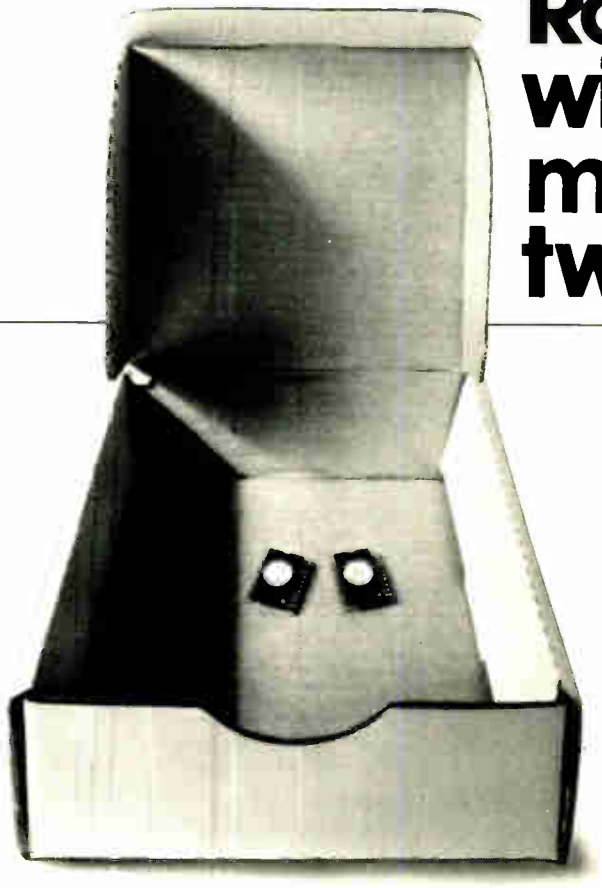
Datamedia Corp. will announce its Elite portable cathode-ray-tube terminal, which has a 9-inch diagonal display. The terminal, which can also drive external CRT monitors, displays 24 lines of 80 characters each. All three models of the new terminal can be equipped with an optional built-in 300-baud acoustic coupler, priced at $300, for operation over the standard telephone network.

The basic model, which operates at 4,800 bauds, provides teletypewriter upper-case text display only; the mid-range unit, which operates at 9,600 bauds, provides cursor addressibility, and the most comprehensive model, which also operates at 9,600 bauds, can handle either APL or ASCII character sets.

The portable terminal is only about half the height of the console model, but both use the same logic boards, which are interchangeable between the two models for ease of troubleshooting. The keyboard, which is hinged to fold into the metal package, is also detachable. The company points out that the large 9-inch screen size enhances operator comfort when it must be viewed over long periods.

Prices of the portable units are $500 more than the equivalent console models. Price of the basic portable terminal is $1,930; the inter-

Rockwell is there with a complete microcomputer on two chips.



WE'VE CUT THE NUMBER OF COMPONENTS

One chip of our new PPS 4/2 contains a clock, CPU, and 12 I/O lines.

The other holds 2K x 8 ROM, 128 x 4 RAM and 16 bidirectional I/O lines.

There you have it: a complete microcomputer on two chips. For many applications, that's all you'll ever need.

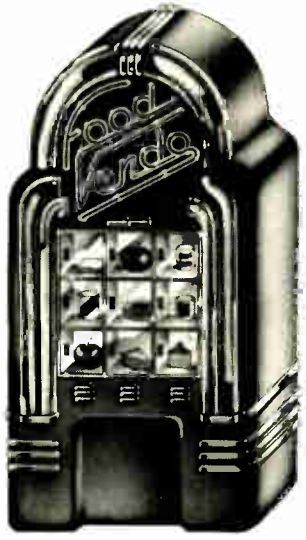
SO YOU CAN CUT COSTS

For example, the complete PPS 4/2 system is priced at less than $35 in quantities of 1000.

As your needs grow, you can add any of seventeen I/O, memory, or peripheral controller chips to your system at similar cost savings.

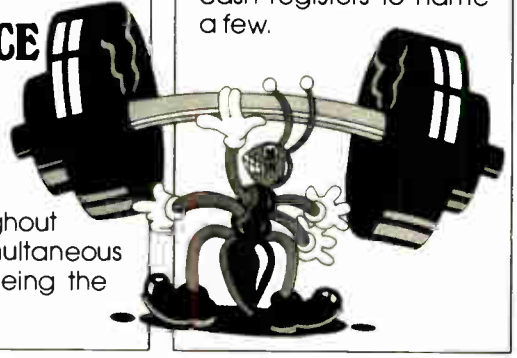
EIGHT-BIT PERFORMANCE FROM A FOUR-BIT MICROPROCESSOR

Rockwell's parallel processing and independently intelligent I/Os throughout the microprocessor system permit simultaneous performance of various functions, freeing the CPU for system thinking. In fact, with Rockwell's unique parallel processing system (PPS), your 4-bit system will actually outperform many 8-bit systems.



APPLICATIONS GALORE

The PPS 4/2 will control any number of mechanical or electromechanical devices — office machines, vending machines, electronic games and low-end cash registers to name a few.



It will also serve well as peripheral controller on larger microprocessing systems, including non-Rockwell CPUs you've already programmed.

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Rockwell International

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mediate unit, which has lower-case, as well as upper case characters, is $2,155, and the more sophisticated version is priced at $2,650.

Datamedia Corp., 7300 N. Crescent Blvd., Pennsauken, N.J. 08110 [366]

Panel aids repair of add-on memory

Intel Memory Systems, Sunnyvale, Calif., will announce its model in-7168 semiconductor add-on memory system for the IBM Corp. System/370 model 168 computer. The new system stores 1 to 8 megabytes in a stand-alone frame 37 inches wide by 40 inches deep. Its 4-kilobit random-access-memory chip is made by Intel's Semiconductor operation.

Robert Sumbs, end-user marketing manager, claims that the system leases for up to 30% less than an IBM memory. It costs less than other add-ons for several overhead factors, including computer-room space, power, cooling, and maintenance delays, Sumbs says.

When used with IBM's minimum memory of 1 megabyte, the unit stores up to 7 megabytes, for a total memory capacity of 8 megabytes. A second unit could be used to increase total memory capacity to 16 megabytes, generally considered the maximum amount of main memory usable by the IBM 370-168 central-processing unit.

The system also has a maintenance panel based on an 8080 microprocessor, which logs errors to warn of potential memory failures that might cause system crashes. The panel also facilitates the "dialing out" of failing sections by the operator. A digital voltmeter in the panel can rapidly check any voltage in the in-7168.

The microprocessor also scans system voltages, which are stored by the microcomputer for readout on the system panel. If any system voltage goes under or over specified tolerances, the memory is powered down automatically.

The system's modular power supplies allow 1 or 2 megabytes of memory to be powered down while all other 1-megabyte modules remain available to the CPU for processing. Thus, maximum storage is available under almost any condition.

The system also contains temperature sensors at strategic locations and will shut down in the event of a system-supply failure or overheating. One of the 8080 microcomputer system's functions is sensing, via the system interface, errors in both IBM and Intel memories.

Correctible errors are logged as addresses in more than 400 register locations available to the operator through the panel display. The addresses for points at which these errors occur most frequently are kept at the top of the register stack to indicate possibly failing memory.

Because uncorrectable errors occur rarely in a semiconductor-memory system, they are logged in a small stack of 16 registers. Since uncorrectable errors can cause system crashes, this log is used by the operator as a basis for immediate reconfiguration of memory.

The microcomputer's program also provides the field engineer with a comprehensive set of other diagnostic capabilities. For example, to expedite testing and maintenance, he can limit error-logging to a 1-megabyte memory segment. Then, by using a module-disconnect control, he can power-down that segment and replace any cards containing failing elements without affecting normal operation of the remainder of the system.

A failure within the microcomputer itself would not affect memory operation. The 8080 system also diagnoses its own failures, should any occur. Lease prices range from $4,500 a month for 1 megabyte of storage to $32,000 a month for 7 megabyte increments.

Intel Memory Systems, 1302 North Mathilda Ave., Sunnyvale, Calif. 94086 [362]

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The GOULD/Brush 2000 Series No other line of direct writing recorders can offer as much.

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Selection: A Gould 2000 Series Recorder to fit your application.

Three new recorders in the 2000 Series lets you choose the instrument that matches your specific needs.

For instance, the Gould 2200 can be ordered as a 100 mm single-channel instrument, or with two 50 mm channels. The Gould 2400 can be a two, three or four-channel recorder, utilizing combinations of 50 mm and 100 mm channels totalling 200 mm. And the Gould 2600 utilizes three, five or six channels totalling 300 mm.

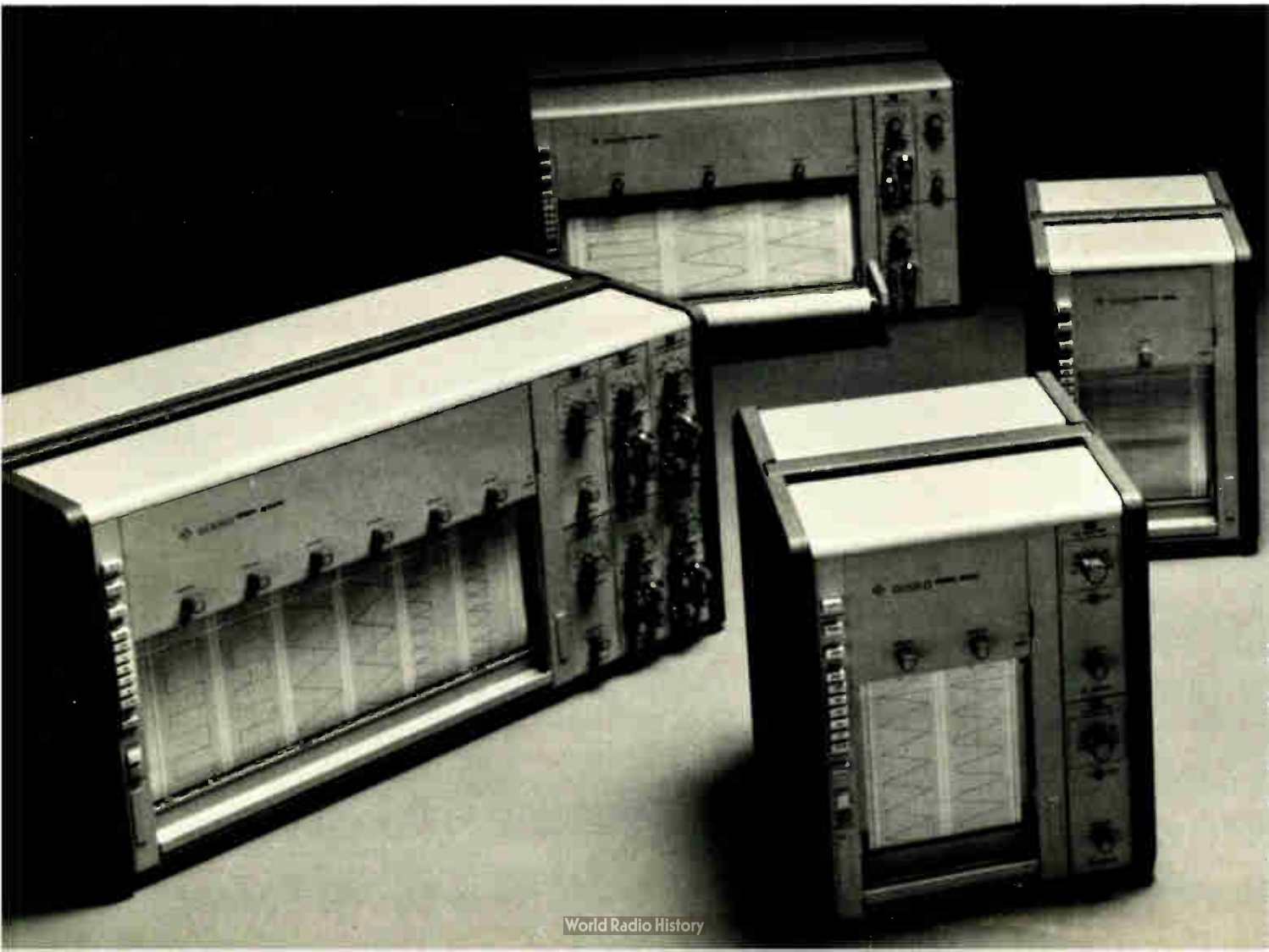
The entire series is compatible with existing Gould signal conditioners so you can use your existing preamps for added savings and flexibility.

