NOVEMBER 17, 1981

JAPANESE MAP STRATEGY FOR FIFTH-GENERATION COMPUTERS/83

Low-cost MES FET receivers capture satellite TV for home/125

Data-base management comes to microcomputers/129

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Electronics International

Automating IC design

CIRCUIT BOARD TESTING: SHOULD IT BEGIN IN PRODUCTION OR IN THE LAB?

Some successful companies charge production with the responsibility for developing test procedures. Others give the job to the design lab. And with many it's a shared responsibility.

However, if these methods were decided by the standards of yesterday's technology, you may increase today's productivity with a different approach. Consider these points:

Testing options begin in the lab.
With today's product designs using microprocessors, memory and other LSI circuits, the question "How to test?" will arise long before a design is released to production. When asked in the hardware/software definition phase, electronic manufacturers can opt for one of three approaches: 1) Not to design for testability, thus leaving test development responsibility to production. 2) Design for go/no-go self test, covering a "critical" subset of board functions, and leaving fault isolation to skilled technicians in production as well as the field. 3) Design for thorough self test, including diagnostics, which facilitate fault isolation, thus providing a total test solution for R&D, production and field service.

Can you afford to design for testability?
Let's take a look at the trade-offs. Option 1 appears to offer the shortest design cycle. However, the designer will probably take longer than planned in design turn-on. And design follow-up with production often takes more effort than expected. Longer production test development time is also likely to delay shipments.

Designing in a go/no-go self test (option 2) solves some of the problems associated with option 1. However, a limited self test may still lead to failures at system turn-on. And without fault isolation, expensive technician time will be needed in production and field service.

At first glance, option 3 may seem to require too much of the designer's time. However, the payback can be significant in reduced debugging time and enhanced test effectiveness. After all, the designer best understands the product structure and critical aspects of its operation. And the designer has the tools and the opportunity to implement design features often required for high fault-coverage testing of complex LSI circuitry.

A decision that impacts production most.
Whatever the decision, production will feel its effect most. A balance must be found between design time and a viable board test solution. HP provides that balance with the 3060A Board Test System. Equipped with the High Speed Digital Functional Test Option (HSDFT), it delivers the flexibility to solve your μP and LSI board testing problems whether you design for testability or not.

For example, the 3060A can activate μP-based, designed-in stimulus firmware and measure the dynamic board response using Signature Analysis. If self-stimulus isn't available you can use the HSDFT programmable stimulus capability (Figure 1).

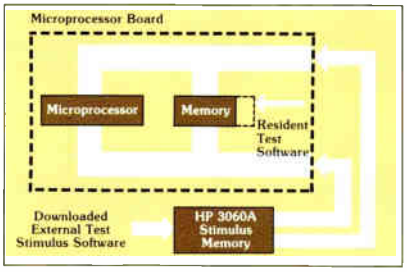


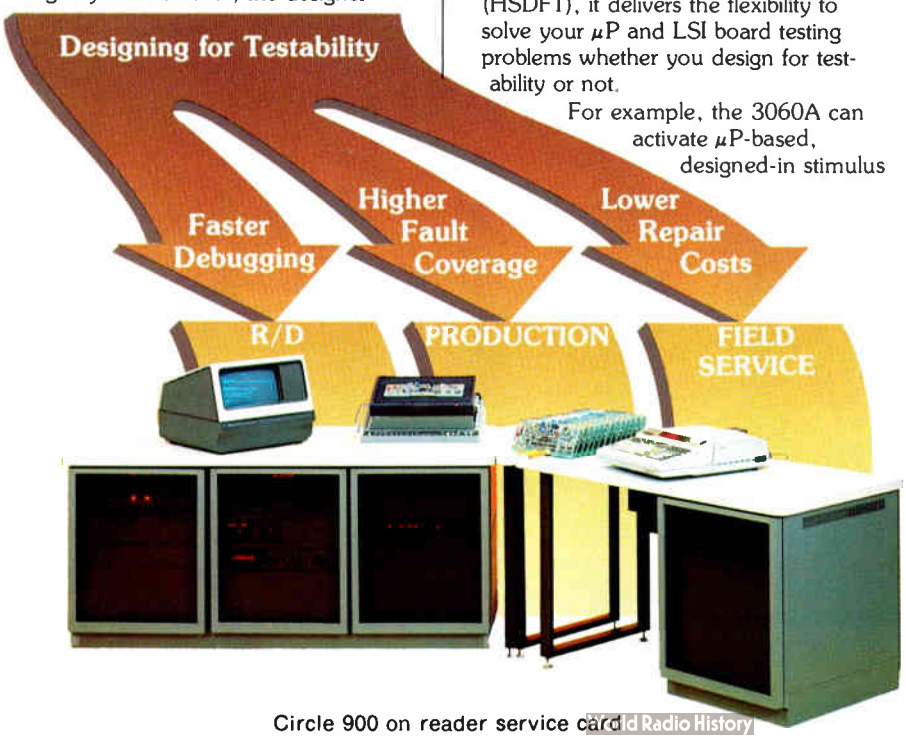
Figure 1 — The 3060A can activate resident test stimulus software or provide that stimulus from its own RAM.

Test stimulus software developed for design turn-on can even be leveraged for production test by downloading from your design system (such as the HP 64000) into 3060A stimulus RAM. Or, alternatively, HP's 3060A Digital Functional Test software provides easy-to-use stimulus and measurement programming procedures.

For fault isolation, the 3060A HSDFT software provides automatic backtracking via in-circuit visibility on the basis of a topological description of the board. And, these procedures can be used as the basis for effective field service repair using HP Signature Analysis instrumentation (HP's 5005A).

The bottom line? Rapid software development, thorough testing, high throughput and efficient field troubleshooting — the complete solution. That's worth investigating.

For more information.
Let HP help you optimize your investment in design, test and service. Write Hewlett-Packard, 1820 Embarcadero Road, Palo Alto, CA 94303. Or call the HP regional office nearest you: East (201) 265-5000, West (213) 970-7500, Midwest (312) 255-9800, South (404) 955-1500, Canada (416) 678-9430.



HP Circuit Testers— The Right Decision

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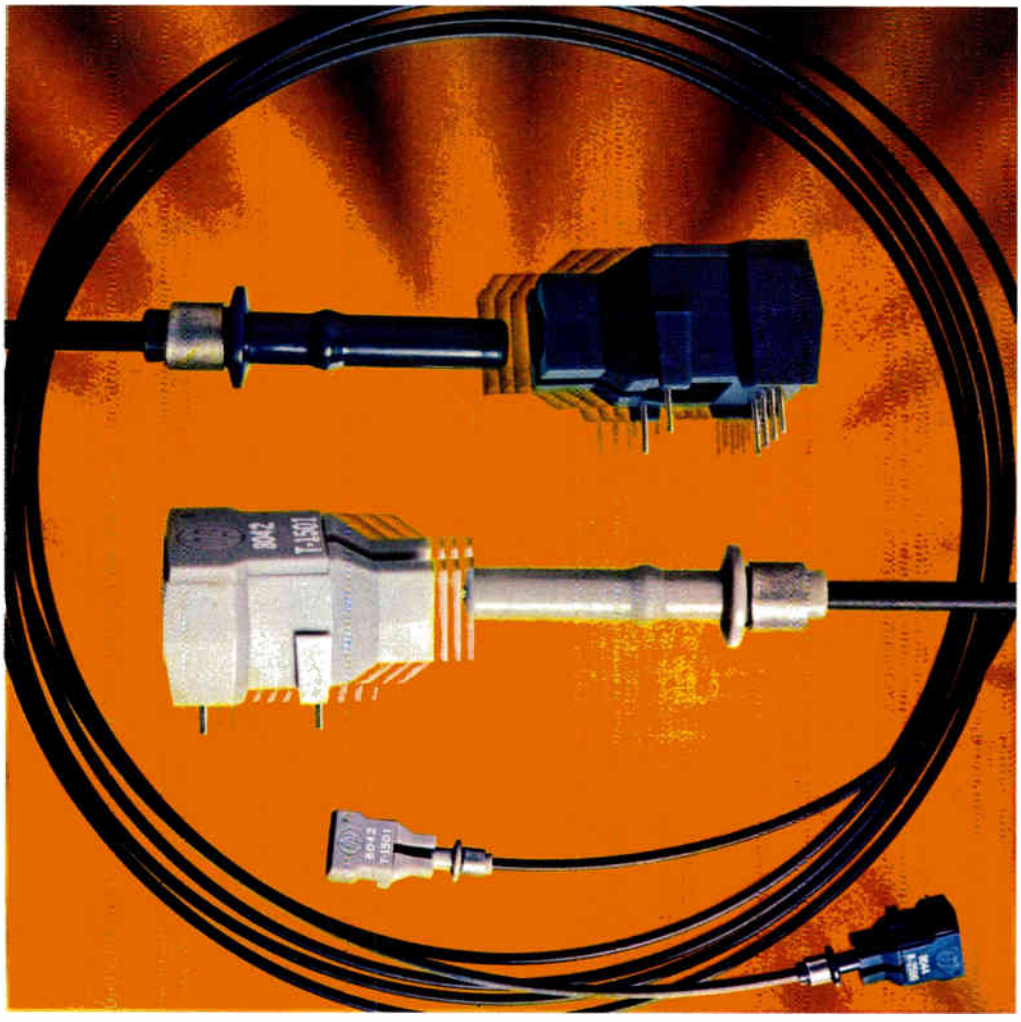

HP's New $55 Link Makes Fiber Optics a Real Snap.

Now you can afford to use fiber optics. For just $55.00* HP's new Snap-In Fiber Optic Kit, the HFBR-0500, gives you an LED transmitter module, an integrated TTL output receiver, 5 metres of connectored plastic fiber cable, 2 spare connectors, polishing tool, and technical literature.

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If you're cost conscious, the HFBR-0500 kit is an affordable solution for your short distance applications. Performance is guaranteed up to 10 Mbaud for cable lengths up to 5 metres. Longer distances are possible at lower data rates.

For more information or immediate off-the-shelf delivery, call your nearest HP components authorized distributor. In the U.S., contact Hall-Mark, Hamilton/Avnet, Pioneer Standard, Schweber, or the Wyle Distribution Group. In Canada, call Hamilton/Avnet or Zentronics, Ltd.

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We handle difficult personalities.

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A system that optimizes design engineering productivity.

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Electronics
The International Magazine of Electronic Technology
Vol. 54, No. 23 • November 17, 1981

Electronics

Highlights

Cover: Design automation facilitates VLSI efforts, 106

When it became clear that process technology could produce very large-scale integrated circuits, designers found they could not handle their complexity without new automated tools. Now these tools are appearing in full force, and their importance warrants a close look. The following four articles are the first in a series that will do just that; more will follow in future issues.

The cover illustration is by Art Director Fred Sklenar

- **108.** The rash of new computer-aided design tools is only the beginning; useful as they are, greater effort must go into enhancing man-machine cooperation, as the history of VLSI design discloses.
- **111.** One way to capitalize on CAD's advantages is a new basic logic cell—the Multi-MOS structure—that lends itself better to symbolic layout than do present cell architectures.
- **114.** A library of standard cells that can be combined into semicustom ICs can provide designs with custom densities at gate-array prices.
- **117.** Hierarchical structure of the logic-design task, plus separation of logic and timing validation, gives faster design with less computing power.

Japanese outline plans for fifth generation of computers, 83

What amounts to a sweeping master plan for the research and development necessary for a fifth computer generation has been unveiled by Japan. It would create machines with problem-solving, inferential capabilities.

Low-cost home receiver handles satellite TV signals, 125

Future television signals may travel via 12-gigahertz satellites, and a low-noise microwave receiver based on gallium arsenide metal-semiconductor field-effect transistors may make direct home reception possible.

Data-base management comes to microsystems, 129

More powerful microprocessors can support data-base management, but the missing ingredient has been the software to do it. A set of software tools fills this need and works with many operating systems and high-level languages.

Rf level meter boosts accuracy by damping internal-error noise, 132

Testing of radio-frequency equipment with greater precision and less operator input is possible with a new rf level meter. Controllable over an IEEE-488 bus, it boosts accuracy with special noise-cancellation and calibration circuits.

In the next issue . . .

A 16-bit microprocessor for peripheral-control functions . . . a preview of the International Electron Devices Meeting . . . more on VLSI CAD . . . packaging VLSI parts: a special report.

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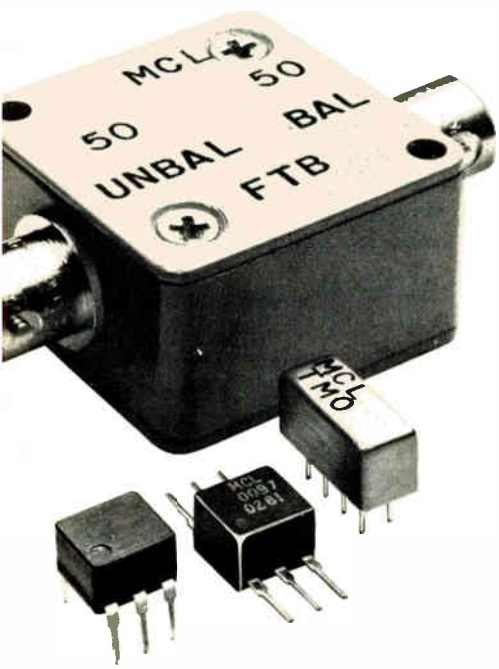

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Imped. Ratio	1	1	1.5	2.5	4	9	9	16	16
Freq. (MHz)	.15-400	8-300	.1-300	.01-100	.02-200	.15-200	2-90	.3-120	7-85
T Model (10-49)	$2.95	$4.95	$3.95	$3.95	$3.95	$3.45	$5.45	$3.95	$5.95
TMO model (10-49)	$4.95		$6.75	$6.45	$6.45	$6.45		$6.45	

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Imped. Ratio	1	2	2.5	3	4	4	5	13
Freq. (MHz)	.05-200	.07-200	.01-100	.05-250	.2-350	8-350	.3-300	.3-120
T Model (10-49)	$3.95	$4.25	$4.25	$3.95	$2.95	$4.95	$4.25	$4.25
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Freq. (MHz)	.025-600	.5-800	.2-600	.15-250	.2-150
T model (10-49)	$3.45	$4.25	$3.45	$3.45	$4.25
TMO Model (10-49)	$5.95	$6.95	$5.95	$5.95	$6.75

FT FTB

Model No.	FT1.5-1	FTB1-1	FTB1-6	FTB1-1-75
Imped. Ratio	1.5	1	1	1
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C 59 REV. A

Publisher's letter

This issue launches a series of articles on design automation—the rapidly exploding technology that industry is embracing to deal with the vast complexity of very large-scale integrated circuits. The series, which will run into the next issue and beyond, actually was born as a result of the incisive Inside the News story that was reported over a year ago [*Electronics*, July 31, 1980, p. 73] by West Coast editors Marty Marshall and Larry Waller. Even then, the importance and timeliness of the subject landed it on our cover.

But even before that article was put to bed, the scope of activity in computer-aided design—or design automation as it is increasingly being called—at companies ranging from American Microsystems Inc. to Zymos Corp. made our editors on both coasts realize there was much more going on than a single article could encompass. So articles were solicited from some of the people who were interviewed in the original story and the lineup was bolstered by other major contributors to the design-automation field. Senior editor John Posa was put in charge of implementing the project.

"The articles in this series are a good beginning," says John, "but by next year we could probably produce another special with a whole new set of authors writing about a whole new set of techniques. Things are moving that quickly."

John sees a similarity now between higher-level software languages and the new methods used to design chips. "Both are hierarchical in nature and allow the user to come up with a global solution. Just as a Fortran program will not produce the most compact machine code, hierarchically designed chips will not be as dense as hand-crafted ones," he observes. "But the issue here is not perfection—it's productivity."

While some in the field favor the term computer-aided design, the name design automation appears to be gaining among the participants. "I think it has to do with the extent of the computer's involvement in the task," John comments. "Computer-aided design connotes a computer helping a person to solve a problem, whereas with design automation the person merely guides the machine while it does most of the work."

The scope of the report required a joint effort between bureau editors and staff editors, many not usually involved with IC layout principles. From this wide participation, an appreciation for the new techniques evolved that, in turn, was instrumental in the selection of Carver Mead and Lynn Conway—proponents of hierarchical system design—as 1981 achievement award winners [*Electronics*, Oct. 20, p. 102].

"The work in design automation is exciting, and I'm pleased with its rapid industry acceptance," says John. "I agree with Ben Lee [author of the article that starts on p. 108] that IC design is beginning to cost more than IC processing. That means the microelectronics industry is facing an entirely new set of economic considerations."

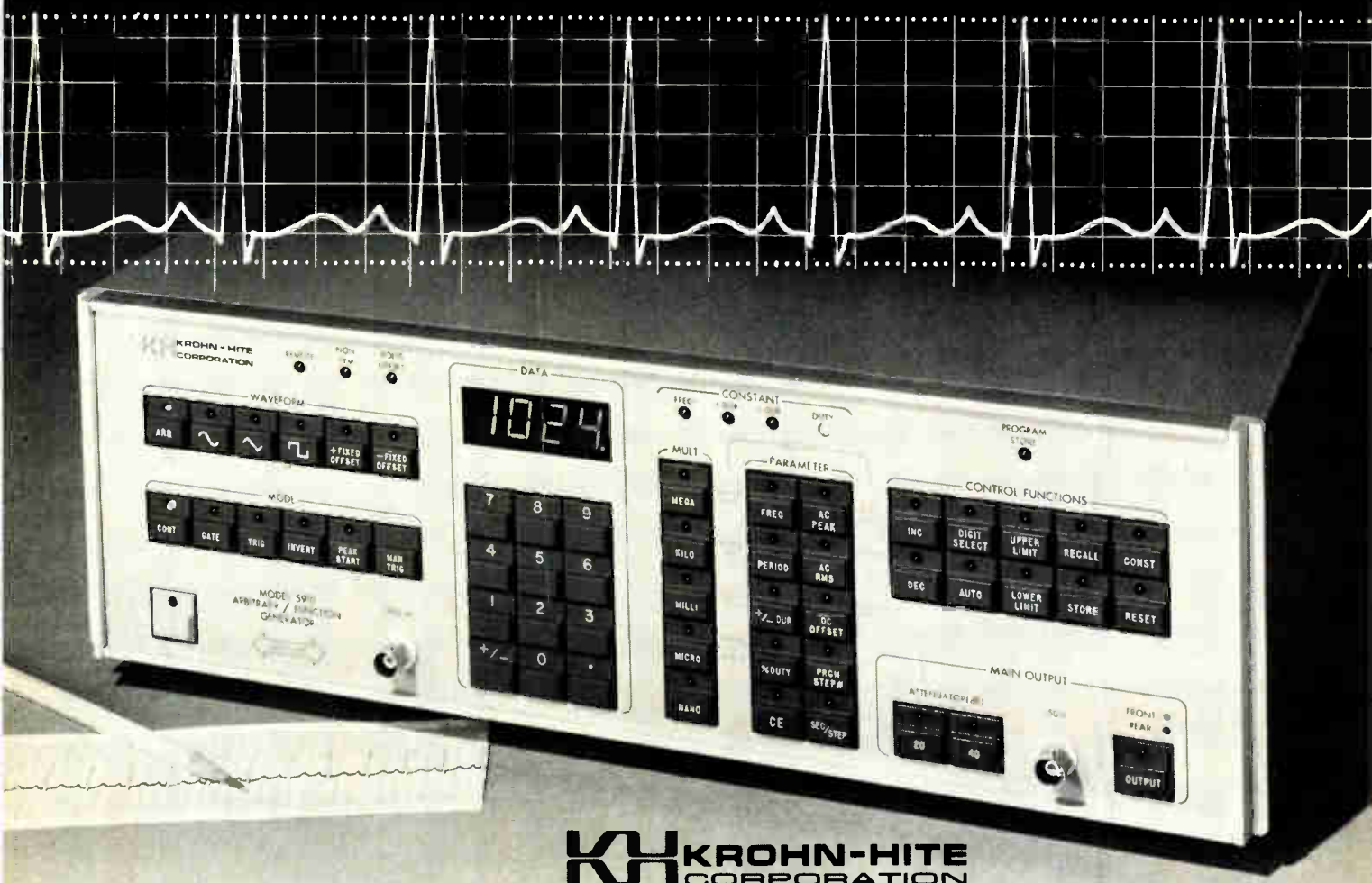
The plot may be complicated,

but this new programmable arbitrary waveform/function generator makes the resolution clear

Any waveform you can draw can be entered directly in volts on the new 5910 generator by means of a 1024 x 4000 matrix. Or instead of manually plotting the points, set the Autoprogrammer to rapidly create any waveshape that can be expressed using loops that involve basic arithmetic functions. Either way, your waveforms can be reproduced repetitively, at any amplitude, with excellent waveform resolution.

By adding this arbitrary waveform capability to our popular GPIB-compatible 5900 function generator, Krohn-Hite offers you double function for your dollar. You have at your fingertips the versatility of a function generator with a bank of nine Storage Registers and an Autoprogrammer with self-contained memory for storing up to 360 steps. Or you can select ARB and produce your own waves digitized to 12-bit resolution.

Easy — that's what they're saying about the 5910. Easy to operate and easy on the budget. Now you can have an arbitrary waveform generator AND a programmable function generator in a single unit.



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Circle 195 on reader service card

Readers' comments

Pipeline precedents

To the Editor: With reference to the International Newsletter item on page 62 in the Oct. 6 issue ["C-MOS version of the 6801 arrives"], the complementary-MOS version of the 6801 designed at Hitachi is not the first 8-bit microprocessor to use pipeline control. The 6502, designed at Commodore's MOS Technology division, and its single-chip version, the 6500/1, were the first to use pipelining. Both are 8-bit processors.

G. Venkatesh
Commodore Semiconductor Group
Norristown, Pa.

Out of print

To the Editor: We have recently received inquiries indicating that reference was made on page 160 of *Electronics* magazine for Sept. 22 to Media Bulletin No. 2006 (1969), issued by the National Better Business Bureau on the subject of flashlight batteries.

We regret to inform your readers that the bulletin is not available and copies cannot be provided to anyone. Since it was prepared by the former National Better Business Bureau nearly 12 years ago, we could not attest to its accuracy today.

J. K. Orr, vice president
Industry Standards Division
Council of Better Business Bureaus

Corrections

In "Cool-running 16-K RAM rivals n-channel MOS performance" (Oct. 6, p. 121), several items in the panel entitled "Closing the price gap" had incorrect labels. The chart on the left should be credited to Integrated Circuit Engineering Corp., the one at the top right should be labeled C-MOS static RAMs, and the Y axis of the bottom right chart should reflect millions of units. Finally, in "IEDM entries continue to push limits" (Sept. 22, p. 97), Bell Laboratories was cited as having reduced the effect of alpha radiation using a buried n-type grid when the correct affiliation was IBM Corp.'s Thomas J. Watson Research Center, as noted in the table on page 99.