The 2000 Series Recorders have an unequalled frequency response of 30 Hz at 100 mm, 50 Hz at 50 mm and up to 125 Hz at reduced amplitude.

Superior resolution is assured through a 100 grams/mm high-stiffness servo controlled pen-motor. The Gould patented Metrisite® servo feedback element enforces 99.65% linearity over the entire channel width. The result: accurate, more meaningful traces.

Features: built-in versatility with each Gould 2000 Series Recorder.

All Gould 2000 Series Recorders have 12 chart speeds from 0.05 to 200 mm/sec. Pushbutton controls are activated from the front panel,



while an external switch closure offers remote stop/start capability at a preselected chart speed.

Plug-in preamplifiers provide a choice of signal conditioners for a large selection of analog measurements. These optional units allow you to expand desired portions of an input signal as well as reject noise or unwanted signal components.

Other standard features include a front panel paper supply indicator with a low paper supply warning light, margin event markers and a programmable timer.

And of course, every Gould Recorder offers the Gould pressurized inking system for the highest quality rectilinear traces — with no smudges, skips or puddles. Cartridge ink supply is good for one year's normal use.

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Clean, modular design has eliminated dials, controls and gauges you don't need to see. On the inside, maintenance has been simplified due to plug-in serviceability and fast access to all major components.

Value: A surprisingly affordable line of recorders.

To all the features of the Gould 2000 Recorders, add one more: a price you can afford. Call your nearest Gould Sales Engineer to arrange a demonstration. Or write Gould Inc., Instrument Systems Division, 3631 Perkins Avenue, Cleveland, Ohio 44114. Or Gould Allco SA. 57 rue St. Sauveur, 91160 Ballainvilliers, France.

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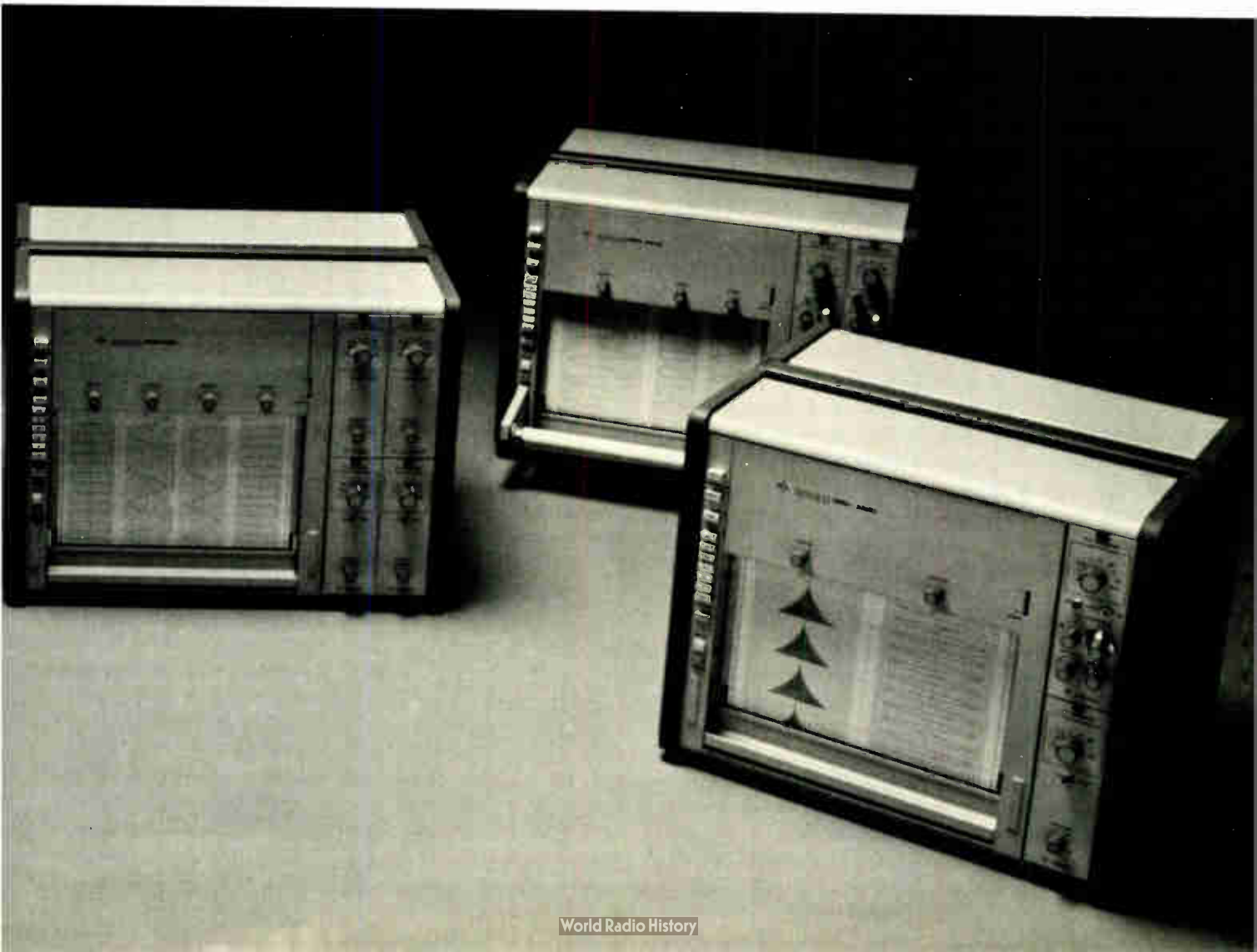


Data-acquisition system fits in DIP

Eight-channel, 8-bit, thin-film assembly has throughput rate of 90,000 conversions a second; is aimed at microprocessor applications

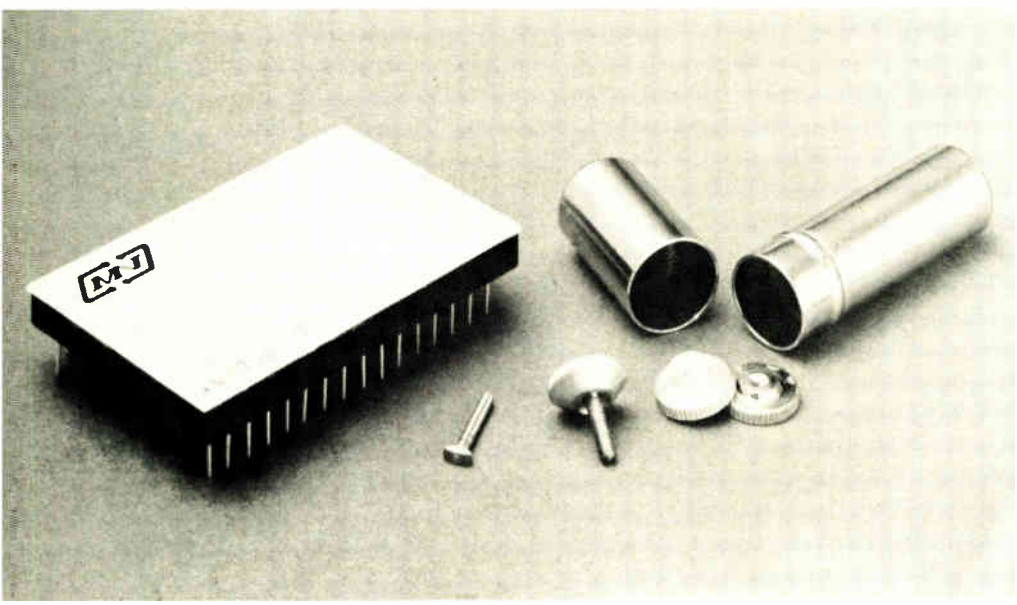
by Michael J. Riezenman, New Products Editor

Over the past few years, medium-speed data-acquisition systems have evolved from assemblies of instruments, to single instruments, to assemblies of modules on large printed-circuit boards, to assemblies of smaller modules on small pc boards. Now Micro Networks has moved them a major step further: a complete eight-channel data-acquisition system has been squeezed into a single 32-pin dual in-line package.

The 8-bit system is aimed at microprocessor applications such as oil-field instrumentation, medical equipment, machine control, and, eventually, automobiles. Product marketing manager Bruce R. Smith predicts that 60% to 70% of the microprocessors to be used in the foreseeable future will require data-acquisition systems for interfacing with the analog world. The MN7100 is the first such system that is compatible in size with a microprocessor. And although its resolution is only 8 bits, Smith estimates that most users do not need more precision.

The system is not only small in size, it also consumes little power. Typically, it draws only 10 milliamperes at +15 volts, 12 mA at −15 V, and 70 mA at +5 V. This corresponds to a typical total power consumption of 680 milliwatts. Maximum is 1,165 mW.

The thin-film hybrid circuit operates over the temperature range from 0 to 70°C. Maximum nonlinearity over that temperature range is half a least-significant bit, maximum zero error is one LSB, and maximum absolute error is 2 LSBs. The unit has a typical aperture time of 50 nanoseconds, a typical acquisition time of 5 microseconds, a typical analog-to-digital conversion time of 6 μs, and a typical throughput rate of 90,000 conversions per second. The quoted specifications on accuracy, linearity, and zero error apply over the full 70°C operating range and for the life of the system.



Each of the MN7100's eight single-ended input channels has an impedance of 10 megohms and accepts voltages from −10 V to +10 V. The absolute maximum voltage that can be tolerated on the analog inputs is ±20 V. In the event of input-circuit failure, the input fault current is limited to 20 mA.

The system contains its own internal clock. The clock rate can be increased or decreased by the external connection of a resistor or a capacitor, respectively. Or the operation of the system can be slaved to an external clock that overrides the internal one. Other than the clock frequency, no adjustments are possible.

For users who require more than eight channels, a multiplexer-enable pin and a sample-and-hold input pin are provided. By using an external counter, triggered by the most-significant bit of the channel output, the user can expand the number of channels without giving up the capability of randomly selecting input channels.

The MN7100 will sell for $195 each in small quantities. Its availability is from stock to four weeks. Among the companion products to be expected in the near future are a data-acquisition system with differential inputs and a multichannel digital-to-analog converter system. Both, of course, will be thin-film hybrid circuits housed in a single DIP.

Micro Networks Corp., 324 Clark St., Worcester, Mass. 01606. Phone Bruce Smith at (617) 852-5400 [340]

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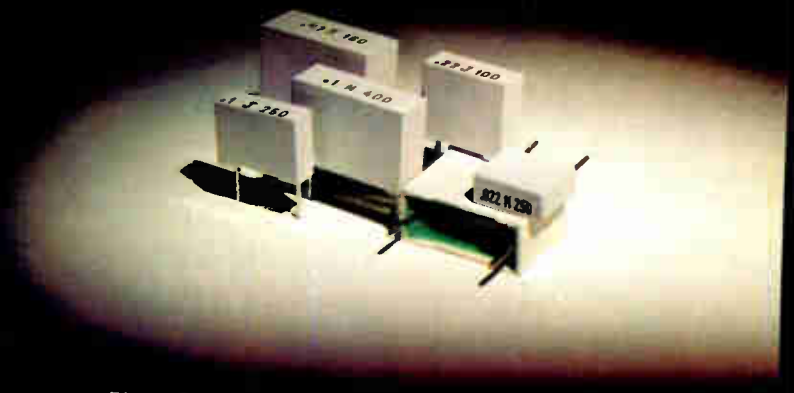

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Circle 144 on reader service card

Standard interface added to mini

Hardware and software package meets IEEE 488 instrument standard, simplifies user assembly and expansion of multipoint test systems

by Andy Santoni, Instrumentation Editor

A wide variety of automatic test equipment is on the market today, but many manufacturers still prefer to build their own instead of buying a general-purpose tester or even one tailored to a particular class of needs. They use commercially available computers and instruments so they can maintain control over all the details of the system and buy only as much capability as they may require.