Interested in higher performance software?

The Mark Williams Company announces **COHERENT**,™ a state of the art, third generation operating system. **COHERENT** is a totally independent development of The Mark Williams Company. **COHERENT** contains a number of software innovations not available elsewhere, while maintaining compatibility with UNIX*. The primary goal of **COHERENT** is to provide a friendly environment for program development. The intent is to provide the user with a wide range of software building blocks from which he can select programs and utilities to solve his problems in the most straightforward manner.

COHERENT and all of its associated software are written totally in the high-level programming language **C**. Using **C** as the primary implementation language yields a high degree of reliability, portability, and ease of modification with no noticeable performance penalty.

Features

COHERENT provides **C** language source compatibility with programs written to run under Seventh Edition UNIX, enabling the large base of software written to run under UNIX (from numerous sources) to be available to the **COHERENT** user. The system design is based on a number of fundamental concepts. Central to this design is the unified structure of i/o with respect to ordinary files, external devices, and interprocess communication (pipes). At the same time, a great deal of attention has been paid to system performance so that the machine's resources are used in the most efficient way. The major features of **COHERENT** include:

- multiuser and multi-tasking facilities,
- running processes in foreground and background,
- compatible mechanisms for file, device, and interprocess i/o facilities,
- the shell command interpreter—modifiable for particular applications,
- distributed file system with tree-structured, hierarchical design,
- pipes and multiplexed channels for interprocess communication,
- asynchronous software interrupts,
- generalized segmentation (shared data, writeable instruction spaces),
- ability to lock processes in memory for real-time applications,
- fast swapping with swap storage cache,
- minimal interrupt lockout time for real-time applications,
- reliable power failure recovery facilities,
- fast disc accesses through disc buffer cache,
- loadable device drivers,
- process timing, profiling and debugging trace features.

*UNIX is a trademark of Bell Labs

Software Tools

In addition to the standard commands for manipulating processes, files, and the like, in its initial release **COHERENT** will include the following major software components: **SHELL**, the command interpreter; **STDIO**, a portable, standard i/o library plus run-time support routines; **AS**, an assembler for the host machine; **CROSS**, a number of cross-assemblers for other machines with compatible object format with **'AS'** above; **DB**, a symbolic debugger for **C**, Pascal, Fortran, and assembler; **ED**, a context-oriented text editor with regular expression patterns; **SED**, a stream editor (used in filters) fashioned after **'ED'**; **GREP**, a pattern matching filter; **AWK**, a pattern scanning and processing language; **LEX**, a lexical analyzer generator; **YACC**, an advanced parser generator language; **NROFF**, an Nroff-compatible text formatter; **LEARN**, computer-aided instruction about computers; **DC**, a desk calculator; **QUOTA**, a package of accounting programs to control filespace and processor use; and **MAIL**, an electronic personal message system.

Of course, **COHERENT** will have an ever-expanding number of programming and language tools and basic commands in future releases.

Language Support

The realm of language support is one of the major strengths of **COHERENT**. The following language processors will be supported initially:

- **C** a portable compiler for the language **C**, including stricter type enforcement in the manner of **LINT**.
- **FORTRAN** portable compiler supporting the full ANS Fortran 77 standard.
- **PASCAL** portable implementation of the complete ISO standard Pascal.
- **XYBASIC**™ a state of the art Basic compiler with the interactive features of an interpreter.

The unified design philosophy underlying the implementation of these languages has contributed significantly to the ease of their portability. In particular, the existence of a generalized code generator is such that with a minimal effort (about one man-month) all of the above language processors can be made to run on a new machine. The net result is that the compilers running under **COHERENT** produce extremely tight code very closely rivaling that produced by an *experienced* assembler programmer. Finally, the unified coder and conformable calling sequences permit the intermixture of these languages in a single program.

Operating System

In part because of the language portability discussed above, and in part because of a substantial effort in achieving a greater degree of machine-independence in the design and implementation of the **COHERENT** operating system, only a small effort need be invested to port the whole system to a new machine. Because of this, an investment in **COHERENT** software is not tied to a single processor. Applications can move with the entire system to a new processor with about two man months of effort.

The initial version of **COHERENT** is available for the Digital Equipment Corporation PDP-11 computers with memory-mapping, such as the PDP 11/34. Machines which will be supported in the coming months are the Intel 8086, Zilog Z8000, and Motorola 68000. Machines for which ports are being considered are the DEC VAX 11/780 and the IBM 370, among others.

Because **COHERENT** has been developed independently, the pricing is exceptionally attractive. Of course **COHERENT** is completely supported by its developer. To get more information about **COHERENT** contact us today.

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Say goodbye to costly, time-consuming full-scale tweaking. The ICL7134 is factory set to 0.006% max. An on-board PROM corrects full-scale, eliminating trimming potentiometers. So labor is reduced, reliability is increased, and long-term accuracy assured.

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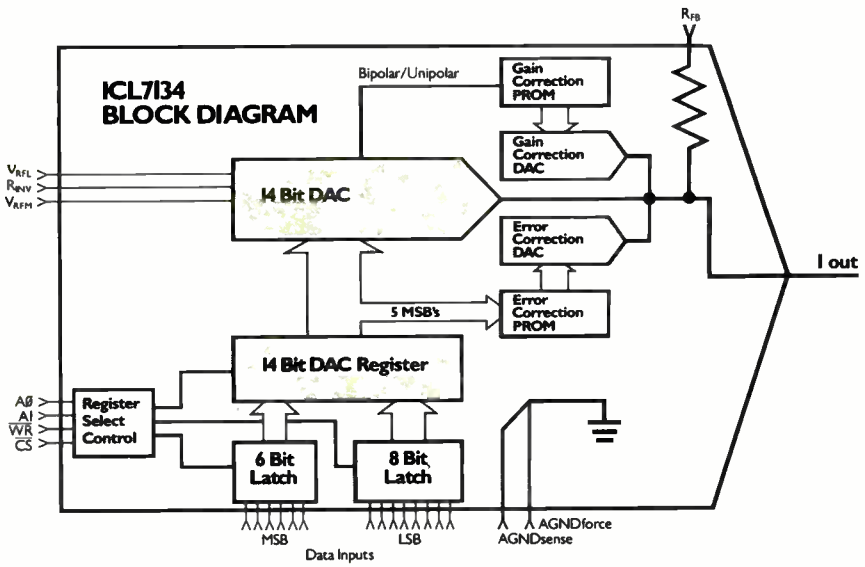
The ICL7134 uses the low-power CMOS technology (10mW typical) that you've come to expect from Intersil. Its other specs are impressive, too: an extremely fast settling time (typically 900 ns.), extraordinarily low temperature drift (5 ppm/°C), full four-quadrant multiplying capability, and a single +5 volt power supply. It all adds up to the best price/performance DAC you can buy.



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News update

■ Only six months ago, ECS Telecommunications Inc. of Richardson, Texas, had all to itself the market for electronic store-and-forward voice messaging [*Electronics*, April 21, p. 99]. Since then, however, a half-dozen firms—including IBM Corp.—have unveiled competing products. The systems cut the time wasted when office workers call someone but fail to reach the person they want.

Companies now offering voice-mail systems include: IBM in Armonk, N. Y.; Wang Laboratories Inc. of Lowell, Mass., Delphi Communications Corp. of Los Angeles; Voice & Data Systems Inc. of Chicago; CXC Corp. of Irvine, Calif.; and Televoice International Corp. of Santa Clara, Calif.

Like ECS's voice-message exchange (VMX), which has been on the market for some 18 months, all these products are high-speed digital systems that are capable of storing, retrieving, and delivering verbal messages, much like text systems. But instead of using video-display terminals, voice systems generally employ push-button phones. Some equipment suppliers also lease voice "mailboxes" to users whose traffic does not justify a private system.

Stimulus. Like others in the industry, ECS believes the recent wave of entries—especially IBM's audio distribution system—will boost the market for voice-messaging equipment as well as increase competition. "Whenever IBM enters a market, it legitimizes it," says Kenneth G. Bosomworth, president of International Resources Development Inc. of Norwalk, Conn. "Because we know IBM is big and well-managed, we know from a corporate strategy standpoint that it wouldn't choose to enter a market unless it might be big. . . . it's clear IBM sees this as a market that will yield hundreds of millions of dollars."

Bosomworth, who has long followed developments in this area, has confidence in the prediction. He estimates that the entire voice-messaging market, both for businesses and consumers, will hit $3.155 billion by 1990. **-J. Robert Lineback**

You don't need a lot of lettuce to get a Cherry

16 character display system for the OEM

The Cherry W416-1050 16 alphanumeric gas discharge display system is a lot more than "bare bones" even though it's priced at just $96 in lots of 5,000. It is equipped with microprocessor controlled circuitry including drivers, character generator, refresh memory and provides 19 control functions at a price so low it's ideal for OEM product applications.

Easy-to-read half inch high 14 segment characters, 7-bit ASCII input, adjustable brightness, fully addressable cursor, and flashing display are but a few of many outstanding features found in this display system. Comes complete with metal mounting bracket to facilitate installation. Works indoors or out from 0° C to 55° C. Best of all this bright new display system is available off-the-shelf.

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Circle 13 on reader service card

People

Market virtually untapped, says Young of Summit CAD

Working hard for what he wants is old hat to Gregg W. Young, co-founder and chief executive officer of Summit CAD Corp. of Houston, Texas. Just as he designed circuit boards to earn money for his electrical engineering degree from the University of Texas, Young's company has offered a design service to fund its own development of a stand-alone computer-aided design system that features a color-raster cathode-ray-tube display, a voice-input microphone, and a laser photoplotter.

Do it yourself. Gregg Young's company funded development of computer-assisted design system.

Some of the troubles plaguing early CAD or design-automation systems, like complicated operating procedures and vulnerability to system crashes, initiated the firm's effort "to determine if a design of a stand-alone system would be feasible," says the 33-year-old Young. "We thought the market, because of our direct experiences, would accept a stand-alone system.

"When we started the design service, our goal was to produce a system. Although both were initiated at the same time, the design service paid our way."

Thus owing no debt to either the public or venture capitalists, the Kansas-born (but Texas-bred) entrepreneur is seeking the low end of the design market for his Pathfinder system. Nevertheless, Pathfinder, which is priced at $60,000, can be worked easily into a large system supporting up to 60 users.

Believing that the major players, such as IBM, Prime Computer, and Hewlett-Packard, see design automation only as a way of moving hardware, Young says, "I don't think hardware people will have a major effect on the market. It's my prediction that the low-end systems will have a greater effect on the market than people are predicting."

Identifying potential sales of $2 billion, Young expects to top $25 million in the next 18 months and agrees with the industry consensus that the market is only 5% or 6% penetrated. He describes the target of his company as "the user who needs the sophistication and throughput of the large systems, but doesn't have it in his budget to start out with a commitment of several hundred thousand dollars."

Young cites some estimates that at the end of the decade there will be only 20% or 25% penetration. "If that is correct, that is a striking fact," he says.

Meanwhile, the company's design service has captured a respectable $200,000-per-month share of an estimated $45-million annual market, numbering among its customers IBM, Teledyne, Xerox, Motorola, HP, and local Houston oilfield service people. Young intends Pathfinder to be equally—if not more—successful.

Collmeyer relishes challenge of heading start-up Weitek

Weitek Inc., a company that recently started in Silicon Valley, is in the business of integrating algorithms into silicon, a business made possible through very large-scale integration and its ability to put systems on chips. And after seven years at Calma Co., a manufacturer of computer-aided design equipment that, like Weitek, is based in Santa Clara, Calif., Arthur J. Collmeyer has accepted the challenge of becoming Weitek's first president and chief executive officer.

"I was attracted by Weitek's people," comments the 40-year-old Collmeyer, who took a pay cut when he changed jobs. Begun last year by three technical staff members from

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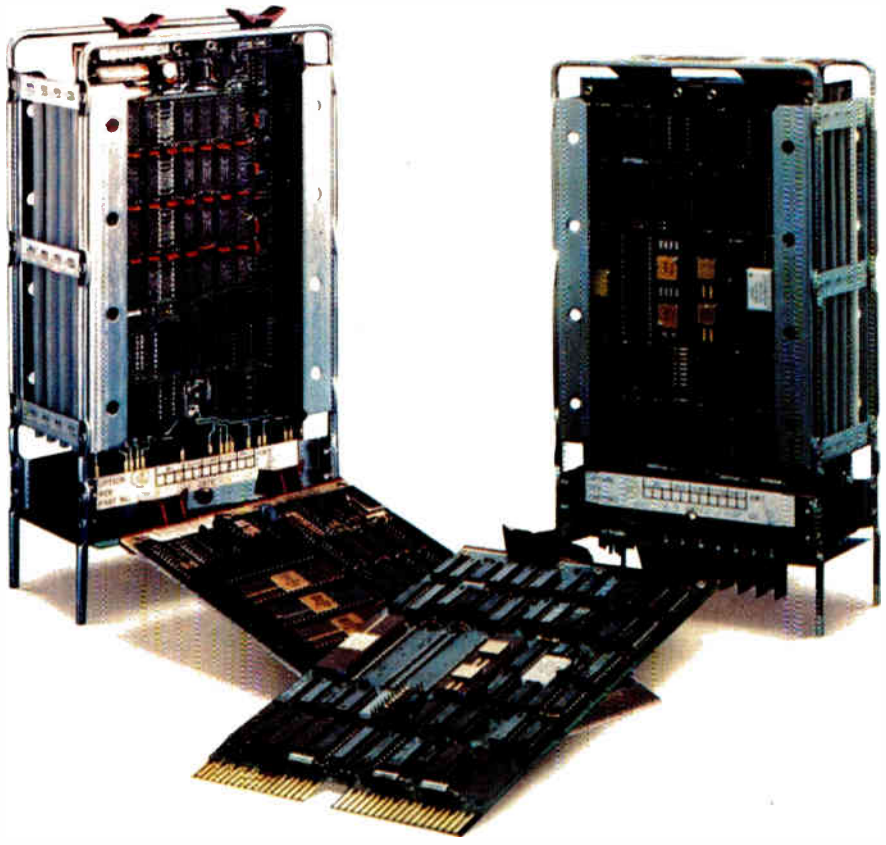

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the Palo Alto, Calif., advanced integrated-circuit laboratories of Hewlett-Packard Co., Weitek now has 14 employees, including Collmeyer.

His performance at Calma certainly makes Collmeyer a credible candidate to run a start-up like Weitek. He hired on at Calma as head of research and development, where he was also responsible for product engineering and production, before working his way up to general manager of its Microelectronics division.

"Calma grew about 60% per year for my seven years there," Collmeyer notes proudly. "It was at $3.6 million when I started, and it should do about $100 million for 1980."

Before that, Collmeyer put in stints as manager of Information Sciences at Xerox Corp., Stamford, Conn., and manager of system development at Scientific Data Systems of El Segundo, Calif., which was acquired by Xerox in 1969.

He wants to help shape Weitek into "a place where bright people can work on challenging problems and see the evidence of their work all around them. If the solution to a problem is understood, you can put it into silicon," he says, "VLSI makes this possible. The formula for prosperous growth is different now; the game has different rules. The chip business is no longer driven by process technology, it has become a systems business." □

Challenge. Arthur Collmeyer wants to help shape start-up company Weitek Inc.

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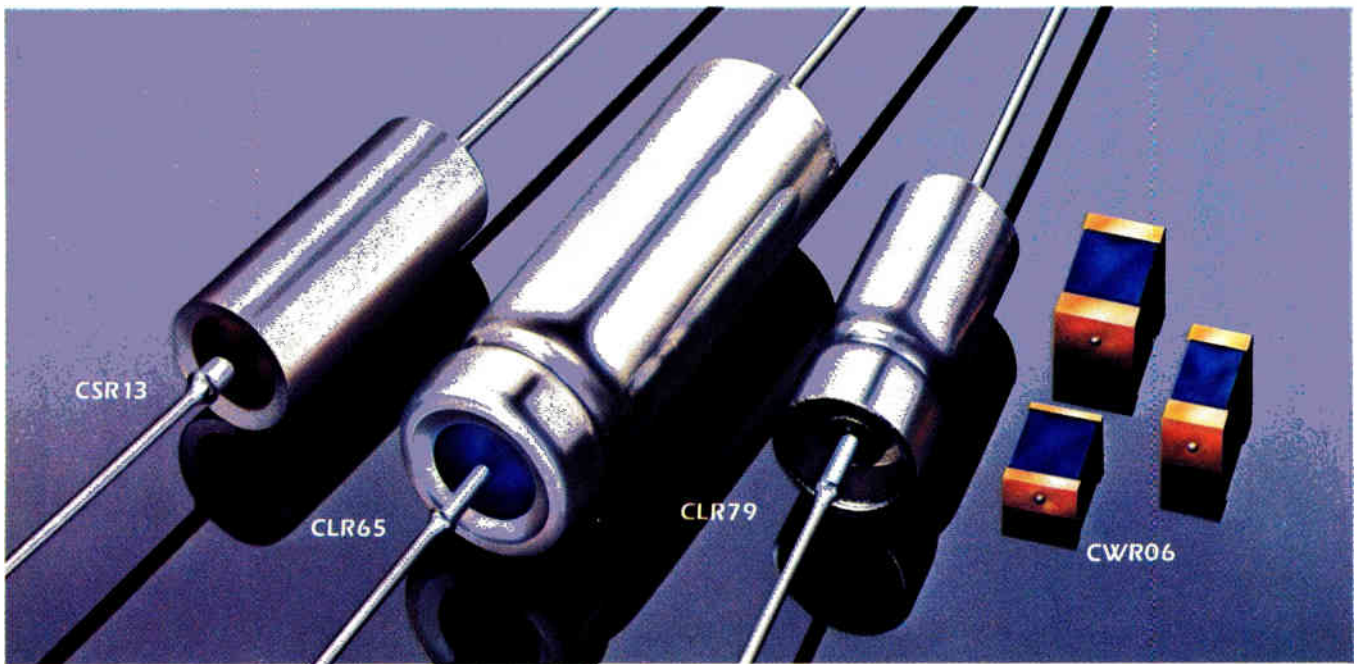

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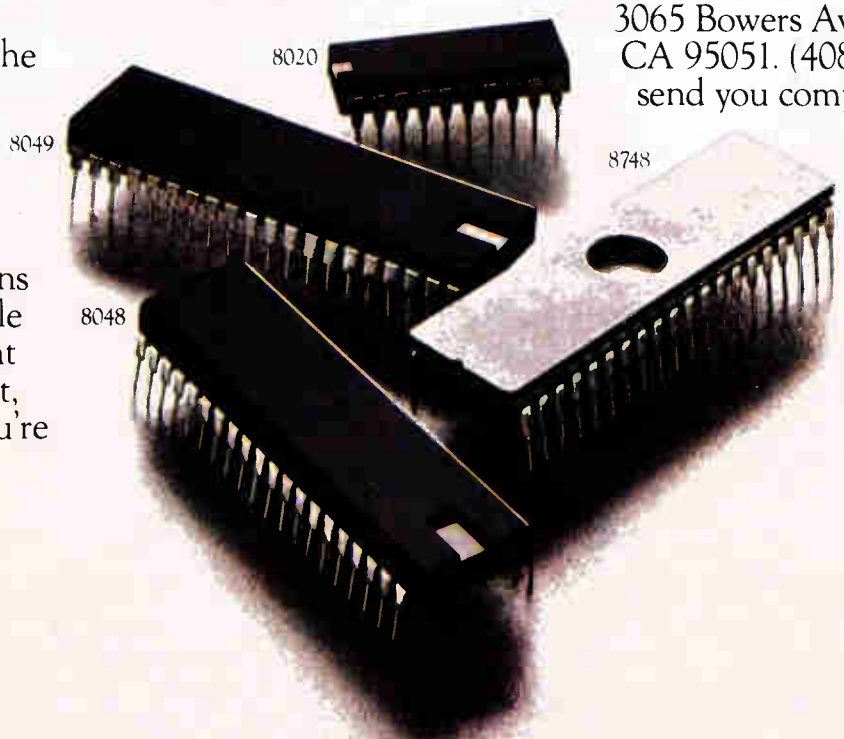

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WORLDWIDE BANK TO USE NEDIX-510F PACKET SWITCHING SYSTEMS

The Sumitomo Bank, Limited will use four NEDIX-510F packet switching systems to enhance their telephone, facsimile, teletype and on-line computer operations. The systems are being installed in New York, Tokyo, Hong Kong and London.

Designed to be the core of NEC's Integrated Voice/Data Communications Systems, the NEDIX-510F can packetize digital data (including voice data from digital telephones), then multiplex and transmit them over leased or dedicated lines—or a switched telephone or telex network—at speeds from 50bps to 64kbps. For optimal use of transmission lines the system provides both real-time and store-and-forward switching.

Packet terminals, non-packet terminals, host computers of different speeds and protocols—all can be linked to communicate with each other through the NEDIX-510F. Each packet terminal can communicate with up to 1,024 other terminals simultaneously over one physical line. Modular hardware and software and a wide range of network components simplify the building of a network structure according to user requirements.

The NEDIX-510F meets CCITT Recommendations and fully complies with other international and national standards. It is a prime example of how NEC integrates computer and communications (C & C) technologies to create a comprehensive information network.

SINGLE-CHIP MICROCOMPUTER HAS BUILT-IN A/D CONVERTER

For the first time ever, a microcomputer incorporates counters, timers, a serial interface, an A/D converter, a 4K-byte ROM and a 256-byte RAM on a single chip.

NEC's new μCOM-87AD (μPD7811G) is an 8-bit single-chip microcomputer with a built-in analog-digital converter for such applications as process control, copying machines, and automobiles. When used in automobiles, for instance, it can convert eight kinds of analog information such as temperature, pressure, and power supply) into digital information for further processing by the on-chip A/D converter.

The μCOM-87AD offers a high speed conversion rate of 50μs. And use of the "successive approximation technique" gives it better cost-performance.

Another outstanding feature is its ability to perform pulse width measurement and frequency counting as well as programmable rectangular waveform output without need of complicated software. This makes it ideal for real-time control applications.

Other features include: Software performance 1.5 to 5 times higher than most other 8-bit single-chip microcomputers; A unique double-buffered serial interface which makes possible a multiprocessor system configuration; Direct addressability of external ROMs and RAMs up to a total of 60K bytes.

NEW MODEMS OFFER THE FASTEST POLLING RESPONSE TIME

Two new polling modems from NEC offer the world's fastest polling response time.