A hardware and software package from Hewlett-Packard Co. can simplify the design, assembly, and expansion of in-house automatic test systems by making it easier to interface programable instruments to minicomputers. Called the HP 59310B, the interface package includes a card that plugs into powered slots of the firm's 21MX and 2100-series minicomputers so that the computer can control a group of instruments via the IEEE 488-1975 standard instrumentation-interface bus.

"This should make automatic testing an awful lot easier," says Bob Brannon, product marketing manager at HP's Data Systems division, Cupertino, Calif. A system can be integrated by plugging instruments into a computer. No software beyond the computer's standard operating system is needed. And adding another instrument to the system takes about 15 minutes, Brannon says, since no major changes have to be made to the system's software.

The $1,000 hardware and software package adds four other features to minicomputer-controlled test systems: several instrument clusters can be controlled by a single mini; the user can prepare programs on one terminal while the computer is executing test programs from another terminal; more than one programing language is available, and the minicomputer can be tied into multicomputer networks.

Each independent instrument cluster is connected to the computer through its own 59310B card and can be configured to perform independent tests. For example, one user can test components while a second checks out printed-circuit cards and a third tests completed products. Another port can be added for preparing test programs, even while the computer is controlling on-line instrument clusters.

The programs can be prepared in any of three languages: Fortran IV, which is convenient for scientific computation; Basic, which is comparatively easy to learn, or assembly language, which uses the minimum amount of storage space and therefore is less expensive—at least as far as hardware is concerned.

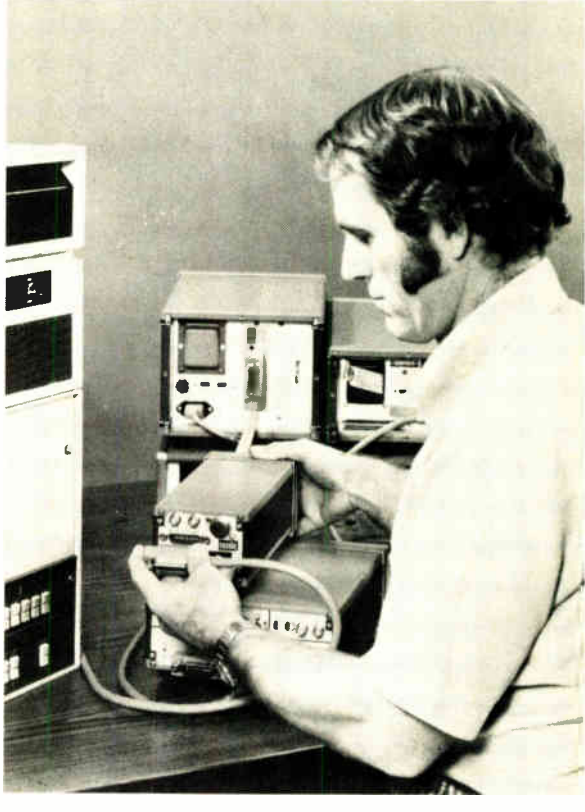
While controlling multiple systems, the minicomputer can also be connected to other 21MX computers or to IBM 360/370 systems via standard data-communications links. This network can be used in a management-information system, for example.

While each of these four capabilities is available in one or another commercial test system, they have never been combined with standard-interface-bus compatibility in a package designed to appeal to engineers who prefer not to buy a turnkey system.

HP has no intention of building turnkey test systems using the 59310B card, Brannon says. The firm can supply equipment and applications assistance, but responsibility for the performance of the system remains with the user, he adds.

Yet Brannon sees a market for 500 to 1,000 customer-built systems over the next two years. With prices starting at $30,000 or so for the minicomputer and its operating system alone, that's a substantial market. "The standard interface bus means there's an awful lot of money to be made by minicomputer iron vendors," he says.

Inquiries Manager, Hewlett-Packard Company, 1501 Page Mill Rd., Palo Alto, Calif. 94304 [339]



Microprocessors

National expands processor line

Upgraded calculator-type chips are added at lower end of performance spectrum

Now that microprocessor makers have seen their 8-bit products become established for data-handling and control applications, they are moving into markets at the lower and the upper ends of the scale. On the upper end, for example, is Texas Instruments' 9900, a 16-bit microprocessor (see p. 99) and Motorola's 10800 4-bit slice, the only device of its kind that uses emitter-coupled-logic technology (see next story).

For applications at the low end, manufacturers are often upgrading their calculator-chip products for general-purpose uses. That's just what National Semiconductor is doing with a group of special-purpose calculator-oriented processors.

The new family, says Orville Baker, product manager for complex MOS LSI devices, will include the MM5781/MM5782 chip set, the one-chip MM5799, and the one-chip MM5734. They will cost between $5 and $10 each when purchased in volume.

"Conventional general-purpose microprocessors," says Baker, "provide functional solutions to various controller-type problems, but are usually overkill in applications involving high volume. Custom-LSI often provides the best cost solution in these situations. But the lack of flexibility, long lead time, and high development costs are incompatible with a large group of products in today's market."

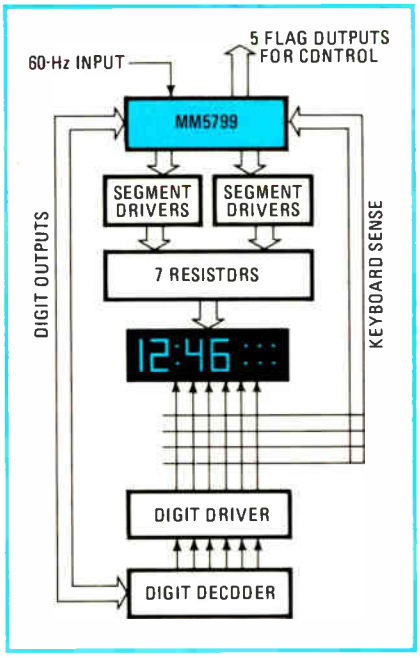
The new circuits, says Baker, offer built-in ROM and RAM, separate bus and registers, single 8- to 10-volt operation with low current drain, direct keyboard interface, BCD or seven-segment outputs, digit-select outputs, built-in display drive (not in the MM5781/82), general-purpose inputs and outputs, and—except for the MM5734—expandability in ROM and RAM.

The MM5781/82 chip set is the high-performance member of the family, says Baker. The 5781 is the control-ROM element, and the 5782 is the memory-and-processor element. Cycle time is 10 microseconds, and the set is expandable in both RAM and ROM.

The MM5799 combines the functions of the MM5781/82 into a single package, but with a reduced amount of ROM and RAM. It also has a 10-microsecond cycle time.

The MM5734 contains only 630 words by 8 bits of ROM and 55 words by 5 bits of RAM on the same chip as the arithmetic/logic unit and is not expandable in either. Although the MM5734 has only a 14-μs cycle time, in many simple controller applications use of that device will provide the most economical solution.

Potential applications for these devices are in portable calculators, table-top calculator systems, electronic cash registers, appliance controllers, water sprinklers, toys and games, TV-tuning synthesizers, instrumentation control, multiple-time-zone clocks, automotive instrument-panel controls, and as an arithmetic extension for standard minicomputer and microcomputer systems.



Fabricated with p-MOS metal-gate processing with ion-implanted depletion loads, the devices are available now.

National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, Calif. 95051 [341]

Motorola's ECL slice gives 100-nanosecond cycle time

One of the fastest microprocessors yet introduced as a 4-bit slice is intended to give computer manufacturers a high level of microprogrammable performance. Featuring a minimum 100-nanosecond cycle time, the MC10800L slice developed by the Integrated Circuit division of Motorola Semiconductor is said to be the first standard product made by emitter-coupled-logic technology. It is also the first of an ECL-based family that Motorola plans to market over the next year. The MC10800L arithmetic/logic unit "should find its initial market penetration in the next generation of mini- and mainframe computers," says Jerry Tonn, product planner for the 10800 family. "It should also find wide application in the emulation of current minis," he adds.

In comparing ECL slices with existing TTL MSI and SSI parts, Tonn says one advantage is "much greater flexibility. With the ECL slice, you can change functions and still use existing software."

The 4-bit unit differs from most other slices because it does not contain memory-register files. Based on talks with prospective users, Tonn says this is "an advantage because, at the present time, nobody is really clear on how many 16-word registers are enough." The Motorola slice offers a "unique three-bus structure" that allows a user to build his own external memory. "Since two of the buses are bidirectional, it is easily adaptable to an external memory that is just as fast as self-contained registers," he says. Speed

Is production testing Memory PC Boards a problem?

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For instance, the MD-107 can automatically test your memory boards, pinpoint the bad circuits, give you hard-copy rework instructions, guarantee your good boards – and do it all right on your production line with your present personnel. In addition to board diagnostics, the MD-107 was designed to do system level testing as well as device characterization of ROM's and RAM's.

Since Macrodata introduced its MD-107 every significant computer mainframe manufacturer has been using this remarkable test system on such devices as the MK4096, the 2107 Series, the MC6605, the 4030, the 4050's, and the 4060.

So if you still think production testing semiconductor memory PC boards has to be a problem, you should find out more about the MD-107.

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Macrodata Corporation, 6203 Variel Avenue, Woodland Hills, California 91364, Phone: (213) 887-5550, Telex: 69-8489

Circle 147 on reader service card

would be in the 10- to 12-nanosecond range.

Other capabilities that Tonn cites for the slice are parity generation and detection, as well as both binary and binary-coded-decimal formats. Applications, in addition to the computer market, include high-performance peripheral controllers, voice synthesizers, secure-speech communications, high-speed switching for telecommunication networks, and real-time data processing. "There is already some interest, too, in medical electronics, particularly in three-dimensional X-ray units," says Tonn. Production quantities are now available. The slice is packaged in a 48-pin, quad in-line configuration, roughly the same size as a standard 24-pin package. The leads are offset, and the MC10800 runs on 1.3 watts. All parts in the planned ECL family will use less than 2 W, Tonn says. Unit price of the MC10800 is $75, but it drops to $50 for lots of 100.

In the future, Tonn says, Motorola will also announce a microprogramable controller, to be sampled in the third quarter, and a memory interface in the fourth quarter. Additional products are planned throughout 1977, he adds, many of which will be TTL-compatible, according to the company.

Integrated Circuit Division, Motorola Semiconductor Group, M10800 Marketing, M142, 2200 West Broadway, Mesa, Ariz. 85202. Phone (602) 962-2151 [342]

Low-cost microcomputer uses 2650 microprocessor

Built around the Signetics 2650 microprocessor, the AMT 2650 microcomputer is a one-card self-contained machine that sells for $195 in small quantities. The unit is supplied with 256 bytes of random-access memory and is expandable to a capacity of 32 kilobytes. Programing is by means of front-panel switches, and two fully buffered, TTL-compatible output-data ports provide interfacing with the user's hardware. Delivery time for the AMT 2650 is 30

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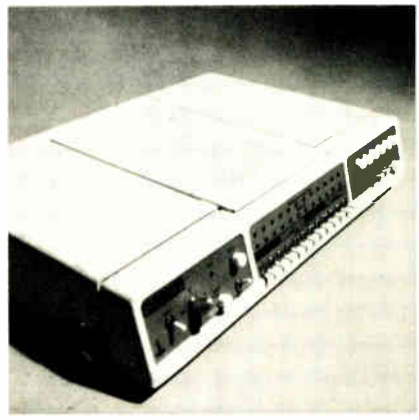
New products

days after receipt of order.
Applied Microtechnology, 100 N. Winchester Blvd., Suite 260, Santa Clara, Calif. 95050 [344]

Prototyping instrument made for IM6100 microprocessor

Designed for the prototyping of computer systems based on Intersil's IM6100 12-bit complementary-MOS microprocessor, a bench-top instrument called Intercept duplicates all functions and timing of the MPU. Since the IM6100 is compatible with Digital Equipment Corp. PDP-8E

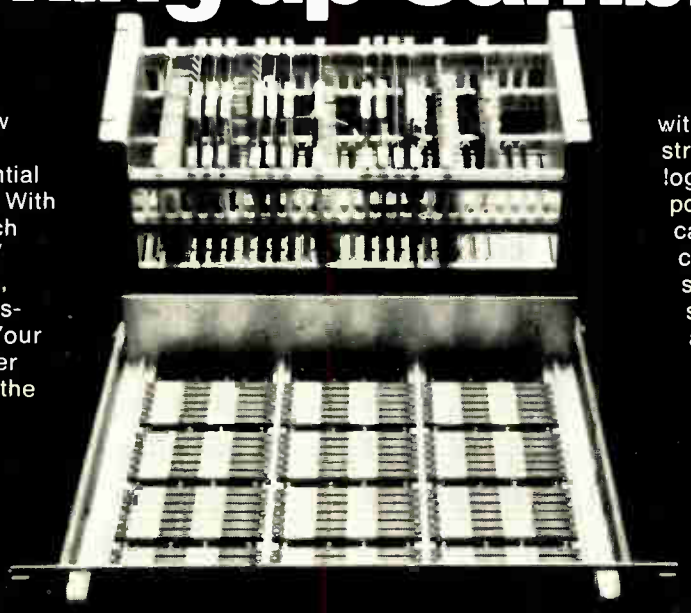


software, Intercept will operate with basic PDP-8E paper-tape programs with no need for software or hardware modifications. Intercept comes with a nine-pin Teletype connector and two uncommitted 25-pin connectors. It sells for $2,850, and delivery time is four weeks.
Intersil Inc., 10900 North Tantau Ave., Cupertino, Calif. 95014. Phone (408) 996-5000 [346]

8-bit microcomputer kit sells for $99

Intended for use with a teletypewriter, the SC/MP kit contains all of the components needed to build an 8-bit microcomputer, including a circuit board and a SC/MP microprocessor. Priced at only $99, the kit includes a 4,096-bit read-only memory which is supplied with a program called Kitbug—a

Everything's coming up Cambion



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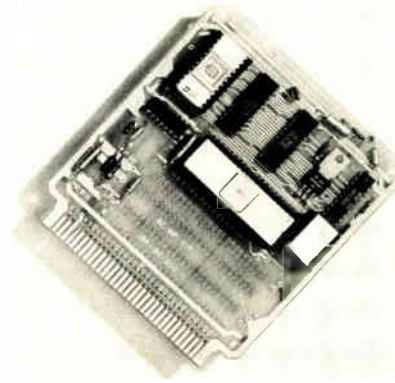

monitor and debugging program that assists in the development of the user's application programs. Kitbug provides teletypewriter I/O routines and allows examination, modification, and controlled execution of user programs. The SC/MP kit is available from stock.

National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, Calif. 95051. Phone (408) 732-5000 [347]

TOPICS

Microprocessors

Computer Applications Corp., Ames, Iowa, has announced its MINmic 1165 microcomputer-design board, priced at $495. Existing minicomputer memory can support the design of microprocessor-based systems. . . . **IMS Associates Inc., San Leandro, Calif.,** is selling its IMSAI 8080, a microcomputer based on the Intel 8080 microprocessor. The price is $599 for the kit and $931 for the fully wired version. For OEMs who do not require a front panel, the prices are $529 and $749, respectively. . . . **Adaptive Systems Inc., Pompano Beach, Fla.,** has developed a typewriter-like terminal that speeds the assembly of microcomputer programs. Visual annunciators provide verification. Price is about $3,500. . . . **Datel Systems Inc., Canton, Mass.,** has come out with a backplane-pluggable analog interface card with 32 input channels that slides directly into Intel's MDS-800 or SBC-80/10 microcomputer.

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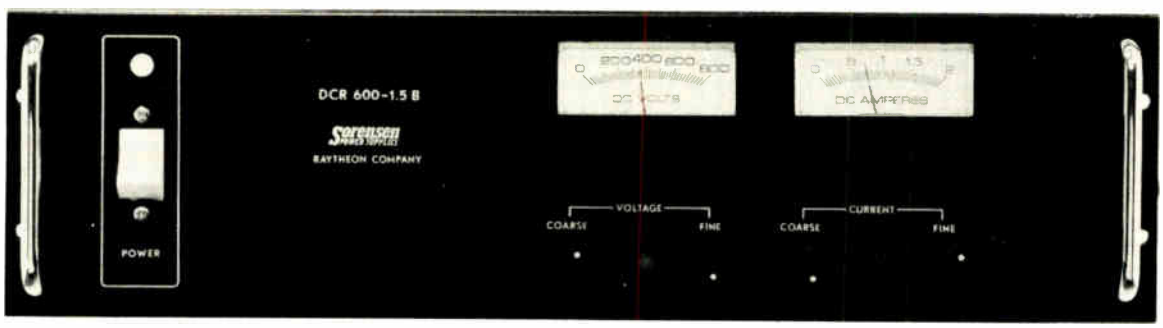

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Of course, once you see how much the LSI-11 in these last two models can do, you can go back to the board version for your production run.

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For more info, call 800-225-9480 (Mass. 617-481-7400 ext. 6819 or 6817). Or write: Components Group, Digital Equipment Corp., One Iron Way, Marlborough, MA 01752. Canada: Digital Equipment of Canada, Ltd. Europe: 81 Route de l'Aire, 1211 Geneva 26, Tel. 42 79 50.

*Prices apply to USA only.

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Materials

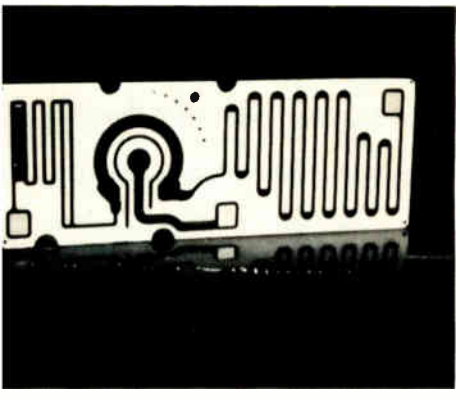
Inks withstand voltage stress

Thick-film resistor types for TV circuits show little change in resistivity

Increased reliability is promised by a new family of thick-film resistor materials available from E.I. Du Pont de Nemours & Co. Intended for bleeder networks and focus potentiometers in television receivers, as well as for high-potential probes for oscilloscopes and other instruments, the 9400-series inks can withstand high-voltage stress, either pulsed or continuous, with little change in resistivity.

Besides improved long-term stability, the fired materials have a smooth surface, which provides good resolution for focus-potentiometer applications in television sets, points out David P. Anisfeld, product-marketing manager for the Electronic Materials division. Furthermore, he notes, both bleeder and focusing elements can be put on the same ceramic substrate, in contrast to the separate printed-circuit boards required for other resistor systems.

There are now four members in the 9400 family: the 9477 ink, providing a resistivity of 100 kilohms per square, the 9478 and 9467 inks with a resistivity of 1 megohm per square, and the type 9479, which has a resistivity of 10 megohms per square. All the inks are blendable to provide intermediate resistivity values, Anisfeld notes.



The 9467 material is particularly suited to applications involving high-voltage pulsing. For transient voltage gradients as high as 75 kilovolts per inch, its resistivity changes by only 0.1%. Similarly, when subjected to long-term voltage stress of 5 kv/in. for up to 1,000 hours, the 9478 material exhibits a resistivity change of well below 1%, Anisfeld says. Competitive materials rated at 1 megohm per square tend to exhibit changes of 3% to 5% when exposed to a transient gradient of 25 kv/in., he adds. All four resistor inks, which are available from stock, are priced at approximately $1.45 a gram.

E.I. Du Pont de Nemours & Co., Electronic Materials Division, Wilmington, Del., 19898 [472]

Transformer-core alloys are low in loss and weight

The line of wrapped, laminated transformer cores made by National Magnetics has been augmented by the addition of two new alloys. Cobisil is a cobalt-iron alloy intended for operation to 22 kilogauss. It is said to yield size and weight reductions of up to 30% over conventional materials. Nicosil is a nickel alloy for operation up to 13.8 kilogauss. With a loss less than 10% of that of conventional silicon steel, it is an obvious choice for high-frequency transformers and switching-inductor applications up to 70 kilohertz.

National Magnetics Corp., 13607 Pumice St., Santa Fe Springs, Calif. 90670. Phone (213) 921-7917 [478]

Dielectric pastes are black for use in plasma displays

For best contrast, the insulating layers between the conductor networks and the cathode segments in a gas-

New products

(1,1760°C). The adhesive is cured by heating it to 250°F for one hour, followed by one hour at 550°F. Ultra-Bond 552 sells for $27.50 per pint; delivery is from stock.

Aremco Products Inc., P.O. Box 429, Ossining, N. Y. 10562. Phone (914) 762-0685 [477]

Foam-in-place rubber reduces shock and vibration

A white foam-in-place silicone rubber, Eccofoam Sil is noteworthy for its resilience. It is intended for the potting of delicate electronic components to protect them against shock and vibration. Supplied as an

easily poured liquid, the material is activated by the addition of a small amount of catalyst. The catalyzed resin has a pot life of about 30 minutes. Eccofoam Sil foams and cures at moderately elevated temperatures. It can be used to temperatures in excess of 400°F (204°C) and remains flexible down to -65°F (-54°C). The rubber sells for $13.75 a pound in nine-pound containers.

Emerson & Cuming Inc., Canton, Mass. 02021. Phone (617) 828-3300 [476]

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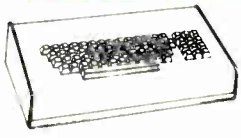

ELECTRONIC DATA ENTRY KEYBOARDS

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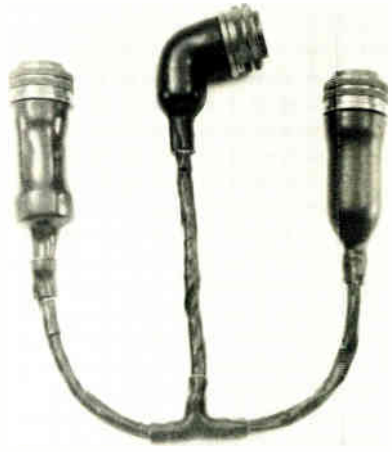

heat-shrinkable polyolefin conductive tubing and molded shapes is coated with a silver-based resin. The proprietary resin formulation remains in intimate contact with the polyolefin even during shrinking; because there are no gaps in the highly conductive surface, the material is an especially effective shield at very high frequencies (100 megahertz and above). Typical shielding effectiveness is 50 decibels at 100 MHz. Called Cho-Shrink, the material is available as tubing with diameters from 0.25 inch to 4 in.

Chomerics, 77 Dragon Court, Woburn, Mass. 01801. Phone Dr. Daniel S. Diamond at (617) 935-4850 [475]

Thermally conductive epoxy designed for die stamping

A thermally conductive, electrically insulating epoxy-resin system has been designed specifically for the fabrication of hybrid microcircuits by the die-stamping technique. Applications for Epo-Tek H70S include chip bonding, lid sealing, and substrate bonding. The material has a room-temperature pot life of four days. Before mixing, the two components have a room-temperature shelf life of two years. Despite the long pot life, rapid curing is possible: 45 seconds at 175°C or 5 minutes at 150°C are all that is required.