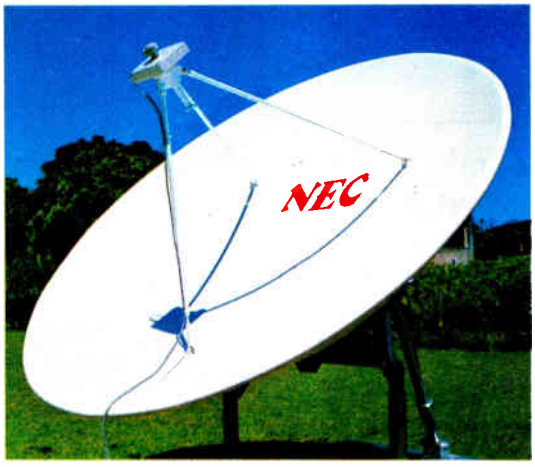
The 9,600bps data modem SP9600 FAST and the 4,800bps data modem SP4800 FAST incorporate a unique equalizer to offer a response time of 15msec. Even if synchronism is lost during data transmission (due to temporary circuit malfunction) this automatic equalizer quickly recovers without training signals because of a retrain-on-data function. And these two models are only about 1/3 the size of competing products thanks to extensive use of LSIs.

Another new model, the 2,400bps data modem SP2400 FAST, is about half the size of comparable modems. It has a polling response time of 7msec, and is designed to meet CCITT's V.26 and V.26 bis recommendations.

All three modems can be used over leased circuits or the public switched telephone network.

NEW GENERATION 12GHz TVROs

With an antenna diameter of only 1.8m, NEC's 861 Series TVROs are economical and easy to install. They are designed to offer excellent reception of OTS-2 and future systems (such as ANIK-C), and are ideal for CATV stations, rebroadcasting and community reception.



Featuring an impressive G/T of 18.7 dB/K, the 861 Series can pull in clear signals even from relatively low power satellites. And NEC TVROs can access any polarization of satellites without extra cost. The outdoor units have an advanced but simple design that will permit easy manual change-over when satellites convert from linear to circular polarization in the future.

The 861 Series has a wide-band antenna—11.50 to 12.75GHz. The low noise converter, based on an NEC-developed GaAs FET, is rated at 360 degrees K. With full 24-channel reception, dual polarization capability and multi-channel reception, the 861 Series provides outstanding performance in a compact and economical package.

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A warning that is not just an empty threat

Nobody can say the world wasn't warned. Last month at the International Conference on Fifth-Generation Computer Systems, the Japanese unveiled a master plan for the development of computers to meet the needs of the 1990s. The plan is not just another exercise in computer-science esoterica; in fact, it is a mobilization on a national scale that is aimed at the domination of the world computer market.

At the conference, attendees received an 89-page preliminary report outlining the ambitious scope of the plan, including detailed research and development strategies and projections of applications and their effects on society. The summary at the beginning of the report is an intriguing mixture of altruism and self-interest, citing the use of information-processing systems to increase productivity, contribute toward international cooperation, save energy, and cope with a (Japanese) society that is aging rapidly (and thus requires advanced health-management and education systems).

Technical details of the plan are described on page 83, but just as interesting and perhaps more ominous are other comments that dot the report. For example:

"Japan has come to be considered an 'economic power' by the other countries of the world. Thus, if we consider the direction in which our industries proceed, it becomes clear that we no longer need chase the more developed countries, but instead should begin to set goals of leadership and creativity in research and development and to pioneer the promotions of such a project throughout the world." *Translation: "We've learned all we can from the U. S., now let's move in and beat the pants off it."*

As to the effects of the project, the report goes on to say: "This effort will not only help our computer industry foster more creative technology, but will also provide our country with a means of bargaining power." *Translation: "We can use our technology to gain a favorable trade position for the natural resources we lack."*

The steering committee is well aware of the unease and suspicion with which the U. S. and European computer industry will view this project, so near the start it pays lip service to international benefits and cooperation. "The project must be an internationally oriented one," it says early on. But, only a few pages later, the report says: "For a number of reasons, it is difficult to make this an international project. Instead, it is desirable to execute it as a national project with Japan having the liberty to decide its course."

What does seem likely is the fulfillment of another recommendation of the committee: "Emphasis must be placed on the importance of public relations activities to avert misconceptions about this project in countries abroad and instead to stimulate enthusiasm in the different countries about its progress." *Translation: "We can't let them think we're going to do to computers what we did to consumer electronics, automobiles, and memories."*

The challenge is there—out in the open for all to see. The plan is an impressively comprehensive blueprint of government-directed, long-range industrial policy, something the U. S. sadly lacks. Given the scope, organization, and muscle the Japanese are putting behind this project, it looks as if U. S. leadership in computer technology will be in for a serious challenge. We had better respond before it is too late.

Pick the application software package that can save you a bundle.

UNITED TECHNOLOGIES MOSTEK

It's the one in the microcomputer on the left. That's right. Completed application software imbedded in a 40-pin DIP. Available off-the-shelf from your nearest Mostek distributor.

We call it the MK95103 Serial Control Unit (SCU20*). It's an 8-bit single-chip microcomputer, preprogrammed with the software routines and communications protocol needed for most remote serial applications. Other features include three 8-bit I/O ports to interface with the outside world. On-chip memory for real-time data logging and event counting. Plus a hardware UART (baud rate up to 9600) to communicate with a host computer. As a result, you can network up to 255 of them on a single serial link.

But the real beauty of the SCU20 is that with it, you can trim development time by as much as 70%, depending on the application.

Equally impressive, it's ideal for a wide range of distributed processing applications such as commercial building energy management. Process control in all types of industries, from wineries to textile mills. Data gathering and control for offshore oil rigs. Or standardized communications between office machines. In fact, the list of networking opportunities is nearly endless.

Saving yourself a bundle of time. And money. Both advantages are yours when you specify application software that's packaged the way it should be—inside a circuit, ready for use. With the SCU20, it already is. To find out more, write Mostek, 1215 West Crosby Road, MS507, Carrollton, Texas 75006 (214) 323-1801. In Europe, contact Mostek International at (32) (02) 762.18.80. In the Far East, Mostek Japan KK (03) 404-7261.

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Can you spot the real

It's me! How can you be sure? Well, who else could come up with over 156,000 solenoids? Only a *real* Guardian Angel. Because of me you can get solenoids in just about any size and shape... pull or push. AC or DC. Tubular in traditional or long life versions. Box frame, laminated and U-frame. And I can even go back to my miracle drawing board and come up with one designed just for you. So why even look at those other phoney angels? You can see it's *me.*

Circle No. 196 for more information on Guardian Solenoids

No, it's me! I'm the one who inspired those Guardian engineers to develop the relays you need. Like my power and open relays. How do you want them? Large, small... miniature or "mini." AC or DC. You name it... I make it. Want another miracle?... OK. How about Guardian dependability. I build it right in. On every relay. How 'bout that? You want the *real* Guardian Angel? Then stop right here. It's *me.*

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*SCU20 is a trademark of Mostek Corporation

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Meetings

International Electron Devices Meeting, IEEE (Melissa Widerkehr, Courtesy Associates, 1629 K St., N. W., Washington, D. C. 20006), Washington Hilton Hotel, Washington, D. C., Dec. 7–9.

Infrared and Millimeter Waves Conference and Exhibition, IEEE (K. J. Button, Massachusetts Institute of Technology, National Magnet Laboratory, Cambridge, Mass. 01239), Carillon Hotel, Miami Beach, Fla., Dec. 7–11.

6th Meeting on Integrated and Guided-Wave Optics, Optical Society of America and IEEE (OSA, 1816 Jefferson Pl., N. W., Washington, D. C. 20036), Asilomar Conference Center, Pacific Grove, Calif., Jan. 6–8, 1982.

5th Los Angeles Technical Symposium, International Society for Optical Engineering (SPIE, P. O. Box 10, Bellingham, Wash. 98227), Los Angeles Marriott Hotel, Los Angeles, Jan. 25–29.

First Spacecraft Electronics Conference, EIA (Frank A. Mitchell, EIA, 2001 Eye St., N. W., Washington, D. C. 20006), Hyatt Hotel, Los Angeles, Jan. 26–28.

Advanced Semiconductor Equipment Exposition and Conference, Electronic Representatives Association and Cartlidge & Associates Inc. (CAI, 491 Macara Ave., Sunnyvale, Calif. 94086), Convention Center, San Jose, Calif., Jan. 26–28.

Annual Reliability and Maintainability Symposium, American Society for Quality Control, IEEE *et al* (H. C. Jones, Westinghouse, MS 3608, P. O. Box 1521, Baltimore, Md. 21203), Biltmore Hotel, Los Angeles, Jan. 26–28.

First Military Computers and Software Seminar, American Defense Preparedness Association (ADPA, 900 Rosslyn Center, 170 North Moore St., Arlington, Va. 22209), Sheraton National Hotel, Arlington, Va., Jan. 27–28.

Workshop On Reliability of Local Networks, IEEE (Robert S. Swarz, Prime Computer, Inc., 500 Old Connecticut Path, Framingham, Mass. 01701), South Padre Hilton Resort, Brownsville, Texas, Feb. 3–5.

16th Annual Television Conference, Society of Motion Picture and Television Engineers (Lynne Robinson, 862 Scarsdale Ave., Scarsdale, N. Y. 10583), Opryland Hotel, Nashville, Tenn., Feb. 5–6.

5th European Exhibition and Congress and Exhibition for Telecommunications, Online GmbH (Postfach 10 08 66, D-5620 Velbert 1, West Germany), Düsseldorf fairgrounds, W. Germany, Feb. 8–11.

Aerospace and Electronic Systems Winter Convention, IEEE (Tom S. Schuler, Rockwell International, P. O. Box 3105, Anaheim, Calif. 92803), Sheraton-Universal Hotel, Hollywood, Calif., Feb. 9–11.

International Solid State Circuits Conference, Institute of Electrical and Electronics Engineers (L. Winner, 301 Almeria Ave., Coral Gables, Fla. 33134), Hilton Hotel, San Francisco, Feb. 10–12.

Aerospace Applications Conference, IEEE (Russel Gaspari, Hughes Aircraft Co., MS S12/V305, P. O. Box 92919, Los Angeles, Calif. 90009), Woodbridge Conference Center, Snowmass, Colo., Feb. 21–28.

Nepcon '82 West, Cahners Exposition Group (222 West Adams St., Suite 999, Chicago, Ill. 60606), Anaheim Convention Center, Anaheim, Calif., Feb. 23–25.

Compcon Spring, Institute of Electrical and Electronics Engineers (Harry Hayman, P. O. Box 639, Silver Spring, Md. 20901), Jack Tar Hotel, San Francisco, Feb. 26–28.

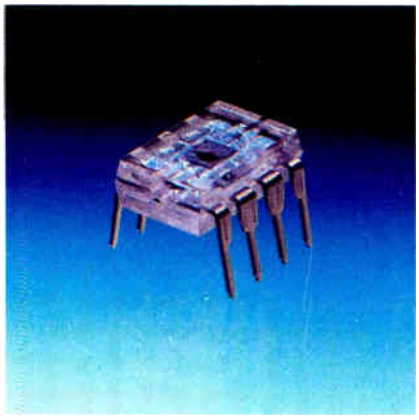
Robots VI Conference and Exposition, Society of Manufacturing Engineers (1 SME Dr., P. O. Box 930, Dearborn, Mich. 48128), Cobo Hall, Detroit, March 1–4.

Introducing the new TRW Optron Automatic Brightness Controller.

It's the first time that ambient light sensing and automatic brightness control functions have been integrated on a single chip.

Pulse width modulation is the key. The output duty cycle varies proportionately with the ambient light level so that the brightness of vacuum fluorescent, LED, incandescent and other types of displays and display drivers can be varied from 0% to 100%. An analog output, which varies linearly with ambient light, is provided for simultaneous or separate operation. Sensitivity can be adjusted externally and independent of ambient light.

Imagine the applications! Stereos, television displays and screens, test equipment, aircraft instrument displays, industrial light



levels, appliances, gasoline pumps, automobile dash displays... the list is virtually endless.

The new TRW Optron Automatic Brightness Controller (OPL100) is incredibly versatile. It can operate from supply voltages of 4.5V to 24V, and offers totem pole output to sink 20 mA or source 50 mA. And it will operate in synchronous or asynchronous modes. It is also available in a hermetically sealed TO-5 eight pin package (OPL105).

This technical innovation from TRW Optron means that for the first time with a single chip, you have the capability of precise automatic control over the brightness of your light source, independent of its non-linearities and sensitivity.

Let us tell you more. For a comprehensive data sheet and application note, ask for Product Bulletin 2091 and Application Bulletin 115. **Contact TRW Optron, 1201 Tappan Circle, Carrollton, Texas 75006, (214) 323-2200.**

TRW OPTRON

An Electronic Components Division of TRW Inc.

Can you spot the real

It's me! How can you be sure? Well, who else could come up with over 156,000 solenoids? Only a *real* Guardian Angel. Because of me you can get solenoids in just about any size and shape... pull or push. AC or DC. Tubular in traditional or long life versions. Box frame, laminated and U-frame. And I can even go back to my miracle drawing board and come up with one designed just for you. So why even look at those other phoney angels? You can see it's *me.*

Circle No. 196 for more information on Guardian Solenoids

No, it's me! I'm the one who inspired those Guardian engineers to develop the relays you need. Like my power and open relays. How do you want them? Large, small... miniature or "mini." AC or DC. You name it... I make it. Want another miracle?... OK. How about Guardian dependability. I build it right in. On every relay. How 'bout that? You want the *real* Guardian Angel? Then stop right here. It's *me.*

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Guardian Angel®?

Don't listen to them! You want a real Guardian Angel? Then watch this. Enclosed relays. AC or DC. Size is no problem. I have mini. I have miniature. I have large and small. Plug-in or printed circuit termination. Some even have built-in test lamp and push-to-test. Mating sockets with solder lug or printed circuit terminals, too. Mechanical life. Those are miracles in themselves. Angel? No foolin' ... *I'm* the one.

Cirlce No. 198 for more information on Guardian Enclosed Relays

You know it's me! Prove it, you say... okay... you want a *solid* miracle? How about Solid State? Like my relays and I/O modules that perform the function of electro-mechanical relays with photo-isolation between control circuit and switching output. Let those others even try to *say* that. And I can do it right off-the-shelf or in custom designs. If you want the real thing you'll pick me. Not an imitation. I'm handing you a reliable relay line.

Circle No. 29 for more information on Guardian Solid State Controls

HERE'S THE ANSWER...

She's *all* of the above. They're all Guardian Angels. You see, ever since the Guardian Angel became our symbol, different models (and you thought she was real) have played the part.

FREE 1982 GUARDIAN ANGEL CALENDAR. Send your request—on your company letterhead, please—to: The Guardian Angel, c/o Guardian Electric Manufacturing Company.

GOULD BIOMATION K100-D

7 reasons why the K100-D is now the world's best-selling logic analyzer.

How the general-purpose K100-D beat out H-P to become #1.

Not so long ago, Hewlett-Packard logic analyzers were the industry standard. We asked digital designers to compare the K100-D with H-P's popular 1610B and 1615A logic analyzers before making any buying decision.

In head-to-head comparison, the K100-D came out looking so good, it's now the best-selling logic analyzer in the world. Here's why:

1. It's easy to systematize.

For automated troubleshooting and production ATE, the K100-D features a fully-programmable GPIB interface.

To help you support a wide variety of bus-oriented systems, there are standard high-performance probes, specialized probing accessories and detailed application notes available on all the popular microprocessor systems currently in use.

2. It's concise.

The K100-D monitors 16 channels in time domain, 32 in data domain, so you can probe enough points to pin down problems at their source.

3. It's fast.

A 100 MHz clock rate resolves signals to 10 nanoseconds. The front end is also sensitive enough to capture glitches as narrow as 4 ns.

4. It's deep.

1024 words deep in memory—for faster, more accurate debugging. The K100-D extends the length of data you can trap from your system at any one time.

5. It's clear.

The K100-D has a large keyboard and interactive video display, a comprehensive status menu, highly useful time domain display, and data domain readout in user-specifiable hexadecimal, octal, binary or ASCII.

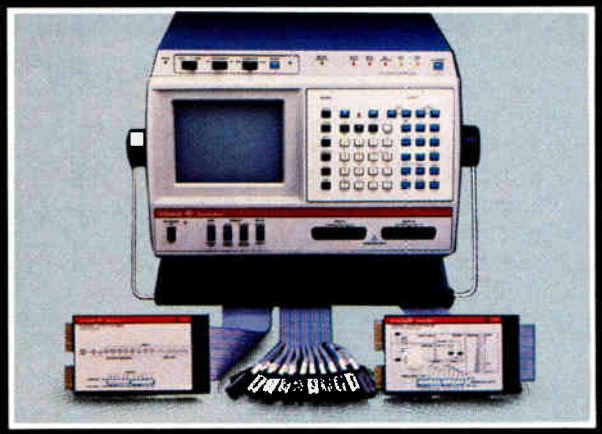
6. It has remote diagnostics.

A new T-12 communications interface option lets your field troubleshooters share their system observations with the best engineers back at headquarters. Remote diagnostics provide faster debugging and save a lot of time and travel for your most valuable people.

7. It's well supported.

You get full applications support from the experts in logic analysis.

For a free copy of our "Logic Analyzer Comparison Guide," request card for microprocessor system application notes, and T-12 Communicator information, just circle the appropriate reader service numbers. Or contact Gould, Inc., Instruments Division, Santa Clara Operation, 4600 Old Ironsides Drive, Santa Clara, CA 95050, phone (408) 988-6800.



The T-12 "top hat" for the K100-D provides logic analyzer remote diagnostic capability. Other options include the GPIB Analyzer and RS232 Serial Data Analyzer.

GOULD

Electronics & Electrical Products

Circle 199 for Comparison Guide
Circle 200 for App Note request form
Circle 201 for T-12 communicator data

No other oscilloscope offers this much in one package.

Large 16K Memory

See things you've never seen before with a time resolution of up to 16,000:1 and a dynamic range of up to 32,000:1. Zoom in on the smallest signal detail with expansion up to x256 on both axes. By using subsections of memory, you can display up to 32 stored waveforms simultaneously.

4-Channel Operation

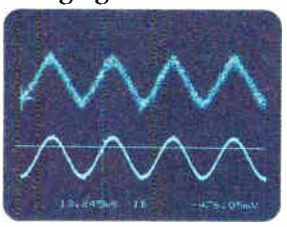
Capture, store and display four signals simultaneously using two plug-ins operating on the same, or totally independent, timebase and trigger. Compare live and stored waveforms in real time. Even compare interactive variables such as voltage/current or stress/strain using X-Y display of either live or stored signals.

Pre- and Post-Trigger Delay

Look into the past or future with a pre-trigger delay from 500 nanoseconds to 37 days or a post-trigger delay up to 106 years. Avoid accidental triggering by checking the threshold and sensitivity using the trigger-view mode.

Signal Averaging

Extract repetitive signals from noise using sweep averaging. Even smooth those slow, noisy, one-shot signals by using the unique point-averaging mode.



Alphanumeric Display

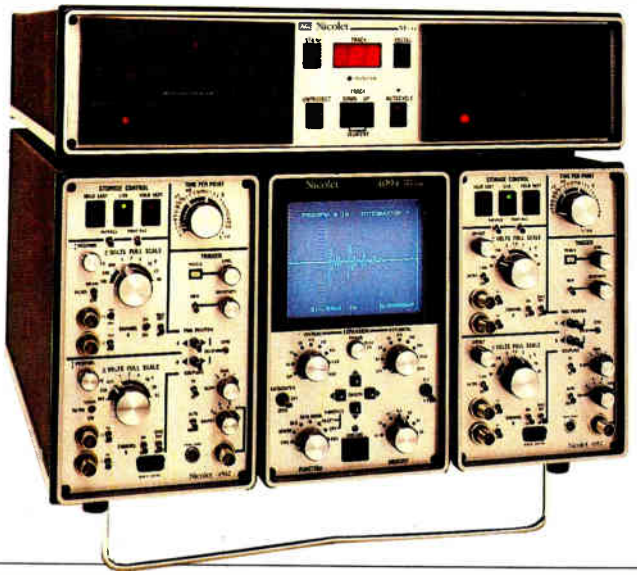
Get absolute or relative measurements from any portion of the waveform using the cursor-interactive time and voltage readout. The numerics include a channel identifier to eliminate errors even on multiple trace displays.

Data Manipulation

As with all Nicolet scopes, manipulate stored data using the pushbutton functions of add, subtract or invert. With the 4094, continue to expand this capability with disk-extended functions of multiply, integrate, smooth, RMS and much more.

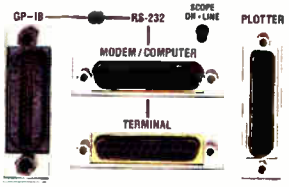
Permanent Data Storage

Store waveforms at the touch of a button on the optional floppy disk or capture and store automatically using the autocycle feature. Get report ready hardcopy records using the standard X-Y or Y-T recorder outputs, or obtain fully annotated plots automatically with the optional digital plotter.



IEEE-488 and RS-232 I/O

Integrate the 4094 into your digital measurement system with the fully bi-directional GP-IB and RS-232 digital I/O option.



One of a Family

Nicolet is the world's leading manufacturer of high resolution digital oscilloscopes. In addition to the 4094, Nicolet offers the 2090 range of 2-channel digital oscilloscopes with many advanced features including high-resolution, disk storage and digital I/O.

Find out how Nicolet can bring digital precision to your analog measurements. For more information, call 608/271-3333. Or write: Nicolet Instrument Corporation, Oscilloscope Division, 5225 Verona Road, Madison, WI 53711.

In Canada: call 416/625-8302.

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The Nicolet 4094.

Electronics newsletter

Mostek closes its E-PROM line

Faced with drastic worldwide price erosion on electrically programmable read-only memories, Mostek Corp. has shut down its E-PROM fabrication line in Carrollton, Texas. Company officials also are deciding whether to bring the MK2764 8-K-by-8-bit E-PROM to market. The fully static device, to have been available last June, has 25% redundancy—much more than competitive parts.

At Data General, CEO is office systems . . .

From now on at Data General Corp., CEO will stand for comprehensive electronic office systems, as the Westboro, Mass., firm becomes the **fourth major minicomputer maker in a month to announce a major thrust into office automation** [*Electronics*, Nov. 3, pp. 42, 106, and 110]. The new offering integrates word-, graphics-, and data-processing functions, includes electronic-mail and local-network capabilities, and sports a "decision support" facility called Present. Though some of the new programs grow out of existing software, each appears to have been significantly enhanced for this effort. The new CEO system operates with Data General's 16- and 32-bit Eclipse processors and will make all office-automation functions available at a single terminal: either a Dasher G300, D400, or D450. The company says it will be shipping the entire package within 90 to 120 days—"and we mean *all* of it," says a source.