Epoxy Technology Inc., 65 Grove St., Watertown, Mass. 02172. Phone (617) 926-0136 [474]

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Instruments

10-MHz scope has digital store

Dual-trace instrument offers 2-MHz sampling rate and optional output unit

By digitizing analog signals for storage in memory, the digital storage oscilloscope acquires the features of a transient recorder and becomes an instrument that functions in the analog domain, much as a logic analyzer works on digital signals. Like a logic analyzer, a digital storage scope can simplify trouble shooting by capturing and displaying waveforms that occurred before a failure.

Gould's OS-4000 storage-scope display can include full, ¾, ½, or ¼ pre-trigger information, and the rest of the display area shows the post-trigger data. The position of the trigger point is indicated by a bright dot on the screen.

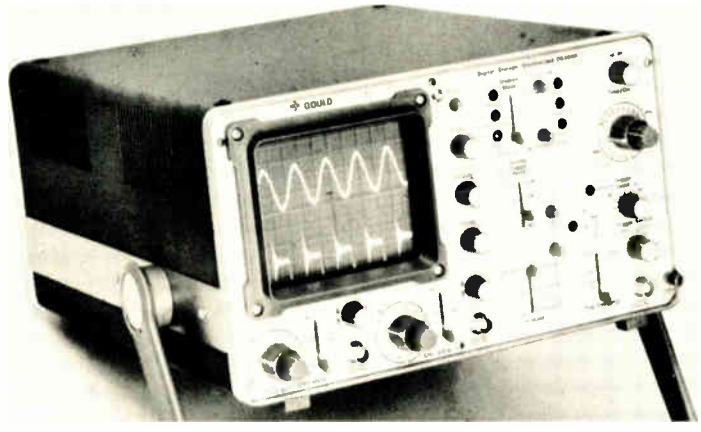
The $3,500 dual-trace instrument has a real-time bandwidth of 10 megahertz and a sampling rate of almost 2 MHz so that 200-kHz waveforms can be stored. In some applications, the OS-4000 can handle 400- to 500-kHz signals before the essential nature of the signal is lost.

In operation, the incoming signal waveform passes into an a-d converter that operates at a speed determined by the time-base switch. The converter's digital output is then fed into eight 1,024-bit random-access memories. The 8 vertical bits give a resolution of one part in 256, or about 0.4%, and the 1,024 points give a horizontal resolution of approximately 0.1% in the single-trace mode and 512 points yield 0.2% in dual-trace operation.

The scope can operate in any of three modes: normal, refreshed, or roll. In the normal mode, the instrument is a conventional 10-MHz dual-trace scope with vertical sensitivities from 5 millivolts to 20 volts per centimeter and horizontal sweep rates from 0.1 microsecond to 0.5 second per centimeter. In the refreshed mode, the input signal is viewed via the RAM store. This permits flicker-free displays to 20 seconds per centimeter. In the roll mode, the display is similar to that of a strip-chart recorder, with the right-hand edge of the display showing instantaneous time and the trace moving across the face of the CRT. Here, a low-speed waveform may be viewed as it occurs, and a predetermined amount of historic information is visible.

In the latter two modes, either half or all of the trace can be locked. When half is locked, a continuously refreshed real-time trace may be superimposed on the stored trace for comparison, whereupon the second trace can also be locked.

An optional model 4001 output unit adds the capability to permanently record any trace stored in the OS-4000 in either analog or digital form. The analog output may be fed to an X-Y or Y-T recorder and



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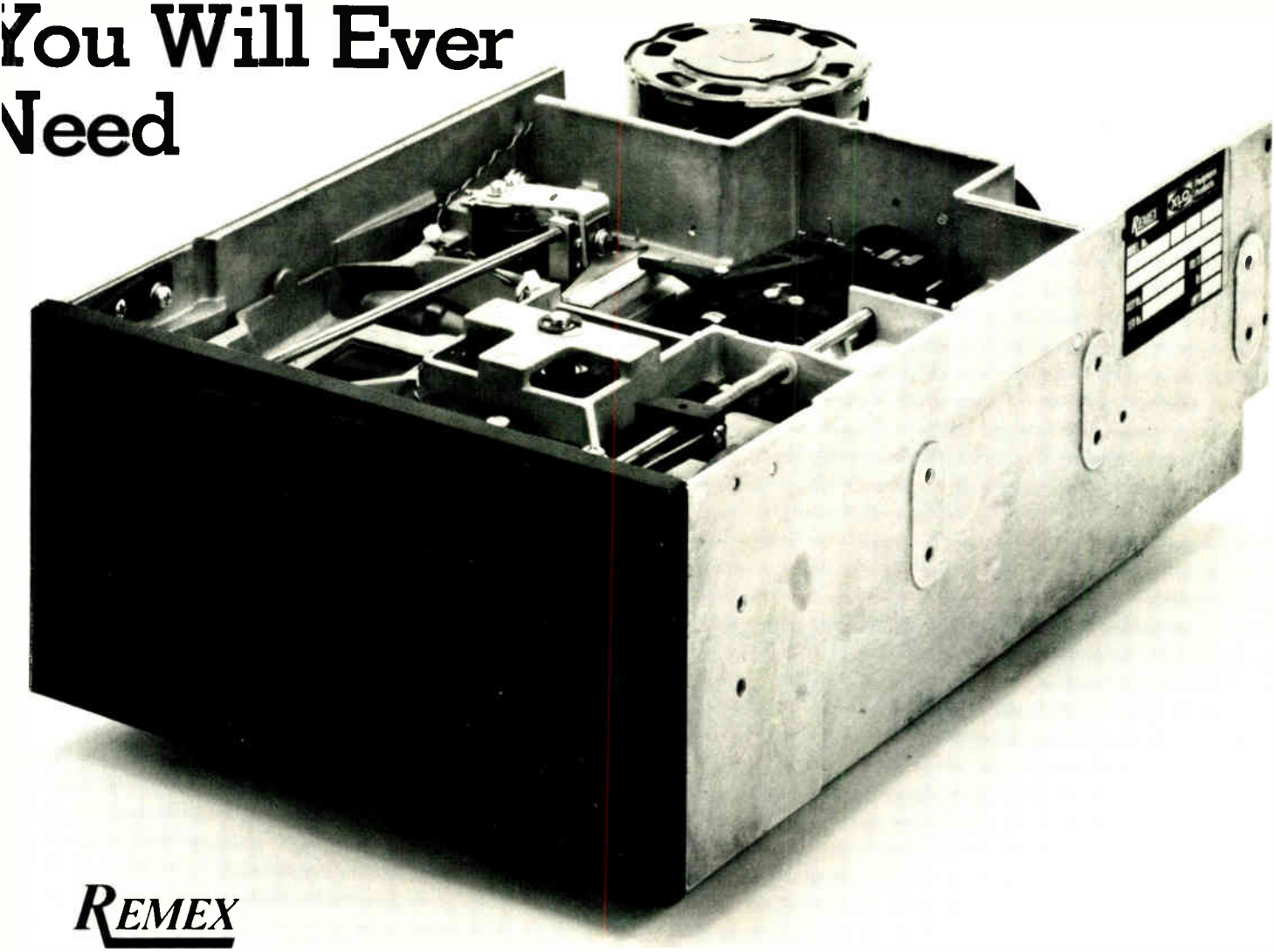

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(714) 557-6860, TWX (910) 595-1715. In Europe and the U.K.: SpA, Microtechnica
Via Madama Christina 147, Torino, Italy 10126.

Circle 163 on reader service card

the digital output is suitable for recording on magnetic tape. The accessory is priced at $900, and, like the scope, is made in England [*Electronics*, April 29, p. 25].

Gould Inc., Instrument Systems Division, 3631 Perkins Ave., Cleveland, Ohio 44114. Phone (216) 361-3315 [351]

Inexpensive audio generator has only 0.02% distortion

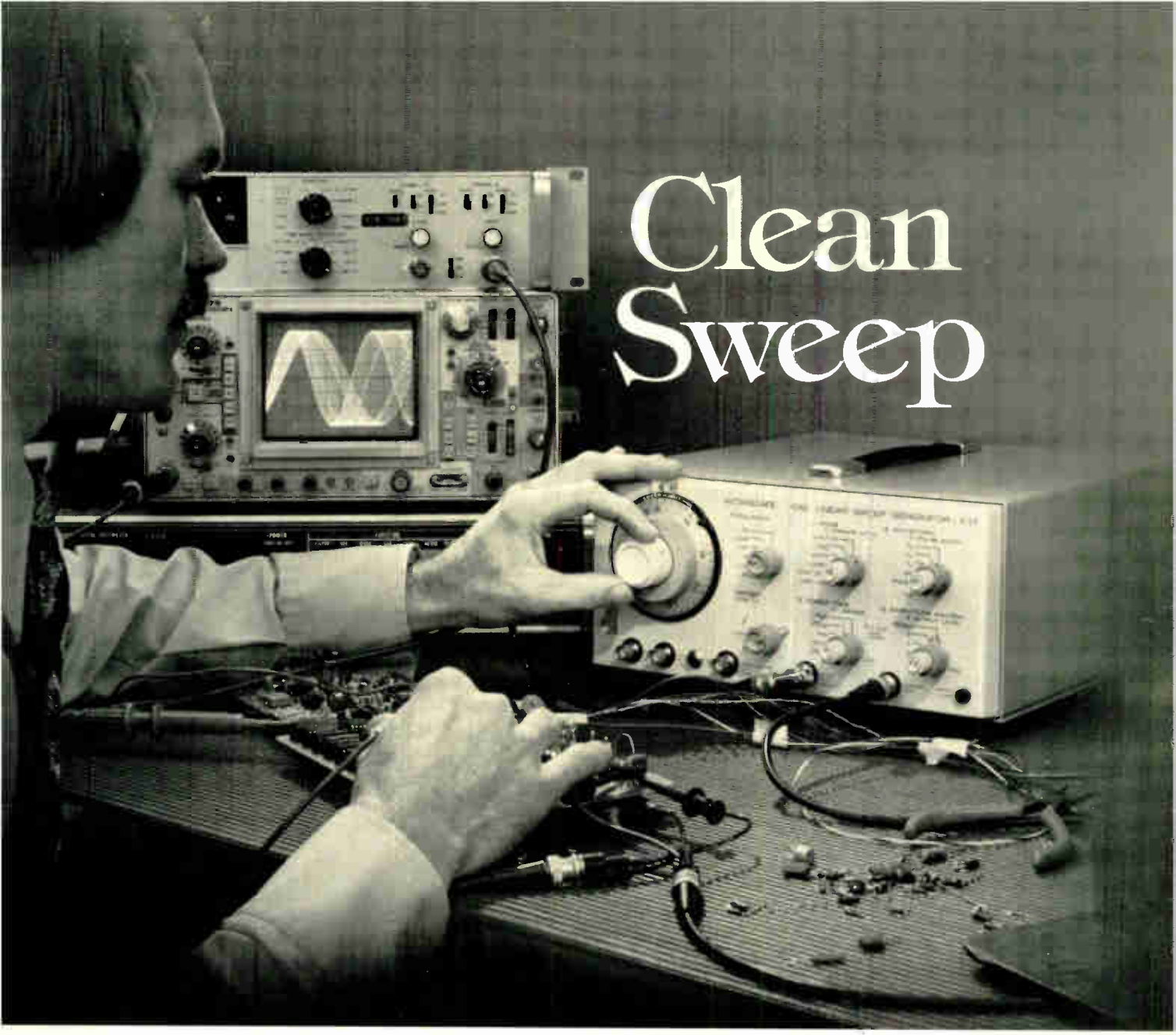
Priced at only $295, the PM5107 low-frequency generator spans the frequency range from 10 hertz to 100 kilohertz and typically has no more than 0.02% total distortion. In addition to sine waves, the compact instrument puts out square waves. A TTL-level output is provided through a separate port. Frequency is set to within 4% by means of a

dial control and a set of multiplier push buttons. The main output port has an impedance of 600 ohms and can deliver square waves of up to 4 volts and sine waves of up to 2 v rms. Attenuation is controlled by a continuously variable dial and a single push button that inserts a fixed 20-dB drop.