. . . and NCR enters market with word processor

NCR Corp. of Dayton, Ohio, is also jumping into the office-automation market with a word-processing system known as the NCR WorkSaver. Using software known as WordReady, developed by the company's nine-month-old Office Systems division, the WorkSaver system **relies upon a line of 16-bit multifunction work stations** supplied by Convergent Technologies Inc. of Santa Clara, Calif. Printers and mass-storage units are also part of the system package, which features user-friendly functions and configurability ranging from stand-alone to clustered work stations.

GE gears up factory automation, plans joint venture

Bent on becoming a major force in factory automation, General Electric Co. has introduced an electronic-vision system and has formed a joint venture to market what it calls computer-aided engineering software. The PN2304 Optomation II vision system **employs a distributed multiprocessor architecture and modular software to provide capabilities** that go beyond those offered by GE's 1978-vintage PN2303 Optomation I. The new system handles randomly positioned parts on a conveyor; its predecessor requires parts to be positioned carefully and is programmed with control switches. GE's Optoelectronic Systems Operation in Syracuse, N. Y., offers the 2304 for about $50,000, twice the price of the 2303. The joint venture, General Electric CAE International Inc. of Milford, Ohio, will sell software for mechanical design and stress analysis. GE's partner is Structural Dynamics Research Corp.

Superfast computer to use data-flow matrix

Designed for fail-safe operation in ultrahigh-throughput scientific applications, a new computer design from Isotropic Nexus Systems Inc., Seattle, Wash., **should be capable of executing as many as 1 billion 32- or 64-bit instructions per second.** The system would use a form of data-flow architecture [*Electronics*, April 26, 1979, p. 92] with multiple arithmetic and logic units made from off-the-shelf array-processor technology. Task

partitioning and data routing would be handled by multiple microprocessors in the highly parallel machine. The modular system would grow upward from units performing 4 million instructions a second by adding array processors. Initial deliveries are scheduled for mid-1984.

Smart CRT terminal costs under $1,100

Prices of smart cathode-ray-tube terminals continue to fall. The latest price breaker, listing for less than $1,100 in single quantities, is a new member of the Viewpoint family of terminals from Applied Digital Data Systems Inc. Unveiled this week by the Hauppauge, N. Y., company at Comdex in Las Vegas, the Viewpoint 90 **may be customized from the keyboard or host computer by using software.** This addition to the product line—known for its ergonomic features and reliability at a low price—can emulate many of today's popular terminals.

32-bit 8086 version in works at Intel

Intel Corp. in Santa Clara, Calif., is working on a 32-bit version of the 8086 microprocessor dubbed the iAPX-386. Unlike the iAPX-432, **it will have an instruction set compatible with the 8086, but will have 32-bit data paths.** It will compete with the 32-bit models of Motorola's 68000 and Zilog's Z8000, though none of the three is likely to see silicon before 1983. At the same time, Intel is trying to make certain it will offer the leader in 16-bit operating systems by signing with Digital Research Inc. of Monterey, Calif., for CP/M-86, a version of the *de facto* standard for 8-bit microsystems, and with Microsoft for MS-DOS, the operating system used with IBM's new 8088-based Personal Computer.

Sperry turns out rugged Josephson parts in lab

New processing techniques for superconducting Josephson logic circuits promise higher yields of extremely rugged parts, reports Sperry Research Center in Sudbury, Mass. Using all-refractory materials like niobium film and amorphous-silicon barriers, rather than standard lead alloys and oxide barriers, produces Josephson parts **immune to the performance-degrading effects of thermal cycling.** The first small-scale logic parts thus fabricated show very uniform, reproducible junctions with capacitances as low or lower as those of present Josephson parts, says the Sperry Corp. division.

Ada compiler to sell for $1,500

Vying for the front runner's spot in Ada software, Western Digital Corp. of Irvine, Calif., this week is unveiling MicroAda, a proper subset of the Department of Defense language. The enhanced compiler, priced at $1,500, is **an introductory tool that can be traded in for full value** when a final version of Ada is completed in June. Work on the subset was performed at the company's System Technology Center in Pittsburgh, which opens formally this week.

Addenda

The first compiler for the Modula-2 language—the brainchild of Niklaus Wirth, author of Pascal—comes from Volition Systems of San Diego, Calif. **The language is the answer to Pascal's inability to handle real-time programming problems and compile procedures separately** for increased programmer productivity. . . . Apple Computer Inc.'s Apple III is **finally ready for mid-December delivery,** and the Cupertino, Calif., company also has introduced a 5-megabyte, 5½-in. Winchester disk drive.

NEW OSCILLOSCOPE TUBE

STORES VERY FAST TRANSIENT SIGNALS

THOMSON-CSF presents its new high performance TH 8911 tube.

This half-tone direct-view storage tube features:

- 10 x 12 cm flat screen
- illuminable graticule
- high writing speed:
  - 10 m/µs for dark screens
  - up to 30 m/µs for luminous screens
- 100 MHz bandwidth
- two mode operation, storage and normal.

This tube is particularly well adapted for the observation of very fast spikes, impulses and a variety of other transients.

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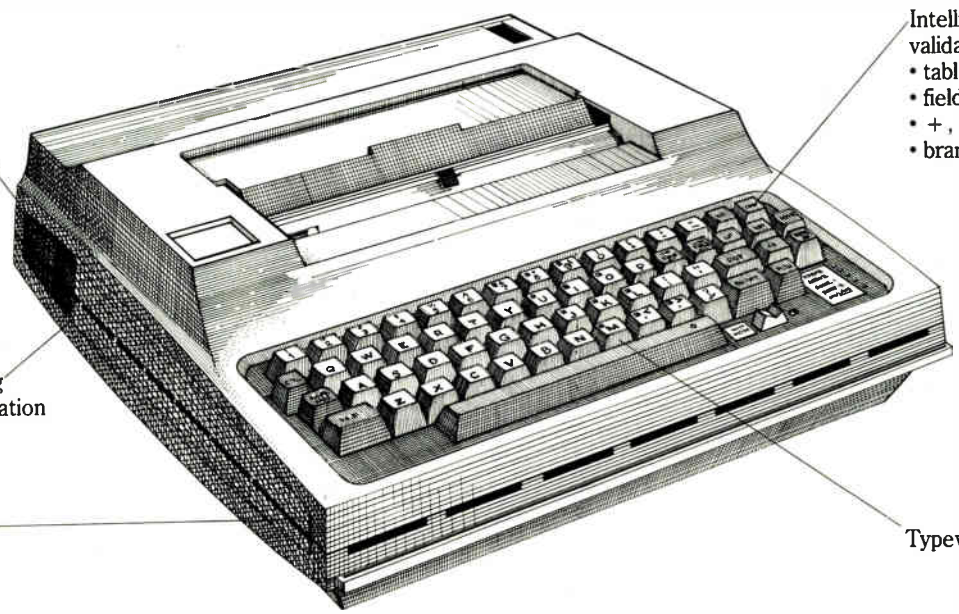
CG 4519

Information Specialist.

767 KSR

Bubble Memory Data Terminal



TI's *Silent 700** Model 767 Electronic Data Terminal is ideal for remote data entry applications—especially those where data integrity is essential. The versatile 767 offers the advantage of high-speed batch synchronous communications with integrated nonvolatile bubble memory data storage for reduced connect time and communications costs. Featuring TI's Data Entry Validation and 3780 protocol capabilities, the 767 easily accommodates integration into new or existing distributed data entry networks.

TI is dedicated to producing quality, innovative products like the Model 767 Electronic Data Terminal. And TI's hundreds of thousands of data terminals shipped worldwide are backed by the technology and reliability that come from 50 years of experience.

For more information on the Model 767, contact the TI sales office nearest you, or write Texas Instruments Incorporated, P. O. Box 202145, Dallas, Texas 75220, or phone (713) 373-1050.

TI invented the integrated circuit, the microprocessor and the microcomputer.

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In Canada, write Texas Instruments Incorporated, 41 Shelley Rd., Richmond Hill, Ontario L4C 5G4, (416) 884-9181. In Europe, write Texas Instruments, M/S 74, B. P. 5, Villeneuve-Loubet, 06270, France, (93) 20 01 01. In Asia Pacific, write Texas Instruments Asia Ltd., 990 Bendeemer Rd., Singapore 1233. Telex RS 21399, or phone 2581122.

Superfast MOS outdoes GaAs in switching speed

by John G. Posa, Solid State Editor

X-ray lithography, advanced processing yield transistors with 0.25-μm channel length that switch in picoseconds

Some of the most sensational improvements in MOS technology are taking place over 3,000 miles from the fabled Silicon Valley in California. At Bell Laboratories, Murray Hill, N. J., researchers using X-ray lithography and other advanced processing techniques have fashioned MOS transistors with 0.25-micrometer channel lengths that switch in a matter of picoseconds—over an order of magnitude faster than those based on today's high-performance MOS technology.

What is more, Bell is on the verge of using the ultrafast MOS switches in very large-scale integrated circuits—one to control a new electron-beam lithography machine, another comprising an entire 40,000-transistor speech-processing system.

Bell's latest accomplishments and plans for its MOS technology were detailed at the 1981 Gallium Arsenide IC Symposium held late last month in San Diego, Calif. Martin P. Lepselter, director of Bell's advanced-development laboratory, was asked to speak at the conference on behalf of silicon technology.

Bell's lightning-fast MOS devices look just like conventional field-effect transistors, except they are much smaller. Heavy use of two-dimensional computer simulations ensures that parasitic influences will not degrade performance. To resolve the 0.25-μm features, Lepselter's group has constructed a complete X-ray lithography system, including a compound mask and fast-acting triple-level resist to minimize radiation backscattering. The machine's latest improvement is an automatic wafer-feeding mechanism.

By paying particular attention to doping profiles, Lepselter and his colleagues have been able to fabricate MOS FETs that do not suffer from short-channel effects such as punch-through—a debilitating side effect to which such scaled-down devices are prone.

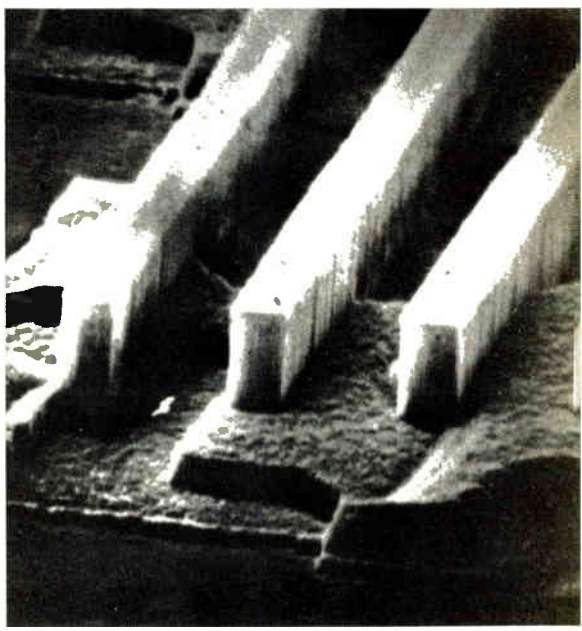
Ultrafast. With their 0.25-μm channels, the FETs switch in a remarkable 20 ps, a value that Lepselter contends will soon be halved. Whereas firms like Intel Corp. are producing commercial chips based on H-MOS-II (high-performance MOS) technology, Lepselter says his transistors "are around H-MOS-V." In fact, his calculations indicate that with theoretically perfect processing, the 0.25-μm FETs could switch in 4 ps—as fast as Josephson junctions.

Lepselter's comments raised considerable skepticism. Proponents of the GaAs technology submitted that his numbers were unrealistic because fan-out loading was not taken into account. Even with loading, however, Bell's FETs will switch in well below 0.5 nanosecond—more like 100 to 200 ps—says Lepselter, adding that with Bell's geometries, delay is so much a function of scattering-limited velocity that the choice of material—silicon or GaAs—is a moot point indeed, in his opinion.

The very fastest GaAs devices, the high-electron-mobility transistors built by Japan's Fujitsu Ltd., switch at room temperature in 30 ps with a fan-out of 1 [*Electronics*, Oct. 20, p. 73]. They run faster than Bell's silicon MOS FETs only when supercooled—and in Lepselter's opinion, supercooling is impractical for commercial VLSI chips.

Armed with their silicon picocircuits, the Bell researchers are now in the process of laying out VLSI chips. The speech processor will perform well enough for both synthesis and recognition functions.

Also slated is a VLSI circuit that will handle all control and processing in Bell's EBES-IV scanning-electron-beam lithography system. The chip will measure 1,150 square mils and dissipate about 1.5 watts. It will include a 5-bit digital-to-analog con-



GaAs' bane. Bell Labs uses x rays and reactive sputter-etching to make picosecond MOS circuits. The 1-μm metal stripes above rest on oxide and polysilicon.

Commercialization of GaAs is at hand

Gallium arsenide now promises to be a very profitable niche for a semiconductor house that delves into the technology, according to Fred A. Blum, founder of Gigabit Logic Inc., Culver City, Calif., a company dedicated to GaAs products. Moreover, he believes products can be produced in high volume quite soon.

"We have to stop talking about it and start doing something," he told the recent gallium arsenide symposium in San Diego. Blum's company intends to sell gate arrays, memories, and monolithic microwave GaAs circuits to computer, communications, and instrumentation equipment makers willing to pay extra for the higher-speed chips.

"Any one of these producers will gladly switch to GaAs devices to obtain a competitive edge," he declares. One maker of high-speed scientific computers he knows about, supplying some two dozen machines per year, could use about $45 million worth of high-speed digital chips, he says. Another $10-million market could develop for very-high-frequency marine radios, he continues. As many as 20,000 such radios are manufactured annually, each requiring from 4 to 10 90-megahertz, variable-modulus frequency dividers at about $50 each. That adds up to from 40,000 to 200,000 devices, or an annual market ranging between $2 million and $10 million. Altogether he foresees a $200 million market for GaAs integrated circuits by 1985.

Chips required for this market should not be difficult to produce, Blum says. He calculates a requirement of 60,000 processed 3-inch GaAs wafers per year and an average selling price per GaAs circuit of $50. This works out to 4 million devices.

If end-to-end yield is a conservative 10%, then 40 million dice must be manufactured. Further, assuming an average die size of 10,000 mil², 60,000 will have to be processed. Blum submits that this is a paltry number compared to silicon-chip volumes, leaving no excuse for the tardy commercialization of GaAs chips.

—John G. Posa

verter that can sample data at rates of 700 megahertz to 1.0 gigahertz with a nonlinearity less than 1.5%, resulting in a beam retrace time of less than 1 ns. Gates in the chip will operate from a 4-volt power supply and exhibit delays of 500 ps when driving 25-ohm loads.

Speech synthesis

Development systems add in-house voice

Buyers of voice chips and systems will soon be able to talk about how much easier it is to build electronic equipment that speaks for itself. Their suppliers are introducing development systems that allow them to produce the vocabulary for speech units in house, rather than outside at the vendors' speech development centers.

Last week, Texas Instruments Inc. announced a new development system, and another major speech-chip vendor, General Instrument Corp., promises one for December. In addition, shipments have started for a development tool from Centigram Corp., a speech-system vendor.

There is a desire for such systems because of the proprietary nature of products and vocabularies, says Sharon B. Crook, product strategy manager for TI's speech-technology operation, Midland, Texas.

This idea is echoed by Murray Duffin, vice president of product management at GI's Microelectronics division, Hicksville, N. Y. "We are now finding that flexibility and the ability to paddle their own canoe are major concerns," he says.

In addition, some users are concerned that speech-chip vendors will be unable to handle vocabulary development once business surges.

Both ways. TI is unveiling for its major speech-chip customers what appears to be, in both price and capabilities, the Rolls-Royce of development systems: it can generate vocabularies from either keyed-in text or a human voice. Other systems handle one or the other.

The system generates the parameters that can be stored in erasable programmable read-only memories, needed to drive TI's TMS5100 and TMS5200 families of speech-synthesis processors, which rely on linear-predictive-coding (LPC) techniques. Inputs are converted into phonemes and then into allophones before being converted into LPC parameters. Phonemes are basic speech sounds; allophones are a larger set of basic sounds that take into account things like position and emphasis in a word.

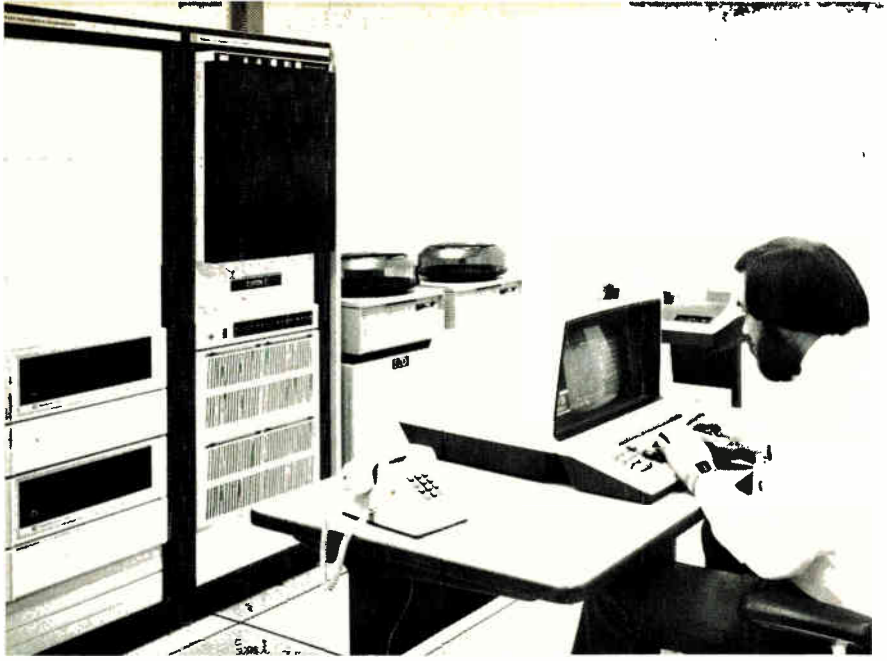
Sophisticated users—and TI expects many of its customers to hire linguists for the job—can enter and edit phonemes and allophones directly. In effect, the speech can be tweaked to sound even better as it moves from text to LPC.

TI's basic development system has two parts. One is the minicomputer-based Multiamplus development system that TI has offered for years. The other part is new—a data-collection processor that is an intelligent slave to the minicomputer and provides the analog interface required to collect and play back speech. TI quotes a total system price of $97,930.

Coming soon. In addition, GI will bring out software and an emulator based on random-access memory for its speech-chip customers this December. Initially, the software package will be compatible with the HP 1000 and Digital Equipment VAX computers, but GI plans to expand this list early next year.

For GI's system, after a human voice has been compressed and placed on a disk, the host computer analyzes the data and produces the speech code that is downloaded into the emulator box. After speech has been edited and is of acceptable quality, the vocabulary can be burned into E-PROMs.

These E-PROMs can then be plugged into GI's new $200 Speech Field Development 2000 board,



Speech maker. The development system from TI includes magnetic tape and 50-megabyte disk drives, a 256-K core memory plus an interface to collect and play back speech.

which emulates its SP256 speech system—the chip set the customer will eventually use. Hardware alone will cost about $3,000; for software, a figure is yet to be set.

LISA. Centigram's speech development system, VoiceWare, helps develop vocabulary for its LISA (logically integrated speech annunciator) voice-synthesis terminal. The Sunnyvale, Calif., firm began shipping it last June. The $30,000 system includes a cathode-ray-tube terminal with a floppy disk and a 5-megabyte 5¼-in. Winchester disk drive, a voice digitizer, and a board version of the LISA terminal. Customers can digitize and compress human speech in real time using LPC and parametric waveform coding. By the end of the first quarter of 1982, Centigram president Gerard Currie expects to add personality modules to VoiceWare to support various makers' speech-chip sets.

Another voice-system vendor, the Votrax division of Federal Screw Works, Troy, Mich., reports that sales are brisk for its CDS II text-conversion development system [*Electronics*, Feb. 10, p. 118], and the CDS III. **-J. Robert Lineback**

Radar

Former Navy freighter sails off with the latest in phased arrays

A 30-year-old former U. S. Navy freighter is getting a new lease on life as a platform for the latest in operational phased-array radar. To be operated by Raytheon Corp., the Observation Island will sail for the western Pacific later this year to put the Cobra Judy (AN/SPQ-11) radar system on station.

The ship is unarmed and will make no attempt to hide its mission, which is to help monitor Soviet ballistic-missile flights in connection with the strategic arms limitation agreements. Cobra Judy will operate in conjunction with another Air Force phased array, the Aleutians-based Cobra Dane radar.

Cobra Dane, in operation since 1977, is best situated to watch for missiles during their initial and intermediate launch phases. The curvature of the earth prevents it from monitoring the final flight stages and this is where Cobra Judy, specially designed for tracking reentering space vehicles, comes in.

A project of the Air Force's Electronic Systems division, Hanscom Air Force Base, Mass., Cobra Judy sits in a 250-ton turret that can rotate 270°. The four-story-high turret contains all the equipment for the high-power S-band radar, including the waveguide and coaxial equipment in the microwave portion of the system that handles many kilowatts.

Phase-shifting the array's 12,288 elements is accomplished with programmable 8-bit p-i-n diode phase shifters. These shifters can tailor both rows and columns in the array and shift phase in 45° increments.

Classic microwave component design was used for Cobra Judy. For example, duplexing is performed by passive-waveguide magic tees, 30 years old in concept, instead of by newer semiconductor devices. In addition, water-cooled traveling-wave tubes energize the 22.5-foot-diameter antenna that can be stabilized independently of the ship's motion.

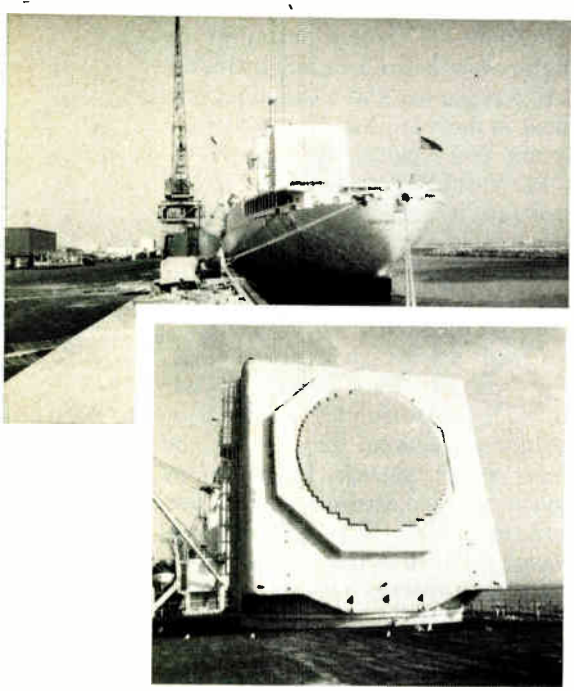
Processing. A digital signal-processing system generates some of the information to help radiate, steer, and shape the beam to maximize the returned information and analyze the returns, says Richard Daly, signal-processing department manager of Raytheon's Radar Systems Laboratory, Wayland, Mass.