Philips Test & Measuring Instruments Inc., 400 Crossways Park Dr., Woodbury, N. Y. 11797. Phone (516) 921-8880 [353]

3½-digit multimeter measures capacitance

The model 20 digital multimeter is a 3½-digit (2,000-count) instrument that measures ac and dc voltage, resistance, and capacitance. The $179 meter has four decade ranges for each function; on the most sensitive of each, it can resolve 1 millivolt, 1 ohm, and 1 picofarad, respec-



F37 Log/Lin Sweep Function Generator

Precision Performance. F37's frequency setability is more accurate to begin with, because you can set your desired frequency with one fully calibrated coarse/fine control. The fine-tune vernier is centered on the dial so the output frequency meets accuracy specs wherever the vernier is set. And for easy and accurate sweep limit settings, you just swing the sweep limit cursor around.

Top Sweep Capability. Inside the F37's sturdy metal case is all the capability you need for sweep function generator applications — triggered sweep and burst modes, log/linear selection, and two separate plotter drive signals, for example. F37 sweep time is ten times faster, too, than competitive models — all the way from 10 picosecs to 100 seconds.

You can count on F37's smooth performance and superior operating features because quality engineering and years of instrumentation experience are built into every Interstate Electronics unit.

F37 — the best sweep function generator you can buy for $795.

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Circle 165 on reader service card

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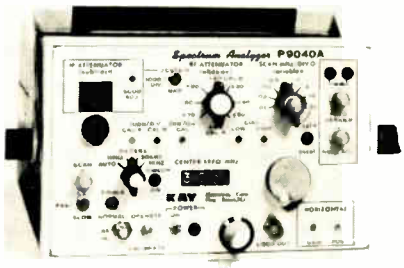
New products

tively. Measurement uncertainty for dc voltage is 0.1% of reading ±1 count; for ac voltage, it is 0.5% of reading ±1 count, and for both resistance and capacitance, the figure is 0.2%. The model 20 uses 0.33-inch gas-discharge displays, consumes 3.5 watts, and weighs 2.5 pounds. It is available from stock.

Data Tech, a division of Penril Corp., 2700 South Fairview, Santa Ana, Calif. 92704. Phone (714) 546-7160 [354]

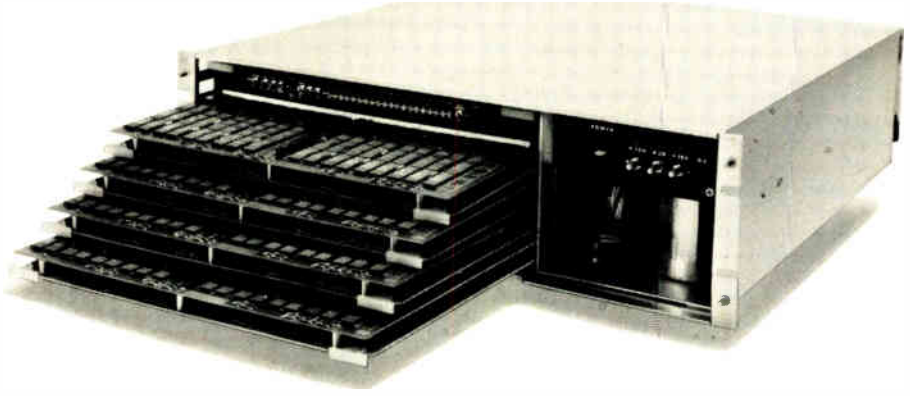
Spectrum analyzer covers 1 to 300 megahertz

Designed to use a separate oscilloscope as a display device, the model P9040 spectrum analyzer covers the frequency range from 1 to 300 megahertz with a resolution as tight as 1 kilohertz. The unit has a 72-dB dynamic range and selectable i-f bandwidths of 1 kHz, 30 kHz, 300 kHz, and 1 MHz. Scan widths can be adjusted from 3 kHz per division to



30 MHz/div, and scan speed can be varied from 40 to 60 scans per second. In addition, the instrument has a one-shot mode for use with X-Y plotters and storage scopes. Input sensitivity is −100 dBm for the version with a 50-ohm input impedance and −50 dBmV for the 75-ohm unit. Supplied as a plug-in module

This complete 16K, 32K, 64K Memory Cycles in just 180 Nsec.



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New products

for use with Tektronix 5103N and 5403 series oscilloscopes, the P9040 sells for $2,390. A universal model that comes with its own power supply for use with any oscilloscope sells for $2,585.

Kay Elemetrics Corp., Pine Brook, N. J. 07058. Phone Jim Connors at (201) 227-2000 [355]

High-potential tester has adjustable current limiting

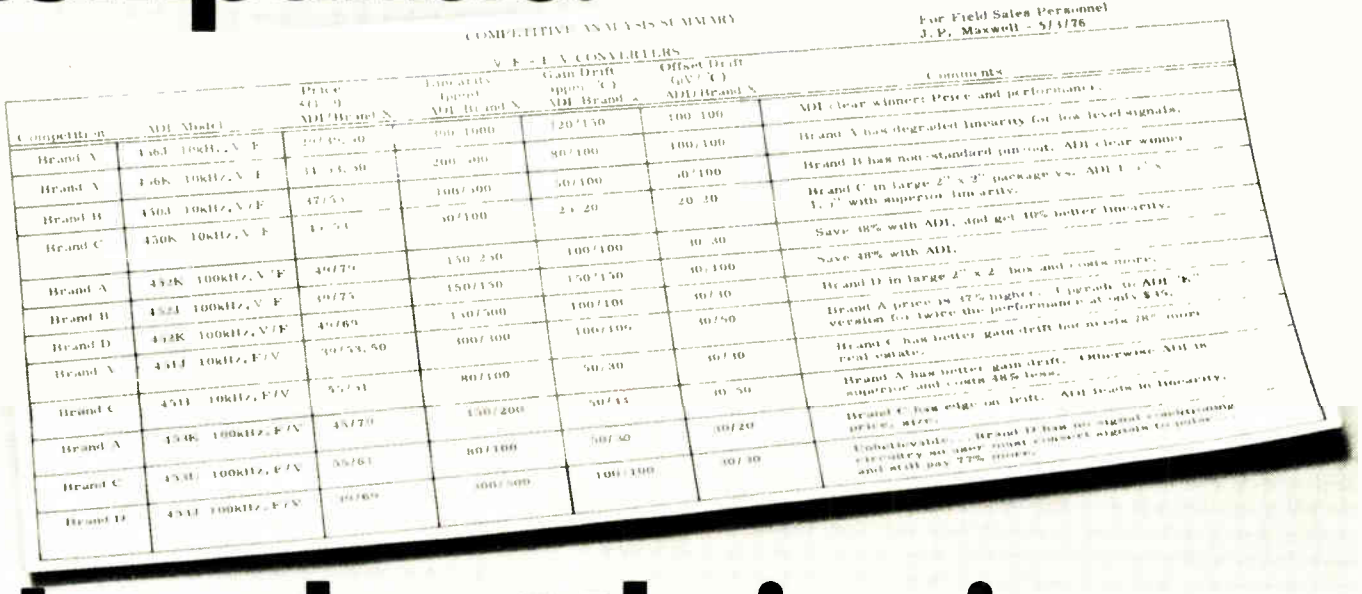
When conventional high-potential testers are used to ensure that a dielectric material or insulation can withstand high voltages, there is always the danger the material under test will be destroyed by a high current if breakdown occurs. The model 16420 tester avoids this problem by incorporating a control that allows the user to limit its output current to any value from 30 to 300 microamperes. A pair of three-digit displays provide simultaneous readout of voltage (from 500 v to 40 kilovolts dc) and current. The voltage-reading portion of the instrument can function independently of the rest of the tester, allowing the 16420 to be used as a digital kilovoltmeter with an input impedance in excess of 1,000 megohms. Priced at $3,180, the instrument has a delivery time of 30 days.

ITT Jennings, 970 McLaughlin Ave., San Jose, Calif. 95122 [356]

TOPICS
Instruments

United Systems Corp., Dayton, Ohio, has reduced the price of its Monsanto model 151A frequency counter from $795 to $550. The 220-MHz counter is available from stock. . . . **Norland Instruments, Fort Atkinson, Wis.,** introduced six options for its NI 2001 programable calculating oscilloscope at Electro/76. They included serial asynchronous digital I/O capability, a cassette file, an X-Y plotter, a computer link, and 8-bit parallel digital I/O capability.

A lot of people's V/F-F/V Converters are pin compatible.



How about their price and performance?

All V/F-F/V Converters are not created equal. You shouldn't have to sacrifice performance for price. Or vice versa.

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For all general purpose applications the Model 450 V/F can achieve 0.01% (13-bit) accuracy over the 1mV to +15V signal range. Model 454 V/F accepts 0 to +20V or 0 to .67 mA inputs and can be operated with bipolar signals up to ±10V. Model 456 V/F offers the lowest cost for applications requiring 0.1% (10-bit) accuracy. Model 452 V/F is a low cost 100kHz converter that offers resolution of better than 16 bits and low non-linearity error of 0.025% max. over 120 dB signal range.

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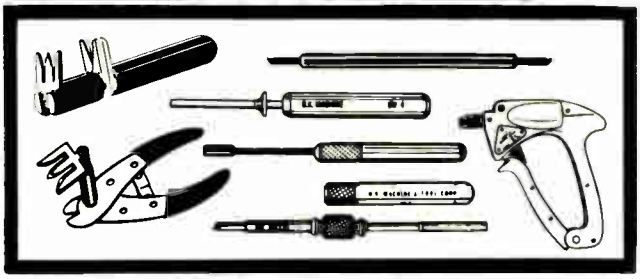

MANUAL
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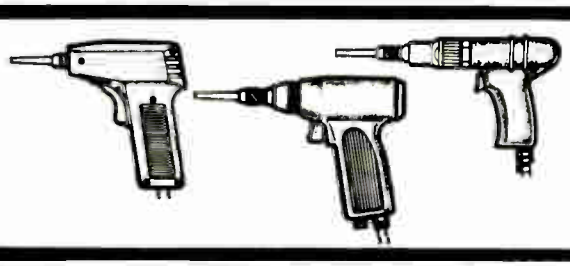

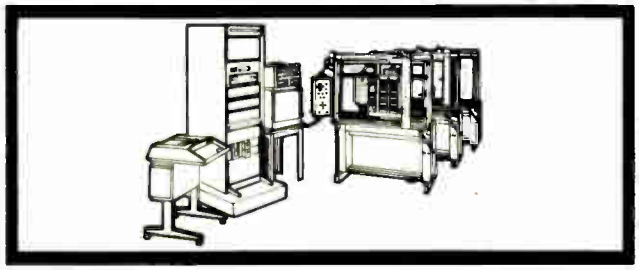

SEMI-AUTOMATIC
WIRE-WRAPPING
SYSTEMS

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4

SELF-PROGRAMMING
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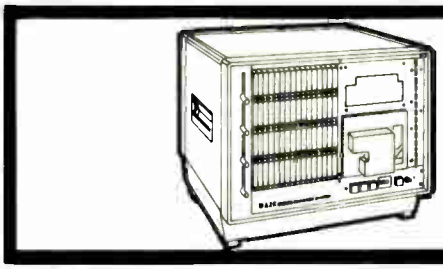

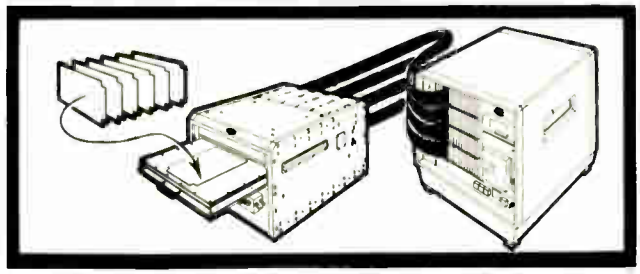

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Subassemblies

C-MOS lowers converter price

12-bit d-a converter sells for $29, uses only 250 milliwatts at ±15 V

Most of today's hybrid digital-to-analog converters for the commercial market employ bipolar switches. However, Hybrid Systems Inc. is using complementary-MOS technology in its low-priced, 12-bit unit, the DAC349. Sam Wilensky, director of engineering for the Bedford, Mass., company, says that bipolar switches are three to five times more expensive than the C-MOS type.