The digital system provides the filtering and fast Fourier transforms for maximizing the signal-to-noise ratio and remove interference. It also helps the radar system to determine the number of missiles, their velocity, range, and bearing.

According to Daly, the processor system's design is state-of-the-art as of 1979, and getting it into operation in only two years "is a notable achievement. A lot of the Cobra Dane work helped us on the Cobra Judy project," he says.

Hardwired. The signal-processing system is hardwired although it is under control of the overall Cobra Judy computer. Resident program software-controlled processors were not sufficiently developed to be included at the time the design was frozen, Daly explains.

Typical of the system's signal-processing paths is one with a 50-megahertz radio-frequency bandwidth that accommodates a two-channel stream of information. The coherent channels in phase quadra-



Watch out. The 22.5-ft.-diameter antenna of Cobra Judy's phased-array radar (close-up) dominates the stern of an ex-freighter, the Observation Island.

ture are converted to digital data streams with a 20-bit precision.

In actual processing, a digital FFT capability can handle up to 8,000 points in a single transform calculation. Calculations are done in a pipeline mode for maximum speed by a series of 13 two-point transform modules in series. They multiply complex numbers using parallel 5-MHz multiplier chips from TRW.

The analog-to-digital conversion is performed at the system's intermediate frequency, and the quadrature channels generated are detected by phase-matched detectors. The whole Cobra Judy show is run by a Cyber computer from Control Data Corp. with assembly-language software from the IBM Federal Systems division. **-Harvey J. Hindin**

Peripherals

Video recorders set to back Winchesters

Despite its high storage capacity, the video-cassette recorder is not widely accepted as a backup for Winchester-disk drives because of a high error rate. But by recording data redundantly, Alpha Microsystems hopes to overcome that obstacle and popularize the VCRs' use.

The Irvine, Calif., maker of small-business systems will formally unveil its AM-610 VCR-interface controller board this week at the Comdex data-processing-equipment show in Las Vegas. With the 610, which has been under development for three years, users can store 100 megabytes on a four-hour cartridge using nearly any standard VCR.

Alpha Microsystems claims that by recording each block of data six times, the error rate is comparable with that of a Winchester, about 1 in 10^{-13} reads. Data is recorded in blocks, with six copies of block 1 followed by six of block 2, six of block 3, and so on, rather than a full recording of the entire file followed by another full recording.

Low cost. One of the hopes for the unit's success is based on its price. VCRs cost about $500 to $600 and the firm's controller lists for $600 to $1,000, putting the total cost slightly below ¼-inch cartridge streamers with only 20-megabyte capacity. Additionally, the media sells for $15 to $20, also slightly less than streamer cartridges, the firm says.

The 610 is Z80-based with 4-K bytes of static random-access memory and 2-K bytes of programmable read-only memory, which holds the microcode. The microcode handles data retrieval and checks for error-less blocks of data using a cyclic redundancy check.

The transfer rate from disk to tape is 600 kilobits per second. But for both recording and playback, the tape requires its specified time from start to finish—four hours to completely fill a four-hour tape. Since this is a relatively slow transfer rate during which the computer must be dedicated to the task, Alpha Micro advises setting the timer on the unit to the system's internal clock and performing the backup at night when the system is unused.

In the event of disk problems, retrieval of the data is also time-consuming. Operating at the VCR's standard speed, it could take four hours to locate a file near the end of a tape. The firm is currently revising its software to take advantage of fast-forward found on most VCRs.

Product manager Rich Oliva feels "people will come over in droves once they see that it works." He predicts that 70% to 80% of the firm's small-business-system sales will include the VCR as a backup device next year.

Detractors. Ray Freeman of Freeman Associates, a Santa Barbara, Calif., research firm specializing in disk and tape products thinks otherwise. "Our conclusion is that the VCR is not well-suited to backup requirements. It's too big and the transfer rate is too slow."

Actually, Alpha Micro is not first with a VCR as a disk backup. Corvus Systems Inc., San Jose, Calif., introduced in late 1979 as its second product the $750 Mirror, a similar controller for VCRs. The firm now sells VCR backups for about 40% of its disk subsystems and recommends four redundant tapings.

Corvus finds acceptance is as yet lacking. "We still have to prove its reliability, even though it has been successful," says chief engineer Bruce Eisenhard. **-Terry Costlow**

Local networks

Interfaces let users mix network gear

Some of the first hardware that lets equipment from different manufacturers be interconnected on a local network will also be shown this week at Comdex in Las Vegas by a company called the Destek Group. Usually, local network hardware is developed by equipment makers for their own equipment, but several firms have announced they are developing so-called universal interfaces that cut across proprietary lines [*Electronics*, July 28, p. 97].

Destek says any combination of up to nine processors and peripherals

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can be tied into any of the four popular interconnection media—coaxial or twisted-pair baseband, rf-modulated broadband, fiber-optic, or conventional telephone lines. The job is done for each device with a combination of custom software packages and a Z80-based interconnect board that sells for $795. Up to nine such boards plug into a $1,500 switching box that supplies power and ties into the network. The boards can also plug directly into an S-100 computer backplane.

More boards. Destek's initial interconnect board in what it calls its NIB-1000 family is designed for the S-100 bus, but boards for other buses are planned. Up to 4,608 devices can be connected to a network. The speed of the network can range from 2 megabits per second for the baseband media up to 20 Mb/s for the fiber-optic.

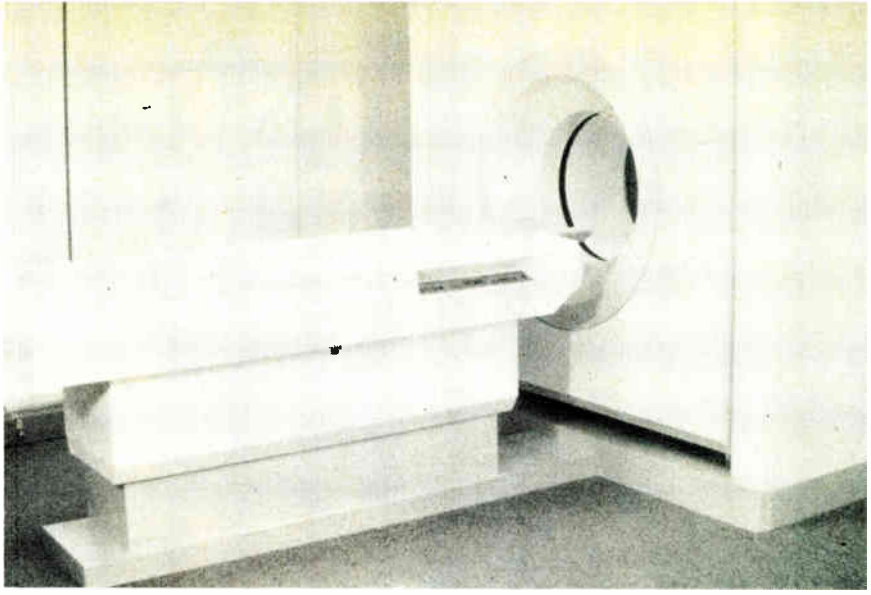
The system will support a range of interconnect protocols, including asynchronous schemes (like Ethernet, for example), Synchronous Data-Link Control (SDLC), High-Level Data-Link Control (HDLC), and Advanced Data-Communications Control Procedure (ADCCP).

Destek, in Mountain View, Calif., was formed in 1980 primarily to develop software products for microsystems. It is working on systems software that allows existing software bases, like Bell Laboratories' Unix or Digital Research's CP/M, to execute on all the popular microsystems, instead of on just those designed to use them. Thus, eventually, Z80 code developed in a CP/M environment could execute on an 8086 microprocessor running under Unix. **-R. Colin Johnson**

Medical

Body scanners get new entries

Though sluggish for the past four years, the U. S. market for computerized-tomographic scanners is attracting new product entries, including one from a company just startng up in the business. The design team at Interad Systems Inc., Schaumburg, Ill., comes replete with experience gained at companies that did not survive the recent CT makers' shakeout—Searle CT Systems and the company that acquired it and was later acquired in turn, EMI Ltd.



Radiator. A computerized-tomographic body scanner being readied for market by Interad Systems rotates X-ray tubes and detectors (in vertical housing) around patient.

But with tailor-made knowledge and lower overhead than its larger, established competitors, Interad comes to market with a much cheaper body-scanning system. According to company president G. H. (Bill) Williams, his new entry matches the performance of top-of-the-line systems like the CT/T 8800 from General Electric Medical Systems and the Somatom II from Siemens, yet sells for $475,000, some 30% to 50% less. The machine offers a choice of 3-, 6-, or 12-second scan times and resolution of 1 millimeter.

Rotation. Like most other high-performance systems, the Interad system employs a rotate-rotate design in which the X-ray tubes and detectors are fixed in the same assembly and rotate in unison around the patient. The relatively low cost, says engineering vice president David Peerenboom, was achieved by "designing out a lot of the extra costs that have been in CT scanners in the past."

For example, the Interad system architecture delegates its data-processing tasks to a 32-bit array processor and employs its central processing unit only as a data and device manager, Peerenboom notes. This design permits an LSI-11/2 microcomputer to be used as the system's chief processor instead of the more costly general-purpose minicomputer used in traditional scanner designs that typically split processing tasks among the CPU, the array processor, and a dedicated subsystem known as the back projector.

New array. The MSP-3000 array processor used in the Interad system is a new product supplied by Computer Design & Applications Inc., Newton, Mass. It contains a built-in display processor as well as an operator keyboard, eliminating the need to purchase these components separately, Peerenboom points out.

In addition, the Interad system uses an 80-megabyte, 8-inch Winchester disk drive from Scientific Microsystems Inc., Mountain View, Calif., a less costly alternative than the removable hard-disk peripherals typically employed. In all, Peerenboom estimates, the Interad approach allows about $40,000 worth of computing power to do the job of a more traditional architecture with about a $90,000 price tag.

Other significant cost savings were made by simplifying the mechanical gantry and patient-handling systems. Scheduling first deliveries for 1982's first quarter, Interad is aiming at smaller hospitals and clinics that have not been able to justify the $800,000-to-$1-million cost of current high-performance scanners.

Interad intends to control the cost of its service operation initially by clustering its early scanner sales in

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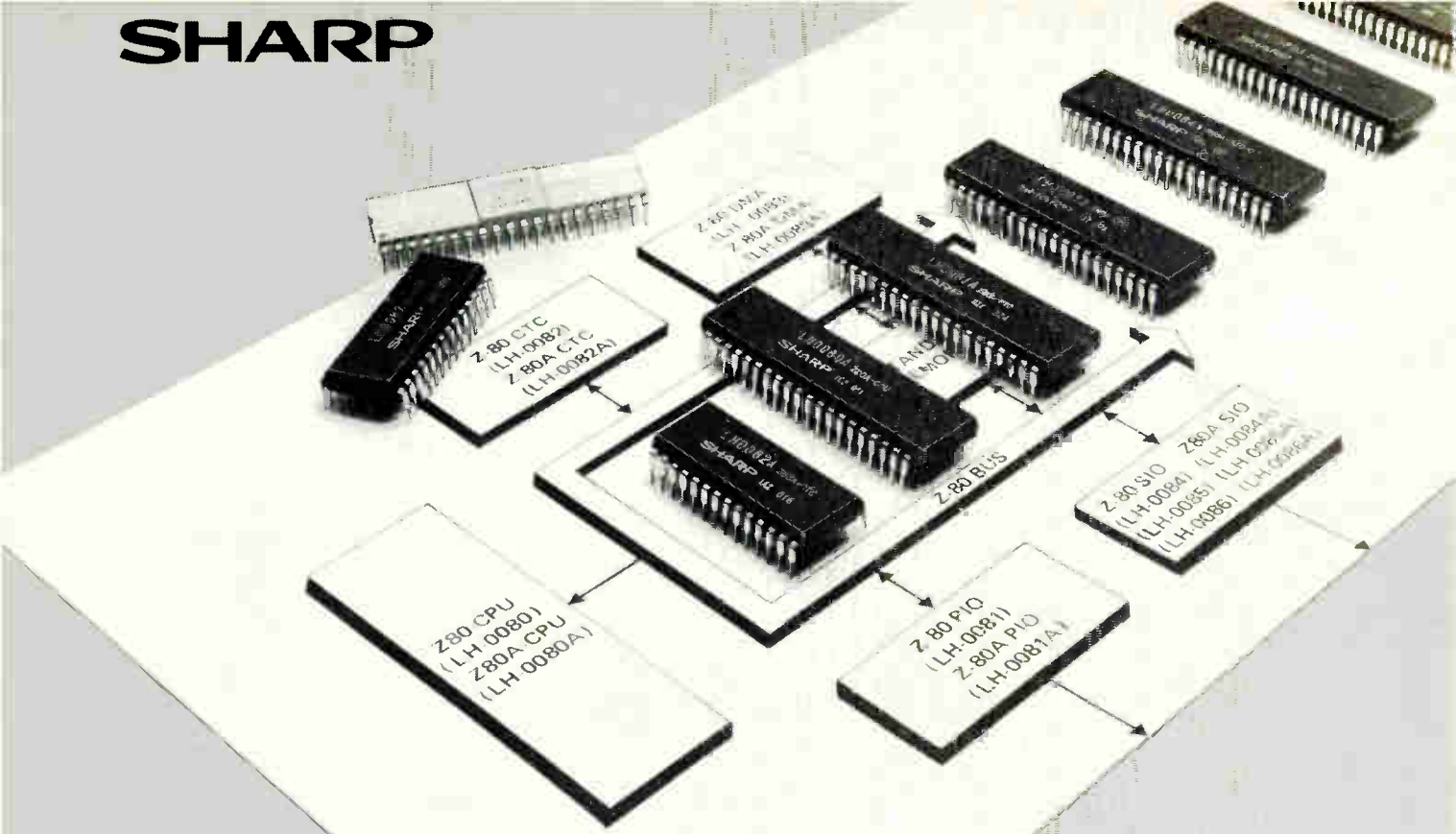

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RAM Capacity	96 × 4 bit	80 × 4 bit	128 × 4 bit	160 × 4 bit + 16 × 2 bit	96 × 4 bit + 24 × 4 bit	72 × 4 bit + 20 × 4 bit
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the Midwest near the firm's Schaumburg offices, Williams says. Plans call for third-party service organizations elsewhere later.

Another. Interad unveils its scanner this week at the Radiological Society of North America's 67th annual meeting in Chicago. Also dropping price at the meeting is Toshiba Medical Systems' TCT-80A, which was introduced this June at a Brussels trade show.

With a base price of $650,000 that includes a multiformat camera for putting cathode-ray-tube images on hard-copy film, the TCT-80A undercuts the price of the company's 2½-year-old TCT-65A by some $200,000.

Given the extensive history of firms that have tried and failed in the CT-scanner business, few observers are willing to place much hope in Interad's chances for success. But most do agree that the small-hospital sector is potentially fertile ground.

Out of some 7,200 U. S. hospitals, about 5,800 maintain fewer than 300 beds, says Kenneth W. Marich, senior health-industry consultant for SRI International, a Menlo Park, Calif., a research and consulting firm. These smaller hospitals, together with about 4,400 U. S. medical clinics and group practices with over three doctors, could all be potential buyers. **-Wesley R. Iversen**

Military

Stealth R&D moves ahead

The Air Force is proceeding with a program to develop radar-absorbing materials and radar-absorbing structures, called RAM/RAS, for its Advanced Technology Bomber that is popularly known as Stealth. Meanwhile, debate within the service and the Congress continues over whether the nation can simultaneously fund the advanced bomber-fighter for the 1990s as well as Rockwell International's near-term B-1B.

Northrop Corp. has been named

News briefs

Personal-computer maker undergoes change

With a name change and new business strategy, Ohio Scientific Co., acquired a year ago by M/A-Com Inc., is signaling a major thrust at the small-business computer market. Soon to be renamed M/A-Com Office Systems Inc., the company under William Chalmers, who became president last July, is organizing its product line in ranges that include the C100, a personal computer retailing for about $3,400; the C200, a family of three systems aimed at single-user small-business applications priced between $4,000 and $8,000; and, at the top, the C300, with three machines based on a Winchester disk drive offering multiple-user and full-networking capabilities priced between $10,000 and $20,000.

One of the earliest personal-computer manufacturers in the field, OSI is now being positioned to serve the microcomputer market, with major emphasis on value-added systems makers as major customers. According to Chalmers, future plans include single-user office work stations for connection to office- and business-communications networks, such as Macomnet, a wideband digital-communications network for voice, data, and video being developed by M/A-Com. The network uses satellite, microwave, coaxial-cable or fiber-optic links to provide intracompany communications or access to data banks.

Major growth measured in factory sales last year

U. S. shipments of electronic equipment, systems, and components totaled approximately $104 billion in 1980, representing a growth rate of 18.5% over 1979's $81 billion, according to data released in the Electronic Industries Association's 1981 Market Data Book. The data book also reports that more than 1.5 million U. S. residents were employed in electronics manufacturing in 1980, and employment in U. S. electronics industries grew by an estimated 7%. This growth compares with a rate of 0.5% for overall U. S. nonagricultural employment.

R&D laboratory established by Sony in U. S.

Sony Corp. of America will establish a consumer-electronics laboratory to concentrate on future product development and adaptation. Sony Consumer Electronics Laboratories, Paramus, N. J., will be a division of Sony Corp. Kenji Tamiya, executive vice president of the parent company, says the lab will conduct research, development, and design work with particular emphasis on technology emerging in the U. S. Included will be cable-TV systems and terminals, receivers for direct satellite broadcasts, and home-information systems and terminals. Products that are developed will be sold in the U. S. and abroad.

Transponders sold on upcoming Comsat by auction

In an approach yet to gain Federal Communications Commission approval, RCA American Communications Inc., Princeton, N. J., auctioned off seven transponders on its yet-to-be-launched communications satellite for a total of $90.1 million. More than 50 bidders participated in the sale at New York City's Parke-Bernet Galleries, better known for auctioning art works than electronics.

The event marked the first time that leases for transponders on a communications satellite—in this case, RCA Americom's Cable Net 2 Satellite, Satcom IV, to be launched Jan. 12—were offered by auction. Bids ranged from $14.4 million down to $10.7 million. They will be applied monthly against lease payments for the transponders beginning April 1982 and continuing through 1988. Full bid payments must be made in mid-January and will represent some $20 million more than RCA Americom could have gained under rate schedules now in effect. Andrew F. Inglis, president of RCA Americom, notes that the auction reduces the opportunity for speculators to obtain transponder rights, then resell them for substantial profit. The bidding underscores the current heavy demand for transponders.

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SHARP Liquid Crystal Dot Matrix Display Unit offers ...

5 x 7 DOT MATRIX ALPHA-NUMERIC

- Clear Characters • Wider Variations
- Reliability under stringent temperature ranges.
- Compatible interface with TTL and CMOS
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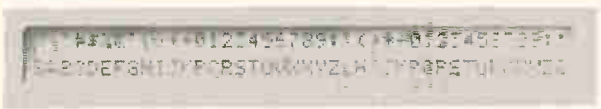
- +5V ~ 7V single power supply.

Now SHARP makes the readout easier to see and greater versatility available by adding 40 and 80 alpha-numeric Dot Matrix Display unit with 5 x 7 dot.

LM-24102

LM-40201



LM-80101

SHARP'S 5x7 DOT MATRIX LCD UNIT

Parameter	Character number (character x line)	Unit outline WxHxD (mm)	Character size WxHxD (mm)	Supply Voltage (V)
* LM-06151	6 Character. 1 Line	60x40 x14.5	4.8x7.5	+5,
* LM-14151	14 Character. 1 Line	93x47 x13.5	2.65x3.75	+5,
LM-24102	24 Character. 1 Line	175x46 x12	3.3x5.05	+5, −5
* LM-24151	24 Character. 1 Line	174x51 x13.5	3.3x5.05	+5,
LM-40101	40 Character. 1 Line	175x45.4x15	2.32x3.28	+5, −5
* LM-40151	40 Character. 1 Line	177x46 x13.5	2.32x3.28	+5 −5
LM-40201	40 Character. 2 Line	230x50 x15	3.4x4.8	+5, −5
LM-80101	80 Character. 1 Line	310x90 x12	2.32x3.28	7V−13.5V

* Select the character combination appropliate for the number of lines required for the read out.
• All types (except LM-06151) can display cursor lime (5 dots)

Driver ICs also ovalable.

LH-5001
LH-5002
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Electronics review

prime contractor for the ATB if the bomber is produced. Lockheed Aircraft is working on a fighter version using Stealth technology and called AFT. Yet another, lower-cost concept is surfacing from Grumman.

The Air Force's Wright Aeronautical Laboratories' Materials section in Dayton, Ohio, says it wants responses by Nov. 22 from potential RAM/RAS developers for two independent efforts. One calls for developing weaving techniques for the materials similar to those used for textiles and incorporating epoxy composites locally for use in RAS.

The other effort seeks design and fabrication concepts for the leading-edge structures that balance the attenuation of radar signals with such mechanical requirements as structural efficiency, damage tolerance, and resistance to lightning strikes and weather erosion.

Costs. Present Air Force cost estimates for the Stealth program put its development at more than $10 billion. Based on projected deployment beginning in 1989, production costs for the bomber alone could raise the total to more than $25 billion in current dollars. Production costs for 100 of Rockwell's B-1B, exclusive of weapons and life-cycle support, are now projected at $35 billion to nearly $40 billion by the Congressional Budget Office. The latest escalation is far above the $12 billion estimate the Air Force got from the contractor early this year and the source of concern as to whether the nation can afford both programs.

Compounding the dispute over two-bomber economics was the reputed leak by Grumman Corp., Bethpage, N. Y., that it is exploring a low-altitude ATB concept that purportedly would be more cost-effective than Lockheed's high-altitude approach. Long regarded as a Navy aircraft supplier, Grumman reportedly employs a delta wing mounted above the fuselage with two tail fins canted outward at 42° from the vertical. Missiles mounted internally would be launched from an opened housing atop the rear of the fuselage, thereby eliminating radar detection of externally mounted munitions.

Radar-absorbent graphite epoxy composites would also help shield the engine inlet mounted flush under the fuselage. A synthetic-aperture radar, mounted forward in the fuselage and covered by a movable shield of radar-absorbent material, could be uncovered for target acquisition and terrain-following maneuvers.

The Air Force made no official comment on Grumman's plan. One source described it as "a company sending out a signal to see if it gets any response." **-Ray Connolly**

Packaging

Pin count hits 40 in small package

The Dutch seem to be taking up the slack from U. S. companies when it comes to upping the pin count in the relatively new small-outline integrated-circuit (SOIC) packages. Philips Industries' Electronic Components and Materials division, Eindhoven, the Netherlands, is now supplying devices in 24-, 28- and 40-pin configurations.

Such packages offer considerably more pins than those being supplied by Signetics and Motorola [*Electronics,* Sept. 22, p. 39]. These companies supply devices in 8-, 14-, and 16-pin packages, relegating 20-pin types to the "under consideration" department. Most American companies take the view that at above 20 pins, plastic chip-carriers with leads on 50-mil centers make more effi-

Mighty mite. Philips' 40-pin small-outline integrated-circuit package, with leads on 30-mil centers, has 85% less surface area than the standard 40-pin dual in-line package.

cient use of space than the rectangular SOIC shape.

Philips also supplies ICs with the smaller numbers of pinouts. Normal lead spacing is 50 mils, but the SO-40, which is the same size as the 24-pin SO-24, has its leads on 30-mil centers. Its size— 0.610 by 0.300 inch—offers a reduction in surface area of 85% compared to the common 40-pin dual in-line package, which measures 2 by 0.600 in. (see photograph, p. 46).

Philips has willingly sacrificed standardization in lead spacing to reduce the overall length of the SOIC package. It should be suited to thick-film hybrid circuitry, although designers used to the 100-mil grid of printed-circuit boards will not be overjoyed with its 30-mil spacing.

Philips, whose SOIC-packaged products are marketed in the U.S. by Signetics in Sunnyvale, Calif., already uses the new packages for several complementary-MOS large-scale integrated products. In the SO-28, Philips has a C-MOS liquid-crystal–display duplex driver for a 40-segment LCD. In the SO-40s, there are duplex drivers for 60- and 64-segment LCDs and a four-digit LCD automobile-clock. **-Jerry Lyman**

Peripherals

Dot-matrix printer 'hues' the line

Color and graphics from a dot-matrix printer listing for less than $2000? Formerly unheard of, say spokesmen for Integral Data Systems Inc.—but unheard of no longer with the Milford, N.H., firm's forthcoming Prism printer.

The new system will not only produce normal black-on-white alphanumerics but four-color output and graphics, too. Further, IDS says that it will have shipped tens of thousands of them by February. Ink-jet color printers in this market have generally sold at prices ranging from $5,000 to $9,000.

Prism is the first of a new, modular, dot-matrix printer line to emerge

from IDS, which plans to market it aggressively through retail outlets. Not only will it have the usual RS-232-C and "Centronics-compatible" parallel inputs, but special graphics and driver modules will be offered to give specific personal computers, like the Apple II and III, color and graphics capability. One also is due for IBM's Personal Computer.

Stripes. The Prism simply takes the old idea of a red-black typewriter ribbon and divides it up into four stripes of color—a choice of cyan, magenta, yellow, and black, or of red, blue, yellow, and black. Substituting one ribbon for the other—they are being produced especially for IDS—varies the tints and shades.

In operation, the ribbon is positioned with the desired color stripe between the print head and the paper. Several high-speed passes back and forth across the paper will generate the colors. The approach is similar to the method used for printing color in newspapers, although resolution is far higher.

The printer's standard features include proportional spacing, boldface, and character densities of 10, 12, or 16.7 characters/inch. At 10 characters/in., the system prints out 132 columns on standard 15-in.-wide paper; the other pitches yield up to 220 columns per page. Four different character sets can be stored in read-only memory.

Prism also includes a high-speed capability allowing printouts at speeds exceeding 200 characters/second; in its normal, or correspondence-quality mode, speed is 150 character/s with the system printing bidirectionally.

It will be possible next year to buy the Prism one module at a time, starting with either an 80- or 132-column basic black-on-white printer, and adding capabilities as time and budget allow. Modules will add a graphics capability, higher print speed, higher resolution, buffer memory, and color. The prices for starter printers still would be higher than those for many of IDS's current products, at just under $1,000 and $1,300 for 80- and 132-column models respectively. **-James B. Brinton**

SSC-155™

SUPERSILVERCOPPER

WHEN YOU NEED MORE THAN COPPER

MORE THAN COPPER?

We identify SSC-155 SuperSilverCopper as a material that deserves your consideration when you need more than copper. Granted, we may be setting the stage for endless semantic arguments . . . or metaphysical arguments for those who want to debate on a loftier level. Is SSC-155 copper or isn't it?

Yes, it is copper. But it is a silver bearing copper to which magnesium and phosphorous have been added. The result is a material with a combination of properties so dramatically elevated over ordinary copper that it could well be considered an entirely different material.

In product bulletins like this one, we will periodically present information about SSC-155, what is currently being achieved with it, and what could be achieved with it.

Chemical Composition

One atom of silver to 5,000 of copper make the big distinction in silver-bearing copper. In SSC-155 it's ten ounces of silver per ton of material that create the SilverCopper matrix to which stoichiometrically determined amounts of magnesium and phosphorous are added.

Element	Nominal Weight %	Range Weight %
Cu+Ag	99.80	99.75 min.
Ag	0.034	0.027-0.10
P	0.058	0.040-0.080
Mg	0.11	0.080-0.13

Physical Properties

Electrical Conductivity ..... 94% IACS; 86% minimum guaranteed
0.504 Megmho-cm @ 20 C

Thermal Conductivity .... 0.83 cal/cm²/cm sec/C
200 Btu/sq ft/ft/hr/F (@68F)

Coefficient of Thermal Expansion ..... 20C to 100C—17.7 x 10^{-6}/°C
68F to 212F—9.8 x 10^{-6}/°F

Density ..... 8.91 g/cm³ (0.322 lbs./in³)

Specific Heat ..... 0.092 cal/g/°C (@ 20C)
0.092 Btu/lb/°F (@ 68F)

Liquidus 1980F (1082C)

Magnetic Permeability ..... Less than 1.002 gauss/oersted

Modulus of Elasticity ..... 11.7 x 10^4 MPa
17.0 x 10^6 psi

Modulus of Rigidity ..... 4.4 x 10^4 MPa
6.4 x 10^6 psi

A Unique Combo

There is an adage in marketing that cautions, "Tell me less of how it came to be, and more of what it will do for me." With that in mind we'll simply state that SSC-155 was developed after extensive research by Copper Range Company, and it delivers to the user this combination of properties unmatched by any other material:

STRENGTH

Strain-hardenable to a range of 40,000 to 80,000 psi (276 to 552 MPa)

THERMAL SOFTENING RESISTANCE

Resistance to softening superior to any commercially-available copper with conductivity better than 80% IACS

ELECTRICAL CONDUCTIVITY

94% IACS; 94-86% IACS depending on temper

THERMAL CONDUCTIVITY

Superlative Thermal Conductivity of 0.83/cal/cm²/cm/sec/°C

DUCTILITY

Extremely formable by drawing, bending, stamping and other operations

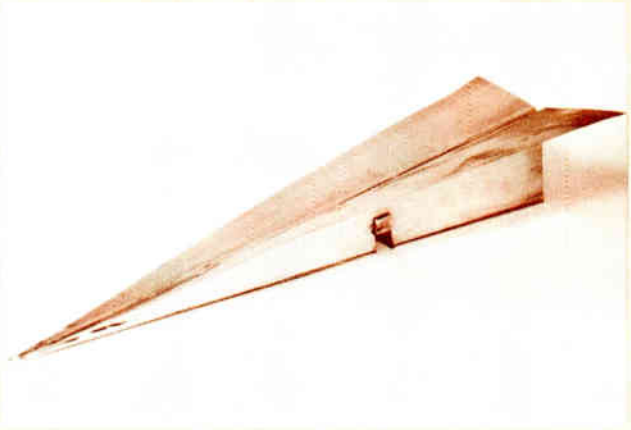
VALUE INDEX

Highest combination of mechanical strength and electrical conductivity at a lower cost than all commercially-available coppers and copper alloys

Excellent Ductility

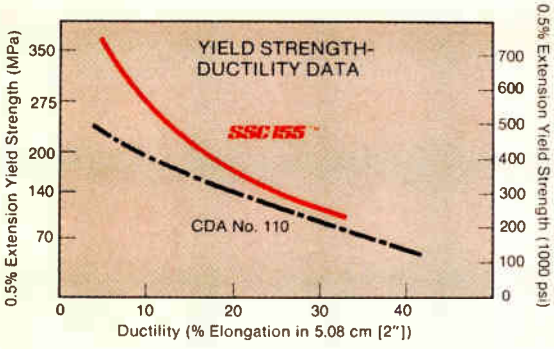
The fine-grained structure of SSC-155 lends excellent formability during drawing, stamping, bending and other tests of ductility, shown here in graphs and in the type of folded "airplane" made by bored students and office workers.

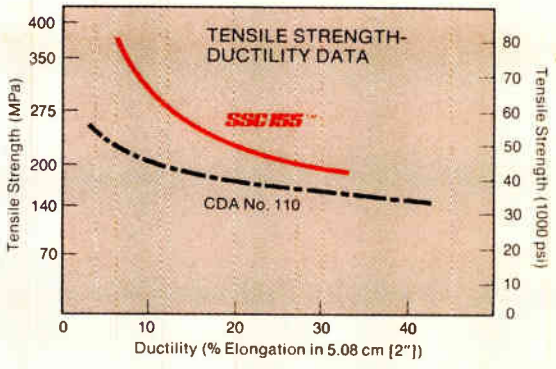
The oxygen-free nature of SSC-155 also permits processing of formed parts in hydrogen or other reducing atmosphere without degradation. And parts can be readily plated when desirable, without poisoning the bath.



Multiple-Bend Requirements

The combination of excellent ductility and fine-grained structure makes SSC-155 an ideal material for complying with the most demanding multiple bend requirements, especially for electronic lead frames.



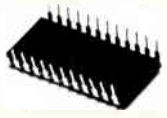


Product Applications

Electronic

The 24 pin Dual-Incline Package illustrated is used in a variety of computer-on-a-chip modules, resistor arrays, capacitor networks and other demanding functions.

Hussey's SSC-155 provides strength/stiffness for automatic insertion requirements, the ductility for multiple bend requirements and the thermal/electrical conductivity needed for highest performance.



Electrical/Mechanical

SSC-155 provides a unique combination of electrical/thermal conductivity, strength, thermal softening resistance, and ductility properties that permit component miniaturization resulting in highest performance at maximum cost efficiencies.

An example of Hussey's SSC-155 versatility is the contact switch and clip parts illustrated below. These parts are incorporated in automotive cruise control where consistent performance is a must.

Contact Hussey:

If you'd like additional information or samples of Hussey SSC-155 or you'd like to discuss your application with a Hussey Representative, call Jim Michel at (412) 766-5101, or write to Hussey/Copper Range, Leetsdale, PA 15056.

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Washington newsletter

20% fewer engineering schools accredited . . .

Contributing to engineering manpower problems is a drop of 20% in the number of fully accredited college and university programs at the end of the last academic year—to about 50% from the prior year's 70% approval rate. Disclosure of the decline in programs accredited for a full six years by the New York–based Accreditation Board for Engineering and Technology came during **congressional hearings by the Joint Economic Committee on the U. S. engineering shortage** (see p. 96). ABET, an autonomous organization supported by the nation's major professional societies, does not deny the previously unpublished report but had no immediate formal comment on its latest findings. They were made known to the Congress by Southern Methodist University's F. Karl Willenbrock while testifying on behalf of the American Electronics Association in early November.

. . . as faculty shortages spur industry action

A four-pronged program to alleviate the growing shortage of U. S. engineering faculty is beginning at the American Society of Engineering Education **using funds provided by eight major corporations**—American Telephone & Telegraph, DuPont, Exxon, General Electric, General Motors, General Telephone & Electronics, International Business Machines, and Union Carbide. Project director is John W. Geils, an AT&T engineering director who is on loan to the ASEE for the first year of the two-year effort, funded at about $100,000 a year. Goals of the program are to (1) collect relevant data to build an accurate and adequate data base on the faculty shortage; (2) develop with industry a viable plan of action for a solution; (3) work with industry, Government, and universities to implement the plan; (4) coordinate the activities of other industrial and association efforts toward that solution.

World trade system for components to start Jan. 1

A new international quality-assessment system that could affect $40 billion in annual world markets for electronic components will go operational on Jan. 1, 1982, the Electronic Industries Association reports. Known as IECQ, for International Electrotechnical Commission Quality Assessment System, it currently has 21 countries participating in it and **is designed to promote world trade in components by giving purchasers the option of relying on IECQ certification** that a product meets a design specification [*Electronics*, Nov. 10, 1977, p. 50]. By U. S. Commerce Department estimates, $26 billion of the 1980 market of $40 billion was in international trade. The EIA, the driving U. S. force in the 10-year development of the IECQ system, says U. S. participation will be managed by the Electronic Components Certification Board, which has scheduled a series of seminars on the system for Washington, D. C., on Dec. 1; Chicago on Dec. 2; and San Francisco on Dec.4.

Cost growth of 380% leads to death of tactical-radar project

Projected unit cost increases of more than 380% over the past year are what led to the House-Senate conference on the fiscal 1982 defense authorization to kill Sotas, the stand-off target-acquisition system being developed for the Army Electronic Research and Development Command by Motorola's Government Electronics division, Scottsdale, Ariz. Costs for the helicopter-mounted, all-weather radar system for detection of air and ground targets beyond the forward battle line **soared to $2.45 billion for 16 division systems from earlier estimates of $969 million for 24 systems,** the conferees report.

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Multilayer Ceramics.
The ultimate decouplers.

You'll find ITT multilayer ceramic capacitors almost everywhere. In sophisticated aerospace communications equipment; the new generation of digital telephone exchanges; home and business electronic gadgetry. All with one thing in common – the need for reliable decoupling capacitors.

ITT Capacitors pioneered multilayer technology and have continued to develop materials and processes to give product performance to match todays IC requirements. Low impedance and low inductance at high frequency are an integral design feature together with the high volumetric efficiency associated with multilayer ceramics.

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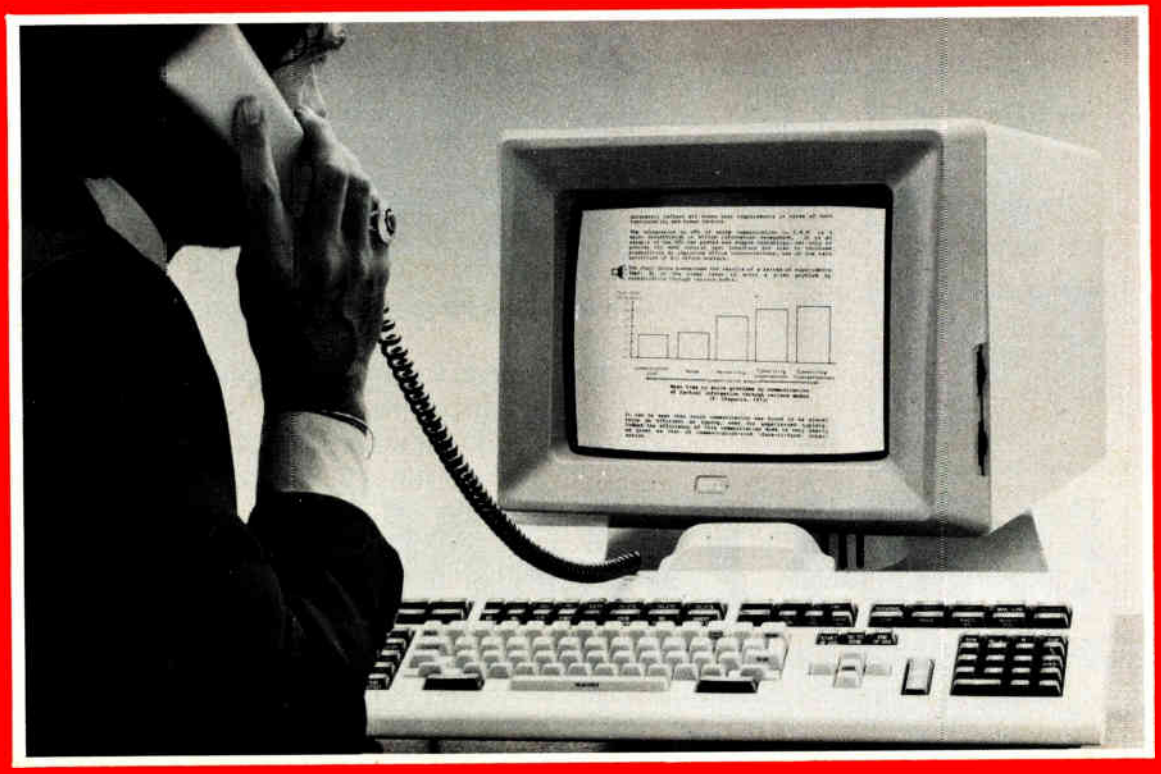
Components ITT

Nov. 17, 1981

Electronics International®

Cobalt-chrome magnetic disks pack in more data: page 67

In automated UK offices, people will annotate documents with voicegrams instead of scribbling notes in the margin: page 72



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Fred Molinari, President

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Circle 56 on reader service card

International newsletter

British Telecom to offer data service

Competition from impending digital data services, such as Cable & Wireless's national fiber-optic network, has brought a sharp response from British Telecom, to the effect that it will offer business users end-to-end digital data links over leased lines by 1982. Its Kilostream service will send data to small and medium-sized customers some four times faster than is possible with conventional modem links, for it **pipes a single 64-kb/s channel direct to the customer's premises over two conventional twisted-pair cables.** At the exchange up to 31 similar data-only channels are multiplexed to form a 2-Mb/s supergroup that interfaces directly with British Telecom's growing pulse-code–modulated network. Data-circuit termination and exchange equipment will be produced by Marconi Communications Ltd. under a contract likely to be worth about $14 million.

Digital standard in sight for world's TV studios

The multiplicity of analog standards at television studios around the world will give way to a single norm when TV production goes digital. A draft standard worked out by the International Radio Consultative Committee (CCIR) of the International Telecommunications Union should be adopted early next year at the CCIR's plenary session. The standard calls for **uniformly quantized pulse-code modulation of TV signals with 8-bit precision,** similar to the approach used for digital telephone transmission. The standard applies to studios only and will not affect transmitting stations or home receivers.

Two satellites to transmit to home TV sets in Europe

The European Space Agency's decision to implement its $423 million L-Sat project means that about 1986 two rival European satellites could be sending TV broadcasts directly to home antennas. First up in 1984–85 should be the Franco-German TV-Sat in fully operational form, whereas ESA's L-Sat, primarily an Anglo-Italian venture with participation from six European countries and Canada, will be a preoperational satellite.

L-Sat aims **to explore such advanced techniques as on-board switching between several spot beams**—one of which is steerable—and combining direct-broadcast and telecommunication transponders. Britain's $140 million share—announced this month—buys the British Aerospace group of companies a leading role, with Marconi Space & Defense Systems Ltd. in Portsmouth supplying the electronic payload. In its fully developed 7-kW form (the first bird will be 3-kW), it could handle five TV channels or one quarter of a million telephone channels. British Aerospace sees a market for 120 such systems by the end of the century.

NTT develops chips for computer systems

Sample chip sets for two 32-bit computer systems have been designed and fabricated at the Musashino Electrical Communication Laboratory of the Nippon Telegraph & Telephone Public Corp. Using p-well complementary-MOS technology on bulk silicon, the devices attain an average propagation delay time per gate of just 2 ns. The largest, which has 20,000 gates and dissipates 0.75 W, measures 1.2 cm square and is **sealed in a 208-pin square ceramic package 4.3 cm on a side.** It and two other chips will serve in a computer designed for NTT's on-line data-processing utility services, while another trio will be used in a multiprocessor electronic exchange. Tests of commercial systems of both kinds will start around the end of 1983.

International newsletter

Display processor for Antiope goes monolithic

Testing of the first samples of the single-chip video-display processor that Texas Instruments France is developing for Antiope, the French teletext system, is under way at the company's factory in Nice. The 11,000-transistor n-channel MOS chip is to go into production next year. **The third and last in the three-chip teletext set** for which TI France received research and development money from the French government, the display processor is designed to be driven by TI's 7040 8-bit microcomputer. Company officials boast that the device is fully compatible not only with the new European standard for alpha-mosaic videotex, but also with higher-quality alpha-geometric videotex systems such as the one being developed in the U. S. by AT&T. The former type addresses squares on the screen, the latter addresses points.

X.22 interface standard attracts wide attention

X.22, the new interface standard for meshing data terminals with data-communications equipment announced by the International Consultative Committee on Telegraphy and Telephony (CCITT), is being closely examined for use in circuit-switched data networks by the Swedish and West German postal and telecommunications authorities. Though no commercial products yet exist, telephone companies elsewhere around the world are also starting to explore X.22, which **allows up to 48 kb/s of multiplexed data to be sent over a single- or multi-point configuration** and which handles data terminal demultiplexing by framing information passed across the interface. Circuit switching of data is an alternative approach to packet switching, which is governed by the CCITT's X.25 standard adopted just this year by IBM and AT&T in the U. S.

NEC extending software services

Nippon Electric Co. is adding five new software subsidiaries to the five it already has. Two in Nagoya and Fukuoka will **make applications services more widely available** to general mainframe users. The other three will supply software for aerospace and radio communications, telecommunications systems, and new technology.

Racal makes bugs for British Army

High technology is being used by the British Army to snoop on out-of-sight troop and vehicle movements. The smart new bugs, developed by Racal-SES Ltd. in Windsor in collaboration with the Royal Signals and Research Establishment, Malvern, use seismic or infrared detectors to **distinguish between personnel, tracked, and wheeled vehicle movements** before transmitting their findings back to the base receiver in a brief 30-ms tone-coded burst. First deliveries to the British Army against a $1.5 million contract are for the Classic (for covert local-area sensor system for intruder classification) System.

Addenda

AEG-Telefunken has negotiated a licensing deal with Sydney Lamb, the American inventor of **associative memories, giving the West German company the right to manufacture and market them** on a worldwide scale. . . . Swiss watchmaker Omega of Biel will start manufacturing **the sophisticated optical step-and-repeat aligner developed by Censor AG** of Vaduz, Lichtenstein. Annual production of the Censor SRA-100 is targeted at 60 machines in the first year and a projected maximum of some 400 by 1985, each selling for $700,000 to $900,000.

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Can Eliminate ⅔ of your CRT Board

Today's word processing challenge. The Solid State Scientific SND5037/SND8002 CRT Controller System is the alternative for cost-effective CRT circuitry. The alternative that drastically reduces part count and offers extended capabilities as a totally user-programmable system. Together the SND5037 and SND8002 drive a wide variety of monitors to meet today's information processing challenge.