Lowering costs, and therefore price, isn't the only benefit the switches offer. Wilensky points out that they provide lower-power operation than is possible with bipolar switches, which should make them especially attractive for microprocessor applications. The DAC349 requires 250 milliwatts of ±15-volt power, compared with 750 mW or more for most d-a converters using bipolar switches.

The multichip unit includes a built-in reference, a precision thin-film ladder network, the C-MOS switches and an output amplifier. By means of pin interconnection, fully calibrated output ranges of ±5 V and 10 V, and 0 to −10 V with binary and offset binary coding are available. No external components are required for operation.

"The beauty of the device," Wilensky says, "is that we use all standard components and connect them in a way that allows us much better performance than you'd expect if you looked at individual component specs."

But performance has not been compromised. Accuracy drift is no more than 30 parts per million per degree celsius over the full range of operation; nonlinearity is held to 15 ppm/°C; settling time to 0.05% is 10 microseconds, and the unit can drive a 10-milliampere load.

The converter combines the C-MOS switches on one chip with another containing the high-accuracy ladder network and application resistors. The resistors are laser-trimmed under computer control to 12-bit linearity while still in wafer form. Carl Kramer, vice president for sales, stresses that no manual trimming is required and that the DAC349 is truly linear to within half a least significant bit (±0.125%).

The DAC349-12 is the commercial-product designation. Its price in quantities of one to nine is $29 each and drops to $25 each in hundreds. A military version, the DAC349-12M/C meets MIL-STD-883 level C requirements, costs $69 each for one to nine, and will be available in four to six weeks. Both parts are in 24-pin packages. Delivery time for the

New products

commercial version is six to eight weeks.

Hybrid Systems Corp., Crosby Dr., Bedford, Mass. 01730. Phone Carl Kramer at (617) 275-1570 [381]

Two-channel power supply is designed for systems use

Systron-Donner's Concord Instrument division has expanded its family of power supplies by one member, designated the DPSD-50 two-channel system supply. According to product manager Gail Dishong, this unit is completely computer-programable and is specifically designed for automatic systems. It features two independent, 1-ampere, 0-to-50-volt floating-output precision power sources.

The unit has a built-in addressable memory whose functions can be programed independently by the same data lines that serve other peripherals. This feature, says Dishong, reduces the number of computer I/O circuits required when more than one power supply is programed. Up to 32 power sources can be programed via a single I/O section. The DPSD-50 is also available with the IEEE 488 interface. Unit price is $3,500.

Systron-Donner, Concord Instrument Division, One Systron Dr., Concord, Calif. 94518 [383]

Triple low-pass filter has 2-pole Butterworth response

Consisting of three unity-gain active two-pole Butterworth low-pass filters on a single card, the model 126 is provided with three DIP switches for the independent programing of the cutoff frequency of each filter. Four standard versions have frequency ranges of 1 hertz to 16 Hz, 10 Hz to 160 Hz, 100 Hz to 1.6 kilohertz, and 500 Hz to 8.0 kHz. Each of the differential-input active filters can be programed to have a 3-dB point at one of 16 frequencies within its range. Roll-off is 40 dB per

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intel memory systems

Circle 173 on reader service card

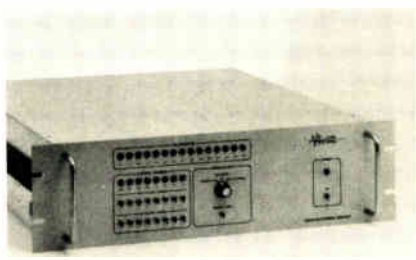
decade for all units. In addition to providing three separate filter channels, the filters can be combined to give three independently adjustable frequency responses from a single input. They can also be connected in series for steeper high-frequency roll-off.

Priced at $196 for the 10- to 160-Hz and 100-Hz to 1.6 kHz units, $215 for the 500-Hz to 8.0-kHz version, and $225 for the 1- to 16-Hz model, the 126 is offered with a choice of two metal enclosures. Delivery time for the filters is 30 days.

Fogg System Co. Inc., P.O. Box 22226, Denver, Colo. 80222. Phone Hal Fogg at (303) 758-2979 [384]

A-d conversion system handles low and high levels

Capable of measuring combinations of low-level and high-level analog signals, the model 1542 analog-to-digital conversion system uses a submultiplexed approach to handle signals from ±10 millivolts full-scale to ±10 volts full-scale. The system consists of two differential multiplexers (submultiplexers), each of which is followed by a fixed-gain



differential amplifier. The differential amplifiers then feed a high-level single-ended multiplexer, which is followed by a digital gain-controlled amplifier with four gain ranges, a sample-and-hold amplifier, and an analog-to-digital converter. Converter resolution can be from 10 to 15 bits. Maximum system throughput rate is 10 kilohertz. Offered with 16 to 64 low-level inputs and 16 to 64 high-level inputs in a single cabinet, the system has a

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Complete new circuitry makes the Model 283 the most dependable and versatile 3½ digit multimeter you can buy. The extra-bright display allows you to use it where other units would cause reading problems. The selectable "low ohms" function permits accurate measurement of semiconductor shunted resistors.

An optional, internal battery pack (BP-83, $50.00) provides 8 hours of continuous use on one overnight charging and charges when the Model 283 is in use on 115/230VAC.

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Circle 175 for product information

Circle 221 for product demonstration

New products

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Tustin Electronics Co., 1431 E. St. Andrews Pl., Santa Ana, Calif. 92705. Phone (714) 549-0391 [385]

Rms converter stays accurate with 20:1 crest factor

The model R501 and R502 true-rms to dc converter modules stay accurate to within 0.25% for input waveforms with crest factors as high as 10:1 and to within 1% for crest factors up to 20:1. (Crest factor is the ratio of peak value to rms value of a signal.) With input voltages from −10 v to + 10 v, the total unadjusted output error for sine waves and other waveforms with low crest factors is a maximum of 10 millivolts + 0.2% of reading for the R501 and 5 mv + 0.1% for the R502. With two external adjustments, the errors can be reduced to 3 mv + 0.1% and 1 mv + 0.05%, respectively. Housed in a module that measures 1.5 inches square by 0.6 in. high, the R501 sells for $68. The R502, which is supplied in the same pakcage, sells for $80. Delivery of both units is from stock to two weeks.

Intronics Inc., 57 Chapel St., Newton, Mass. 02158. Phone Richard Sakakeeny at (617) 332-7350 [386]

TOPICS

Subassemblies

Master Specialites Co., Costa Mesa, Calif., has announced that its model 905H readout assembly has been qualified to MIL-R-28803/1—the military specification for segmented readouts. The display assembly is a fiber-optic unit that uses light-emitting diodes as a light source. . . . **Trio Laboratories, Plainview, N. Y.,** is selling a three-output power supply—the model 673. The switching supply is capable of operation at full load for 30 milliseconds after ac power is cut off.

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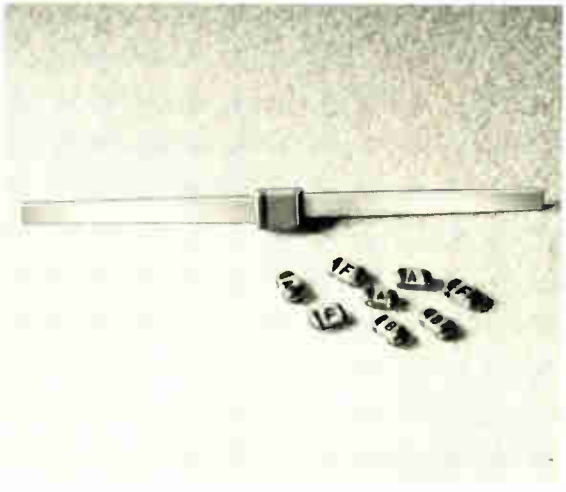

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X7R Ceramic	100 pF-1.0 μF	CDR (BP)	10 pF-.01 μF
Z5U Ceramic	6800 pF-1.5 μF	'Vee Cal' Adjustable-Fixed	1-680 pF

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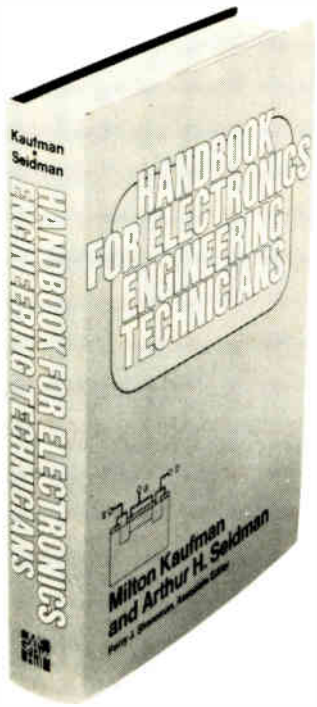

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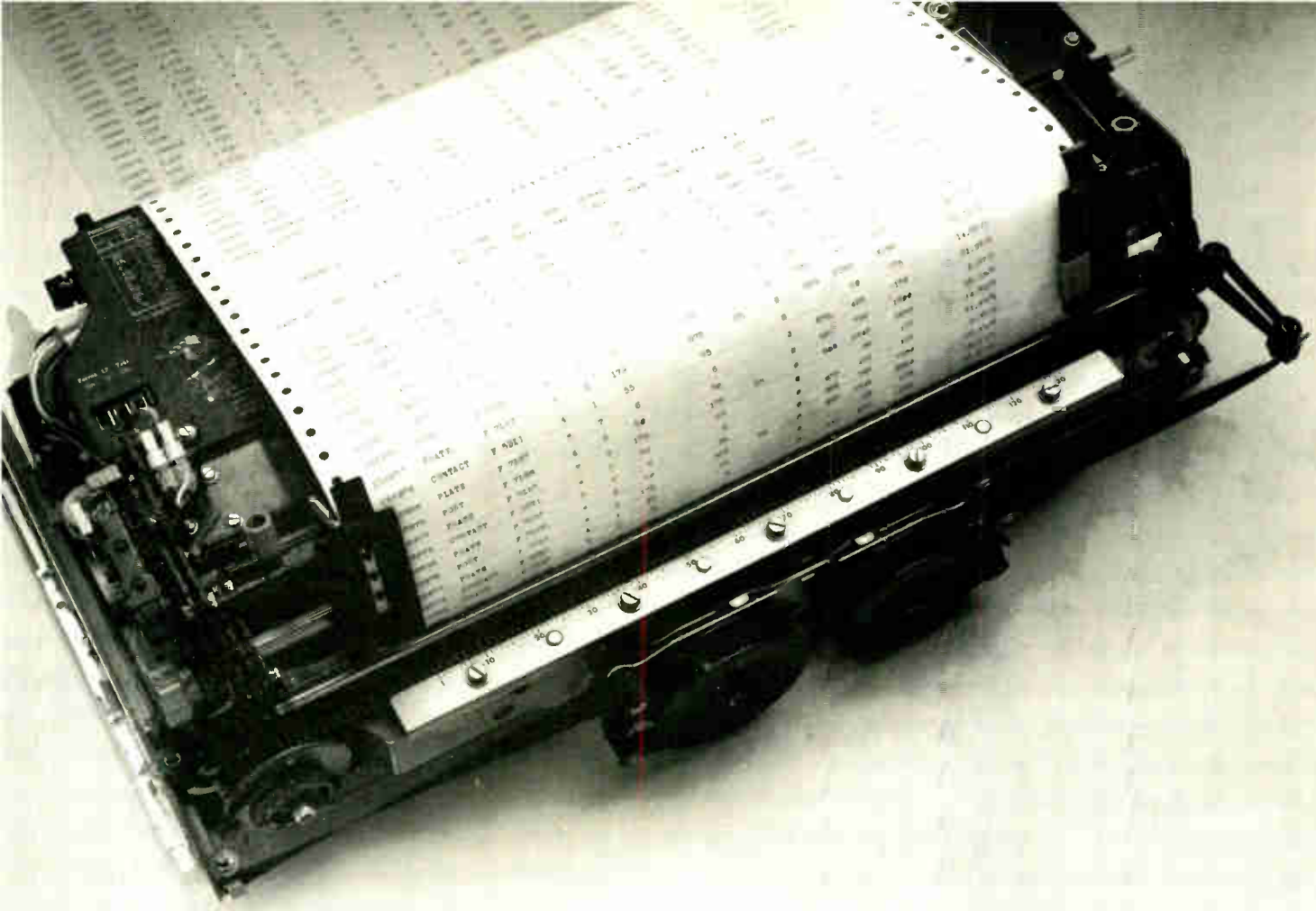

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New literature

Displaying data streams. Application Note 167-8 tells how to use a pattern analyzer to achieve a stable display of a digital data stream. The method described involves the use of the HP 1620A pattern analyzer. Copies are available from Inquiries Manager, Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif. 94304. Circle 421 on reader service card.