Take a look at the SND5037. The Solid State Scientific SND5037 is one of the fastest, most flexible, programmable, CRT controllers in the industry. The SND5037 provides the resolution needed in applications such as alpha-numeric terminals, point-of-sale systems, trans-action machines and PBX consoles.

And the SND8002 is the popular character generator that can be used in virtually all applications requiring character display. Features include an on-chip video shift register (various frequencies available), on-chip horizontal and vertical retrace, video blanking, four modes of operation, on-chip attributes and four on-chip cursor modes.

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Solid State Scientific

Circle 5 on reader service card

Make the most of your host with the lowest cost development tool available.

It's called RADIUS*. By using one with a host computer (any host †), you can develop Z80 and 3870 applications for a lot less than ever before. In fact, at $2995, plus an emulation module, RADIUS is the most inexpensive microprocessor/ microcomputer development station available. Yet it's fast, powerful and reliable.

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A SMART WAY TO DEVELOP PLANS FOR THE FUTURE.

In addition to Z80 and 3870 emulation capability, RADIUS will also accept the forthcoming emulation module for the MK68000, our new

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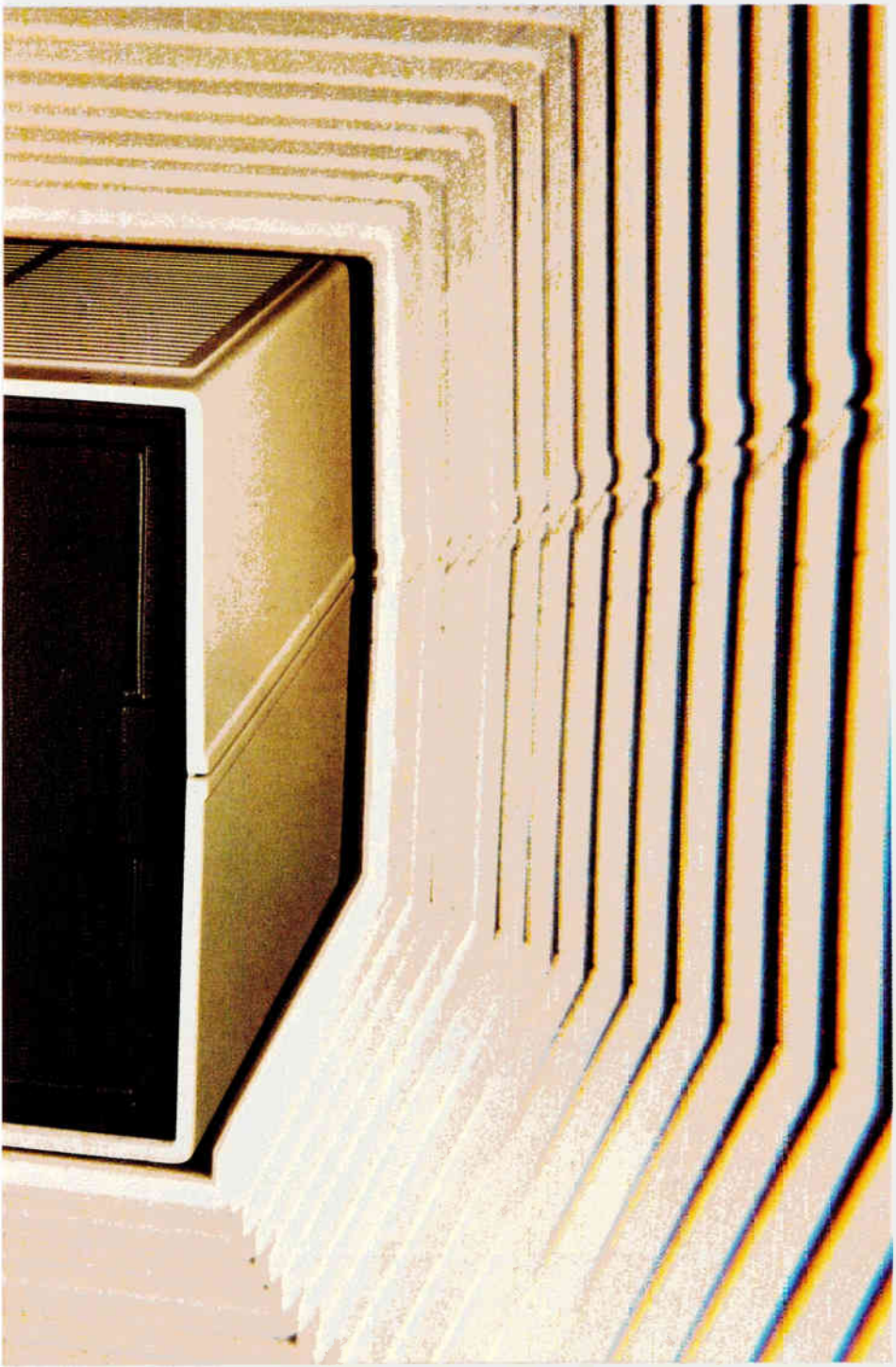

16-bit microprocessor. So no matter which way you're going or plan to go, 8-bit or 16-bit, RADIUS can help you get there. For less.

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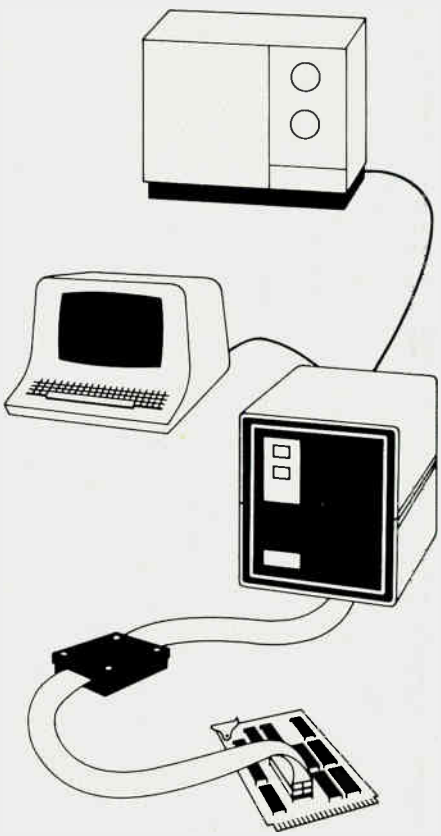
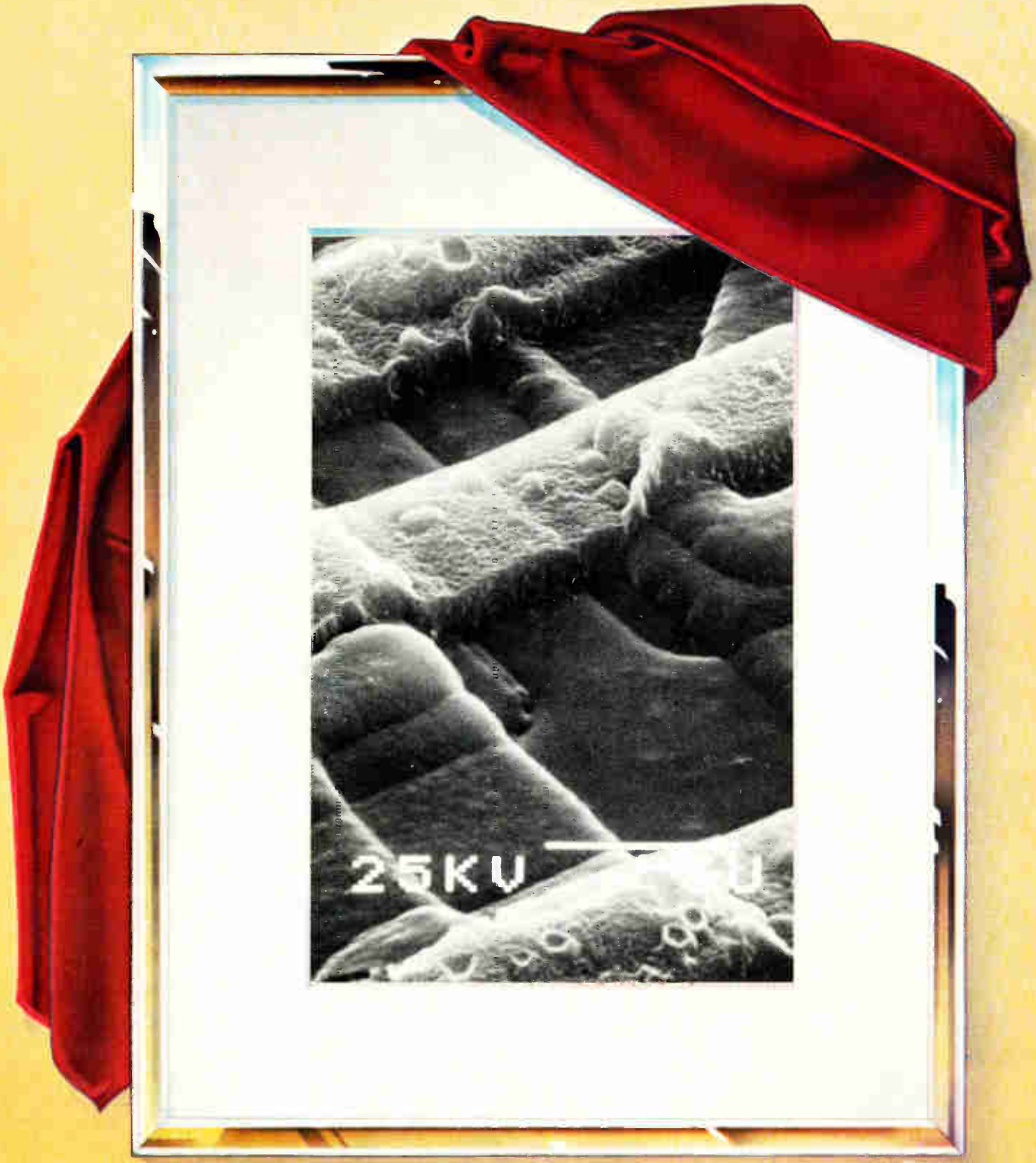


*RADIUS is a trademark of Mostek Corporation

†Handshake software packages available for DEC, PDP-11 and VAX. More will be available soon. For others, Mostek will provide source code and compatibility conversion instructions. (DEC, PDP-11 and VAX are trademarks of Digital Equipment Corporation).

Circle 61 on reader service card

A MASTERPIECE IN ALUMINUM ETCHING



Al+2% Si+4% Cu ETCHED ON A DEVICE WAFER WITH NO RESIDUE AND NO WET DIP REQUIRED.

FROM A NEW ARTIST, THE APPLIED MATERIALS AME 8130 ALUMINUM ETCH SYSTEM

Applied Materials introduced its AME 8100 Series Plasma Etch Systems by showing customers the first plasma etch test results suitable for framing. Rapid industry acceptance proved the need for true masterpieces of the kind created by the AME 8110 for oxides and the AME 8120 for polysilicon etch.

Now we can unveil the first masterpiece in aluminum etching from our new artist, the AME 8130. No other etcher on the market can achieve results like these in the etching of aluminum. The 8130 very cleanly etches all aluminum alloys anisotropically or with controlled profile, with no residues and with high selectivity to PSG and silicon. And with the 8130 there is no after-etch corrosion of aluminum.

The 8130 uses the same revolutionary technology as the 8110 and the 8120. That's why we offer *guaranteed* etch rate, uniformity, selectivity and uptime just as we did when we announced the AME 8100 Series. As before, you get an autoloader to automatically change wafer batches while you are processing 24 3-inch or 100mm wafers, or 18 125mm wafers.

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Find out why the artistry of Applied Materials' plasma etch systems is truly the *art nouveau* for state-of-the-art semiconductors.

GUARANTEED SPECIFICATIONS FOR BATCH ALUMINUM ETCHING OF 24-100mm WAFERS

MATERIAL	SUBSTRATE	ETCH* RATE (Å/minute)	SELEC-* TIVITY
Aluminum	PSG	1500	15:1
Al + 4% Cu + 2% Si	PSG	700	8:1

Line width loss using a typical (i.e. HPR 204 or AZ 1470) positive photoresist is less than 0.5μm.

*Exact etch rate and selectivity depend on the properties of the Al alloy film and substrate.

Applied Materials®

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TERADYNE

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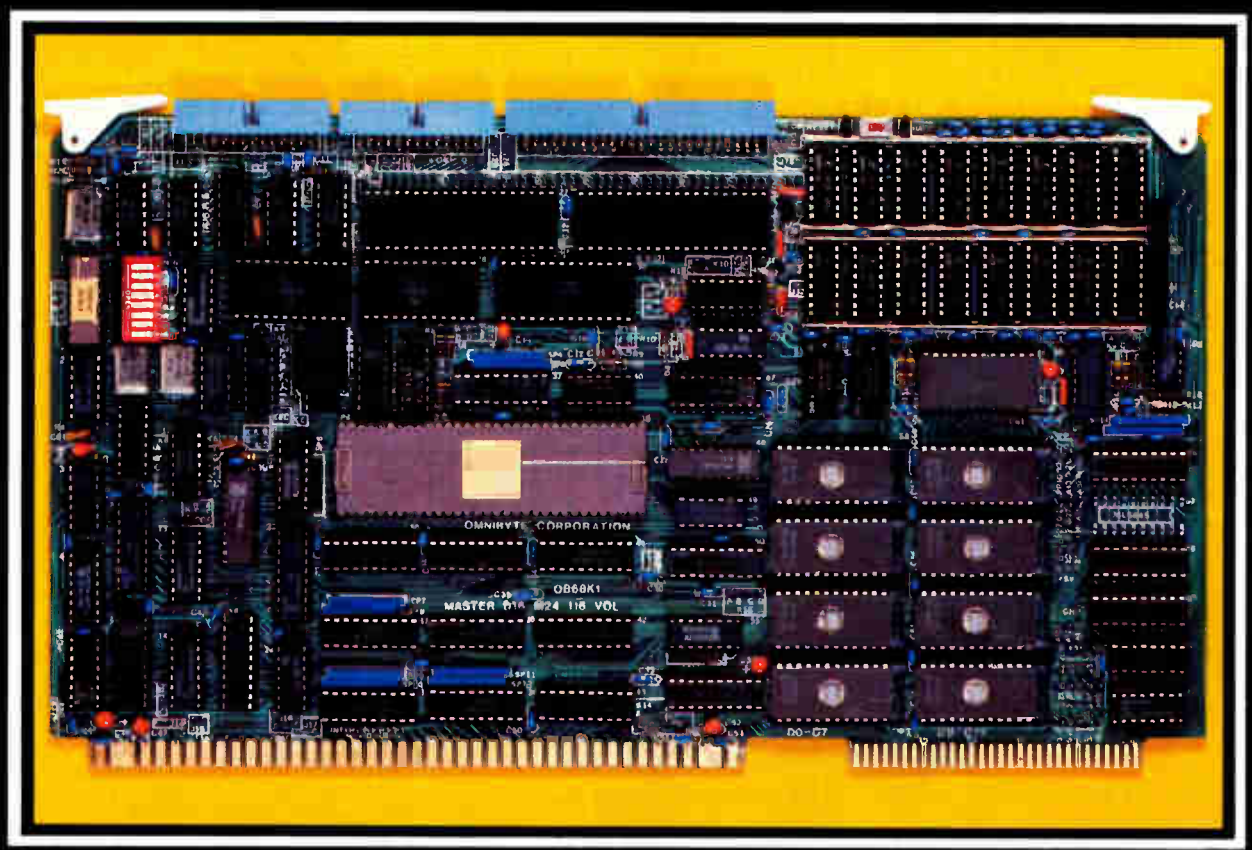
OMNIBYTE
OB68K1®



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The Multibus just got *A LOT* more powerful

The OB68K1 is a powerful, highly versatile single board computer capable of functioning as a stand-alone system, or as the central processor in a large microcomputer system. It features:

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- ★ 32K or 128K bytes of RAM
- ★ 8MHz processor speed
- ★ (7) prioritized-vectored interrupts
- ★ (2) RS232C serial ports
- ★ (2) 16-BIT parallel ports
- ★ triple 16-BIT timer/counter
- ★ user programmable memory mapping PROMs
- ★ crystal controlled baud rate generator with 16 standard rates

MULTI-PROCESSOR CAPABILITY

The OB68K1 is designed to function in either a single or a multi-processor environment. All onboard memory is protected from access by other processors and devices, permitting multiple boards to run concurrently. Since the OB68K1 will address up to 16 megabytes of total memory, it is possible for several boards to access a common pool of memory and I/O devices within a shared bus system.

SOFTWARE SUPPORT

Because the board is configured with the same I/O arrangement as Motorola's MEX68KDM design module, any software developed for the KDM module, including the MACSBUG® monitor/debugger, will operate on the OB68K1. An off-the-shelf operating system is currently available from Hemenway Corporation (Boston, MA) and high level languages are reported to be available from several major software houses by early fall.

For more information about the OB68K1, ask for our free summary sheet or send $10 for a detailed technical manual. Contact Randy Cochran, Marketing Manager.

OMNIBYTE

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Cobalt over chrome outclasses oxides for magnetic disks

by Robert T. Gallagher, Paris bureau manager

Glass substrates enhance superb magnetic properties of cobalt-chrome, boosting bit density for computer disks

Although cobalt can be magnetized to extremely high levels, it has a very low coercivity and thus can be demagnetized so easily that it has long been considered useless for magnetic recording. The time for reconsideration has come, say engineers at the CII-Honeywell Bull research center in the Paris suburb of Les Clayes sous Bois.

They have found a way to increase the coercivity by as much as 30 times, pointing the way to disk memories much denser than those currently in use. What is more, these denser disks should be cheaper because their substrates are glass and not machined aluminum.

Hexagonal. Key to the new disks is the discovery that cobalt deposited on chrome crystallizes hexagonally, which dramatically alters its magnetic properties (ordinarily the crystal structure is cubic). "It is just one of those lucky accidents of nature that cobalt crystallizes in this way on chrome," says Jean-Pierre Lazzari, general manager of the research center's technology division.

"The chrome is useful in another way, too," he adds. "It gives strength to the glass substrate, and it also assures excellent adhesion."

The higher magnetization of cobalt makes for two major advantages over conventional magnetic-oxide recording media. The recording density can be regulated by changing the temperature at which the cobalt layer is deposited and by varying its thickness. In addition, the chrome-cobalt combination boasts a magnetic hysteresis loop that is almost square, further enhancing its recording qualities.

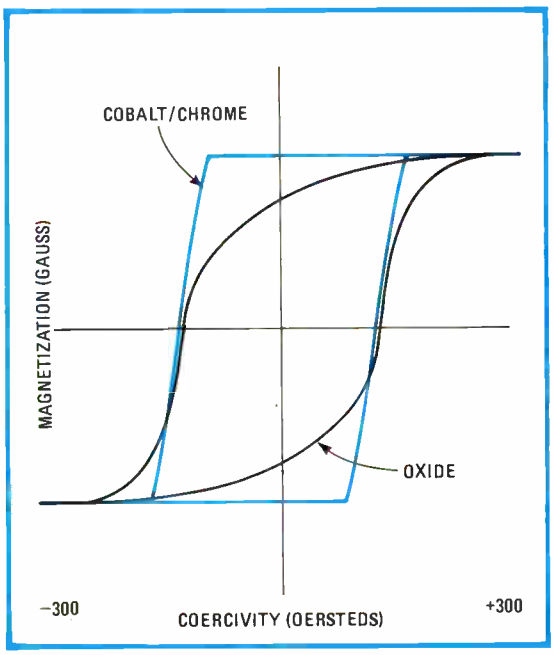
The glass substrates, despite what at first might seem a fatal fragility, add their own advantages. Unlike the aluminum substrates, which undergo meticulous milling and polishing processes, the glass is used as received from the supplier. Indeed, the surface of the glass is so smooth that its surface roughness can scarcely be measured. The only constraint is to use glass of high-enough quality to withstand the rotation and shock to which a disk is subject.

Automatic pilot. The manufacture of the disks, which is in the pilot stage at CII-HB, is automatic. First the glass substrates are chemically washed and then ionically cleaned. Then a 3,000-to-5,000-angstrom layer of chrome is deposited on the surface.

A layer of less than 1,000 A of cobalt is deposited on the chrome and, finally, a hard protective coating is put on the cobalt to prevent oxidization. The layers are deposited under vacuum at a temperature of 400°C.

Disks made in this way have a surface so flat that the recording head is no longer required to fly over the surface but can make contact with it. For practical purposes, contact is a clearance of about 1,000 Å.

Although the state-of-the-art of disk reading is not advanced enough to take full advantage of these chrome-cobalt disks, Lazzari maintains that 12-centimeter disks made



On the square. Cobalt over chrome magnetizes and demagnetizes in a near-perfect rectangular hysteresis loop. Used for computer disks, its threshold for reacting to write pulses becomes much sharper and helps make possible higher packing densities—up to 1,000 bits/mm—than are possible with conventional oxide coatings.

in this way initially will have a capacity of from 25 to 30 megabytes per face. They should be on the market by 1985, he expects.

With an improvement in the electronics of disk reading, the density could be as much as doubled. The surface of the disk could easily accept narrower tracks, but the signal would be too weak to be read by current hardware. To fully exploit the disks, a low-noise integrated amplifier close to the reading head will be needed.

The end result of the new disks, Lazzari says, will be smaller memories with higher capacity. One of the few disadvantages is a preconception of some users.

"Many people have a real psychological block against using glass disks," explains Lazzari. "Nonetheless they are not really more fragile or less reliable. To make doubly certain, we are going to make them to standards of operation and vibration very close to those used by the military." **-Robert T. Gallagher**

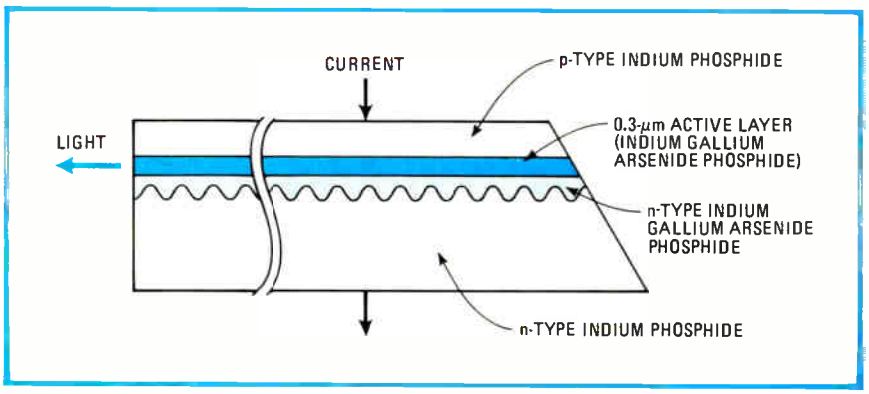
Japan

1.5-μm laser operates at 23°C

A team at the Musashino Electric Communication Laboratory of the Nippon Telegraph & Telephone Public Corp. is the first in the world to develop a single longitudinal-mode room-temperature laser for the 1.5-micrometer band, the wavelength around which optical fibers have their lowest losses.