Capacitors. An eight-page condensed catalog of capacitors from Vitramon covers porcelain, ceramic, and ceramic-chip capacitors. Units with capacitances from 0.5 picofarad to 4.7 microfarads are described, as are the company's Vee-Cal adjustable-fixed parts. Copies can be obtained from Vitramon North America, P.O. Box 544, Bridgeport, Conn. 06601 [433]

Finding aperture time. Technical Note V-14, "Graphs Give Aperture Time Required for a-d Conversion," is a four-page document that discusses the problem of aperture time in analog-to-digital conversion and presents graphs showing the required aperture time as a function of resolution and either dv/dt or sinusoidal frequency. Copies can be

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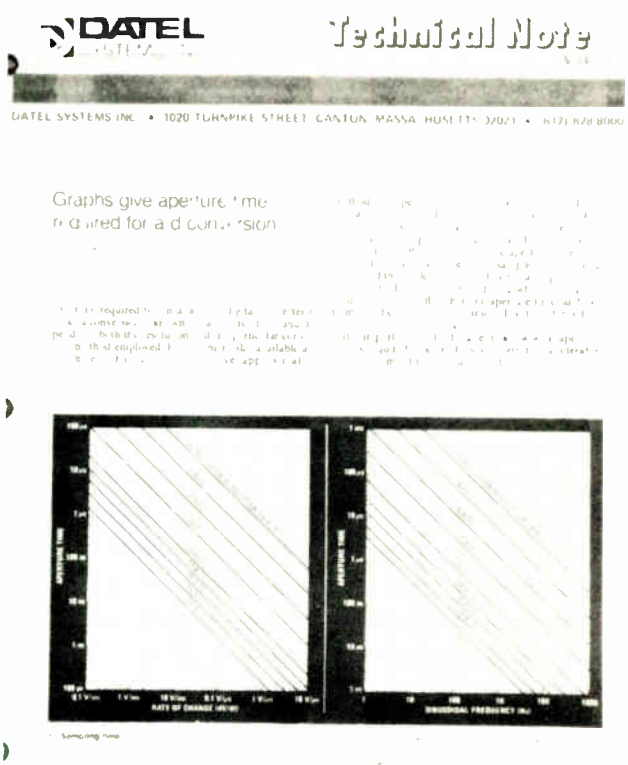

obtained from Datel Systems Inc., 1020 Turnpike St., Canton, Mass. 02021 [422]

Datapro newsletters. Free issues of *Datapro OfficeNews* and *MiniNews* are being offered by Datapro Research Corp., 1805 Underwood Blvd., Delran, N. J. 08075. *Datapro OfficeNews* is a four-page monthly newsletter reporting on major developments in office systems and business equipment. *MiniNews*, also a monthly newsletter, covers the fields of micro- and minicomputers. [423]

Capacitors. A 64-page condensed capacitor catalog includes essential size, performance, and rating information for Kemet solid tantalum, monolithic ceramic, and precision film capacitors. The conveniently tabbed volume is available from Sales Dept., Union Carbide Corp., Components Dept., Box 5928, Greenville, S.C. 29606 [424]

Making pc boards. A patented process for temporarily attaching components to printed-circuit boards is described in a 12-page booklet entitled "The Stabilizer Process." The process uses a solder-compatible material to hold components in place for lead cutting and wave soldering. Copies can be obtained from Hollis Engineering Inc., P.O. Box 1189, Nashua, N. H. 03060 [425]

Switches. Licon's full line of switches, including push-

New literature

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Plastic knobs. Hundreds of thermoset plastic knobs are described and shown in a new catalog from Kurz-Kasch Inc., 711 Hunter Dr., Wilmington, Ohio 45177 [427]

Shielded cases. A variety of rfi shielded cases is covered in a six-page short-form catalog put out by Compac, 222 Middle Country Rd., Smithtown, N. Y. 11787 [428]

Educational films. More than 500 instructional films and video tapes, on subjects ranging from random processes to the mechanics of polymer processing, are described in a 100-page catalog that can be obtained from Russell Seidel, Room 9-230, Massachusetts Institute of Technology, Cambridge, Mass. 02139. The films and cassettes were prepared at the Center for Advanced Engineering Study at the Institute. [429]

Antennas. The line of land-mobile communications antennas and antenna systems made by Phelps Dodge is covered in an 80-page catalog. Included are base-station and vehicular antennas, cavity resonators, duplexers, combiners, multicouplers, and various accessories. A separate section of the catalog is devoted to supporting technical data. For a copy, write to Catalog 176, Phelps Dodge Communications Co., Route 79, Marlboro, N. J. 07746 [430]

Transformers and filters. A catalog collating more than 3,000 standard transformers and filters, many of which are produced to MIL-T-27 specifications, is available from Decco Inc., 2655 Perth St., Dallas, Texas 75220 [431]

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Official proposal

Baltimore County, Maryland Notice Of Intent To Assign A Communications Project

In the near future, the Professional Services Selection Committee will recommend the assignment of a Communications System Project to a prequalified engineering firm.

Because of a change in project scope, this advertisement supersedes the previous one published in August, 1975.

Services required are as follows: PROJECT 76-04 COMMUNICATIONS PROJECT

Currently the underground communications structure is being completed in conjunction with the Courts Building Plaza. The utilization of the space will involve the development of a communications system, associated performance specifications for the equipment to be used in this system, and project management until full operational capability is achieved. This will be a combined use facility serving Fire, Police, Civil Defense and all general government agencies using radio equipment. 911 systems and Computer Assisted Dispatch (CAD) are contemplated for the facility along with the telephone, teletype and radio facilities. Federal funds will be utilized in this project which is estimated to cost $3,000,000.

This project will require the services of a firm thoroughly familiar with communications equipment and systems. Experience with a similar installation is necessary, along with a thorough knowledge of the current state of the art in communications equipment. The experience and knowledge will be applied to the development and coordination of a full program approach with the responsible department and the using agencies.

To be considered for award, all prequalified firms, including those that submitted letters of interest in response to the original advertisement, must submit a GSA Form 255 on this project. Any firm not presently prequalified should do so immediately by filing either a GSA Form 251 or 254.

All Form 255 submittals must be received by the Chief of the Bureau of Engineering, Room 200, County Office Building, Towson, Maryland 21204 by not later than 4:30 P.M., E.D.T., June 14, 1976.

By order of the County Executive of Baltimore County, Maryland.

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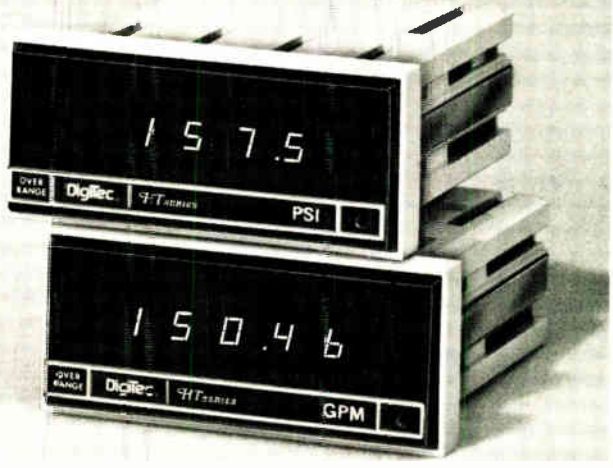

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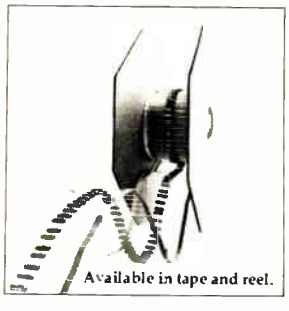

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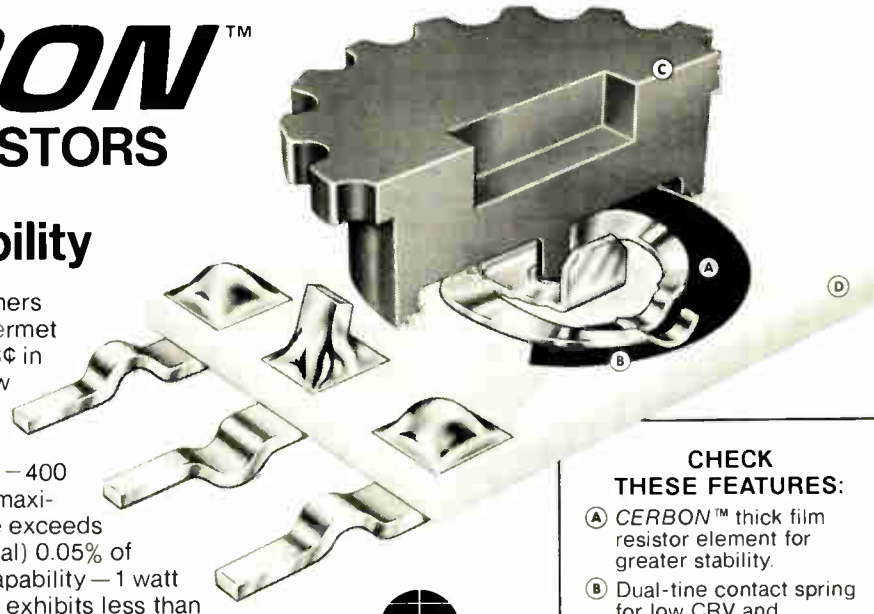

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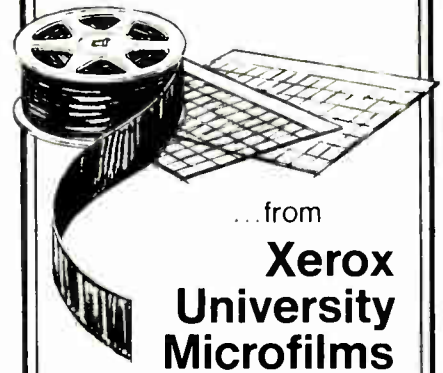

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Introducing the GR 1795 logic circuit tester. The first tester to give you the full diagnostic capability of our GR 1792 series of testers. For about one-third the cost.

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Or, you can buy our alternate model GR 1795-LTM.

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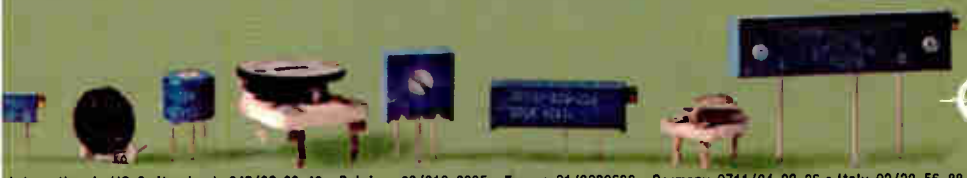

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