The task was difficult. Lasers using the usual Fabry-Perot cavity with a length several hundred times that of the generated wavelength may have gain-bandwidth characteristics that cause them to oscillate every 10 angstroms over a range of 100 Å. Under dc operation, the strongest mode will prevail. However, during the transient conditions of pulse modulation, unwanted multiple modes exist.

Devices built by other groups, including those at the Tokyo Institute of Technology and at the Central Research Laboratory of Hitachi Ltd., have high threshold currents caused by low gain. Operation at room temperature is impossible; the devices would burn up if they were not cooled.



Corrugated action. Tuning and mode purity of NTT laser is achieved by using a matched-pitch refraction grating between an indium phosphide substrate and the active layer.

Buried. The device developed at the NTT lab is a buried-stripe, double-heterojunction laser with a distributed feedback that generates a beam at a wavelength between 1.51 and 1.54 μm. Tests indicate a negligible degradation of mode purity for pulse-code modulation at rates up to 400 megabits per second, the speed of the fastest modulator available.

Tetsuhiko Ikegami, head of the optical-device section, is confident that the device will operate at even higher modulation rates. He predicts that the new laser will open the way to fiber-optic communication systems with repeaters spaced up to 100 kilometers. It might also point the way even further in the future toward coherent systems [*Electronics*, Nov. 20, 1980, p. 73].

Ikegami expects his group to continue development of the device for roughly two years. Then it should be possible to transfer the technology to communications-equipment manufacturers for 1.5-gigahertz communications systems.

Substrate. The laser is fabricated on an n-type indium-phosphide substrate. Tuning and mode parity are achieved by scattering the laser beam from a corrugated surface atop the substrate, as shown in the figure. The 0.45-μm pitch of the corrugations, together with the 3.4 index of refraction of the laser's active layer determines the wavelength of the laser beam, which is 1.5 μm in air.

Only one mode can survive the scattering from the distributed corrugations, which eliminate multimode operation and mode hopping. The technique resembles the method being used by Aerospace Corp. of El Segundo, Calif., in developing phased arrays of tuned lasers, [*Electronics*, Oct. 20, p. 42].

Index of refraction changes with temperature variations cause a slight change in wavelength, but it is limited to less than 1 Å/°C. Even that small effect is minimized by keeping threshold current, and the associated heating of the device, low.

Interference. The substrate of the laser is patterned by using a standard integrated-circuit photoresist but without a mask. The beam from an argon laser is split and then combined at an angle to form an interference pattern whose pitch, and thus that of the corrugations, depends only on the angle at which the beams are combined. Development and etching processes are standard.

A low-temperature liquid-phase epitaxial process at about 600°C is required so as not to disturb the corrugations during growth of an n-type indium gallium arsenide phosphide layer that is 0.3 μm thick. (At the usual liquid-epitaxial growth temperature of about 640°C, the corrugations would melt.)

A thin undoped active layer of indium gallium arsenide phosphide followed by a 1-μm-thick layer of p-type indium gallium arsenide

Fluke 1720A Instrument Controller

IEEE-488

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phosphide completes the basic structure. The active layer has a low-phosphorus content to give a bandgap energy that is equivalent to the 1.5-μm wavelength. The two layers that sandwich the active layer have more phosphorus for a bandgap energy equivalent of about 1.2 μm for the n-type indium gallium arsenide phosphide and 0.9 μm for the indium phosphide.

The laser is completed fairly conventionally by defining the stripe, etching away material on both sides, and then growing indium phosphide layers on both sides that protect the junctions. Completed, the laser has a strip of 3 μm wide and about 300 μm long.

Amplification. In operation, electrons are injected into the active layer from the n-type layer just above the corrugations. Light generated in the active region is amplified. The layers with a low index of refraction that are sandwiching the active layer form a waveguide at their interfaces with the active layer and confine the light.

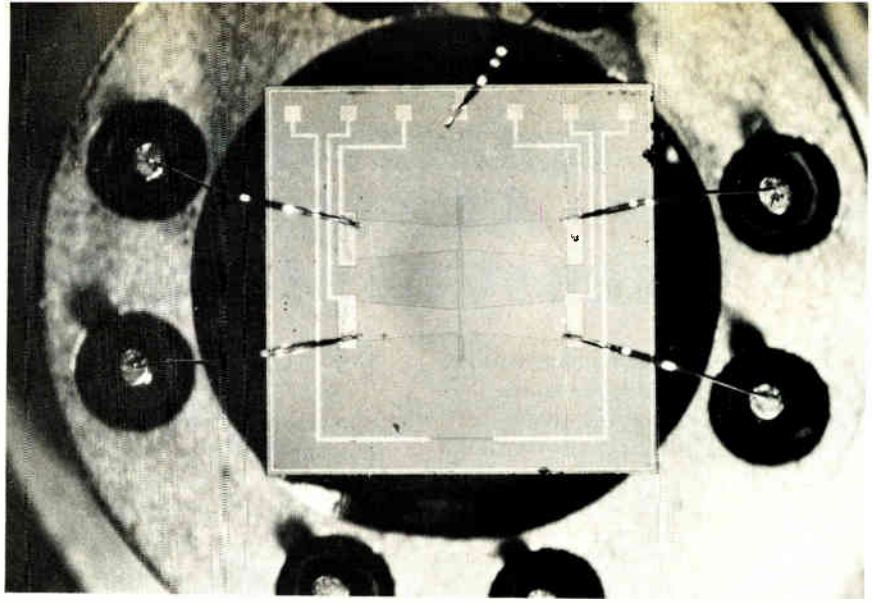
However, a small amount of light does leak into the layer above the corrugations. This slight leakage serves as the source of the distributed feedback that tunes the laser. Because of its lower bandgap energy, the layer immediately above the corrugations is transparent to the 1.5-μm light. **-Charles Cohen**

West Germany

Electronic barometer calls fair or foul

If the people who promote semiconductor pressure sensors for Siemens AG have their way, the household aneroid barometer with its moving parts will be consigned to the curiosity shop, supplanted by an electronic barometer.

Designers at the Components division of the Munich-based firm have put together a notebook-sized demonstration model of a solid-state barometer that measures air pressure once every minute and shows the result, to the nearest millibar, on a 1-centimeter-high liquid-crystal display. The barometer will run for at least two years off a power supply of four 1.5-volt batteries.



Under pressure. Four resistors diffused into a thin silicon membrane form a bridge whose resistance varies when the membrane flexes because of changes in atmospheric pressure.

Siemens is not the first to turn a semiconductor pressure sensor into a barometer. Industrial versions already exist, company designers point out, but these measure air pressure continuously and so draw too much power to operate off batteries. The requisite line-power supply for the industrial model makes for a fairly bulky and heavy instrument.

Demonstration model. Nonetheless, Siemens' development does not signal the company's entry into the barometer business. "Our device is only a model, to show barometer makers that using solid-state techniques in their instruments can result in a number of advantages," says Rudolf Knauer, who headed the project. Along with the battery-powered barometer's advantages in weight and size, its digital output permits an easy interface with computers should it be used in industrial applications.

Knauer figures that production versions of the barometer could be made for about $35 in quantities of 100,000 a year. The device has already piqued the interest of an Italian firm, for shipboard use.

The Siemens model consists essentially of four circuit groups: the pressure sensor and its amplifiers; an analog-to-digital converter; an LCD module, and clock-signal circuitry. All the parts mount on a 140-by-75-millimeter printed-circuit board.

In use, the KTY 10 semiconductor sensor, made by Siemens, delivers a voltage, proportional to absolute air pressure, of 70 microvolts per millibar when the supply is 6 V. This signal, which is temperature-compensated and boosted several times in a multistage integrated-circuit amplifier, goes to the integrated a-d converter.

Because of its relatively high current consumption of 2 milliamperes, the converter is activated for only half a second every minute. During this half-second, the air-pressure measurement is sampled, controlled by the clock-generating circuitry, which is based on complementary-MOS gates. The LCM 1011 liquid-crystal module contains memory and driver circuits that service the four-digit display.

As for the pressure sensor itself, it basically is a bridge circuit whose four 7-kilohm resistors are diffused into a thin silicon membrane. On one side of the membrane is a vacuum cell, on the other a small metal tube open at the top to the influence of atmospheric pressure. As the pressure rises or falls, the degree of membrane deflection away or towards the vacuum cell changes. Piezoresistive effects cause the resistance in the bridge to change, which, in turn, results in the pressure-proportional signal.

The barometer circuitry can be calibrated with a reference voltage so that the millibar value shown on the display corresponds to the pres-

Fluke 6070A and 6071A synthesized signal generators. The new generation.

For two decades Fluke has produced RF equipment including a full line of signal sources, counter/timers, and RF voltmeters — quality products that users have specified with confidence.

We're now introducing the new generation of sophisticated instruments in the Fluke RF family: the 6070A and 6071A, two general purpose synthesized signal generators that offer unmatched price/performance value in the market.

Most-wanted features through innovative design.

Both instruments feature a large output dynamic range — the 6070A covers frequencies from 200 kHz to 520 MHz; the 6071A range extends to 1040 MHz — and also deliver a high degree of spectral purity. Fluke engineers have developed a number of unique synthesis techniques resulting in noise performance that equals or exceeds that of the best cavity-tuned generators you can buy. Versatile AM, FM and ØM — internal or external, simultaneous or separate — give these new synthesizers the flexibility for wide- ranging applications.

All the brains of 16-bit microprocessor control.

An integral 16-bit microprocessor makes these new generators incredibly easy to operate. Convenience features include simplified keyboard data entry, digital frequency sweep, digital spin knob tuning for pinpoint frequency control, a learn mode memory, self-diagnostics and error code flagging plus other special functions only advanced digital technology can provide.

Full programmability for automated test systems.

The 6070A and 6071A are equipped with an IEEE-488 bus interface as a standard feature for systems applications and all necessary front panel functions are remotely programmable. Complete status information can be supplied back to an instrument controller such as the Fluke 1720A. Both "teach" and "learn" modes are provided.

A full line of RF accessories is available to extend the capabilities of the 6070A and 6071A, making them excellent tools for the designer, bench user or laboratory technician.

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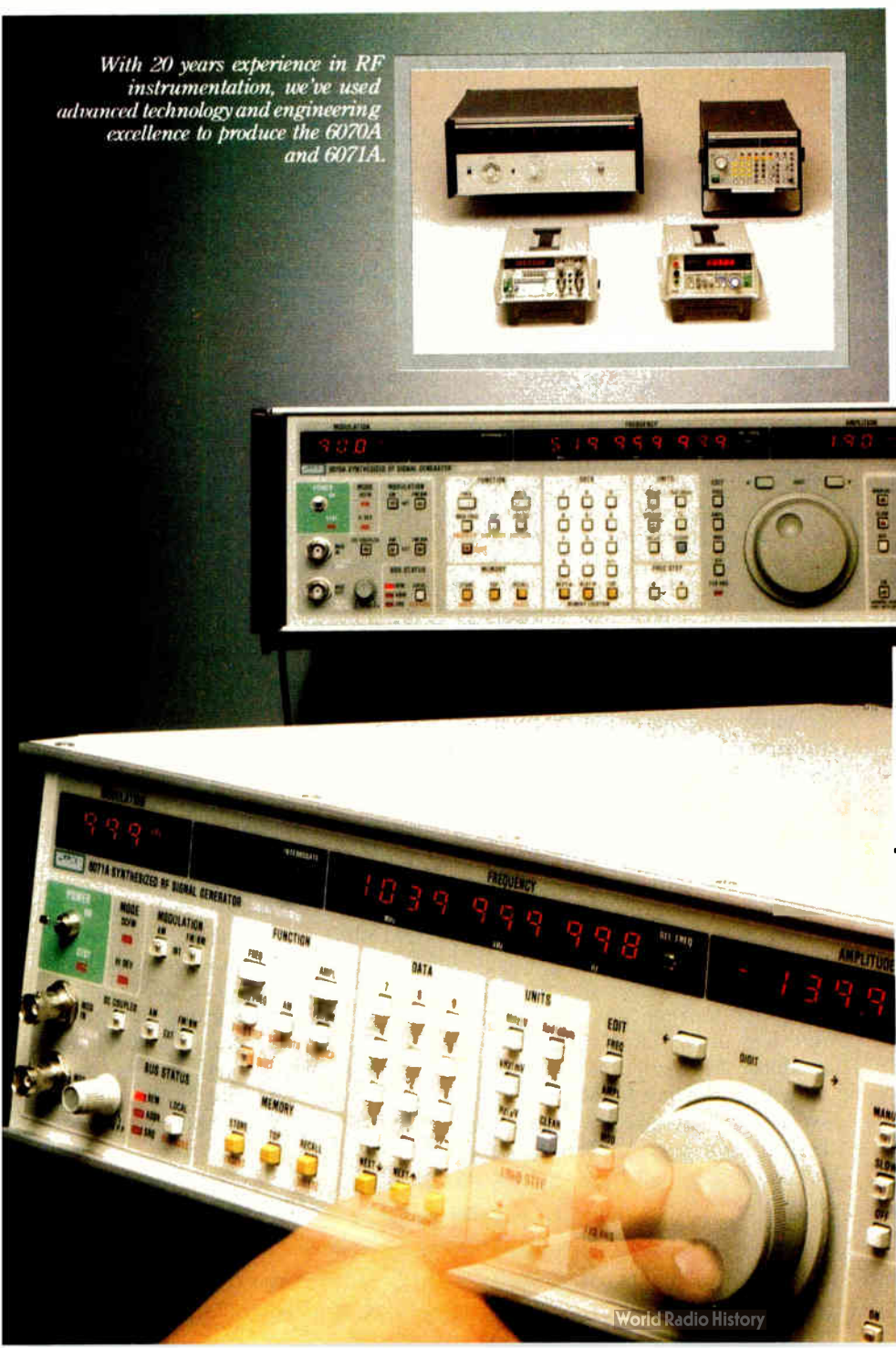

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sure at the point of measurement. For a pressure referenced to sea level, an offset voltage can be added that varies with the geographic location. Moreover, Knauer points out, the barometer circuitry can be modified so that it compares air pressures over several hours. Thus, the barometer would show whether it were rising or falling. **-John Gosch**

Great Britain

Computer and communications-gear makers rush into office automation market

British Prime Minister Margaret Thatcher intends to campaign for office automation by doing as well as by preaching. Early next year, she'll be issuing memos, summoning ministers to her side at Number 10 Downing St., or asking for their comments on draft cabinet documents, all with the aid of a local network that will handle both text and data.

Before mid-1982, the $500,000 prestige installation, the work of a small, new London company called Xionics Ltd., will have voice facilities added to it; encryption will follow in 1983. For voice messages, the system digitizes speech, compresses the data, and stores it on disks. These "voicegrams" then can be forwarded selectively to any users of the net or to all of them.

Show biz. In part, the No. 10 Downing St. voicegram network is an exercise in showmanship—like the electronic office at the White House in Washington—designed to promote the Thatcher government's Information Technology Year. But even before the promotion started, a lot of firms that produce hardware for telecommunications, for data processing, and for obsolescent offices had decided the office automation show must go on. In recent weeks, several have raised the curtain on their new acts.

- Britain's ICL, largest of the native computer makers, has teamed with the Canadian telecommunications producer Mitel Inc. to market systems tied together by Mitel's Superswitch digital private automated branch exchange. At the same time, ICL is hedging its bets with a variety of local networks.
- Plessey Office Systems Ltd. responded to ICL's incursion into the PABX sector by revealing the broad outlines of its electronic office strategy. Plessey's long-brewing plans call for a mid-1982 launch of a product line based on its best-selling digital PABX, which in effect provides a ready-made 64-kilobit/second (the digitized voice rate for the exchange) channel for each user. The PABX will serve as a concentrator and gateway for services like telex, teletex, electronic mail, and data processing with interfaces for ICL and IBM mainframes.
- Gestetner Ltd., an old established duplicator manufacturer in bad need of new technology, hopes to move front stage by buying Nexos Ltd., the state-backed office equipment company that's now up for sale.

However, the established companies like ICL, Plessey, and Gestetner are not alone in the quest for market share. Xionics has already sold more than $2 million worth of its local net hardware since it started up in January, 1979. To insure reliability of its networks, Xionics transmits 10 bits of parallel data over twisted-wire pairs and duplicates all the interfaces.

And the first UK company to get on the market with a second-generation office system integrating word-processing and voicegram facilities is Office Technology Ltd. of Winchester, a break-away group formed by four IBM office-equipment specialists in January, 1980. The company is part of the Information Technology Ltd. group of companies run by entrepreneur Tony Davies.

Office Technology believes that "few companies can afford specula-

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Electronics international

tive investment in untried office technology". So OTL has developed a high-performance cluster word-processing system to which voice facilities and other enhancements can be added when the customer is ready.

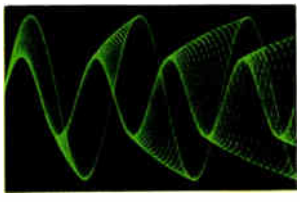
As a word processor, for example, the star-connected cluster can support up to 32 workstations and printers from a central disk file of up to 640 megabytes capacity. Each work station displays black-on-white proportionally spaced text and scrolls it both horizontally and vertically. An 80-hertz refresh rate keeps the screen flicker-free.

Two roles. Hooks are provided within this system to expand its capability progressively. "It's a good vehicle for pilot office systems," says Bob Remington, an industrial psychologist and one of the four founder-directors of OTL. Foremost of these enhancements is what is termed its voice capability. This has two basic roles: first, to avoid telephone ping-pong by storing and automatically forwarding short verbal messages; second, to provide an alternative to scribbled notes in the margin of internal documents.

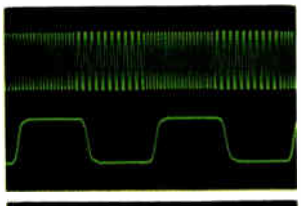
In the firm's information management system, annotation is readily accomplished with the aid of the display cursor and a set of voice-related keys similar in function to the controls of a cassette recorder. Once a document has been annotated, a loudspeaker symbol in the margin alerts addressees to any voicegrams stored alongside the text.

Other planned enhancements include the addition of auxiliary processors to the central controller—which currently uses two Intel 8086 16-bit microprocessors—to provide additional document processing plus statistics and heavy mathematics. Also promised are a local and remote networking gateway, as well as a facility for twinning the central controllers to achieve a high level of resilience. At home, OTL will market the system itself; in the United States it will be marketed through agents. In the UK, a six-station system sells for the equivalent of about $12,700 per station. **-Kevin Smith**

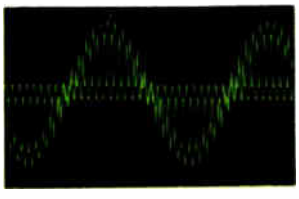
Modulation Analyzer FAM



AM + FM



FSK



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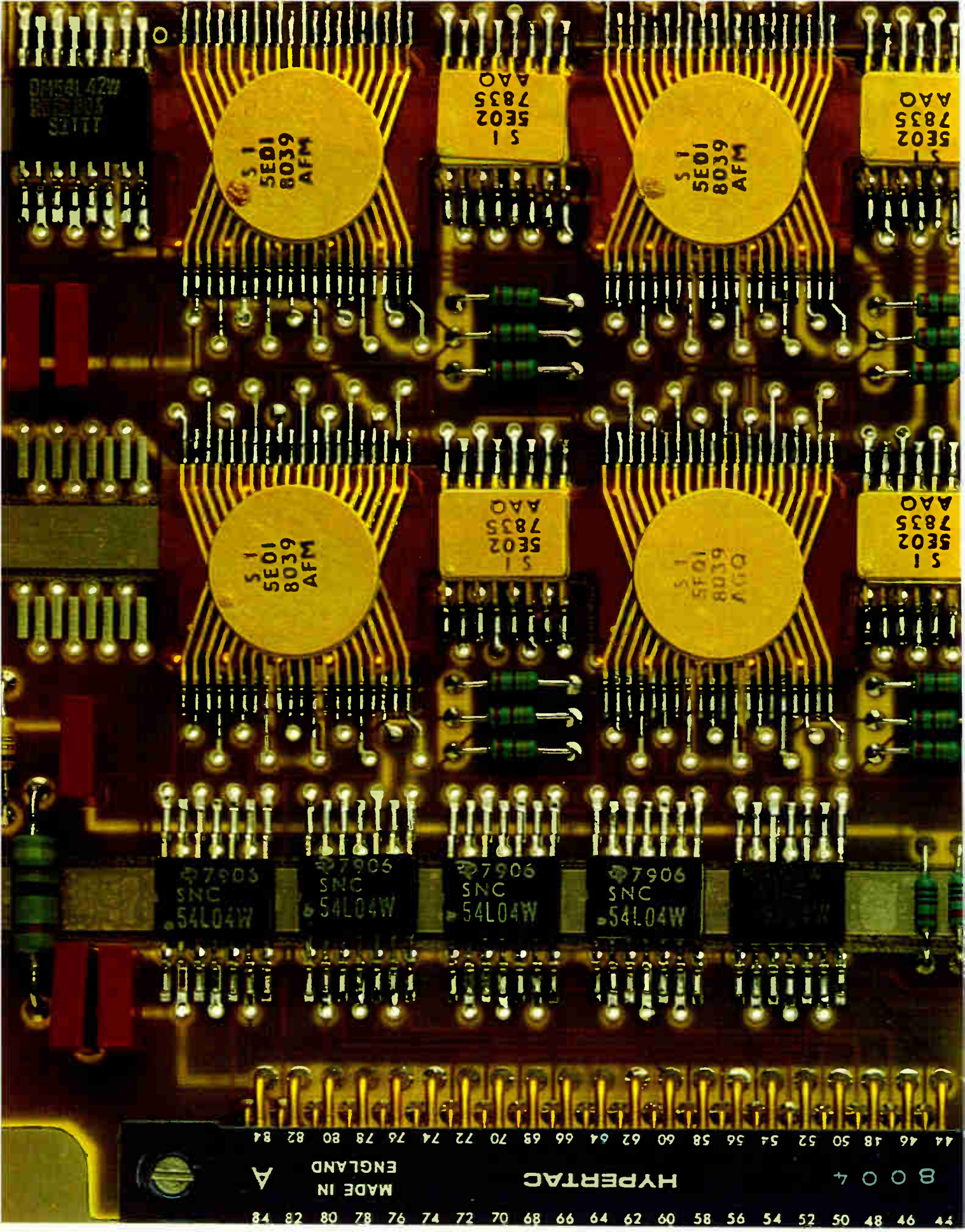

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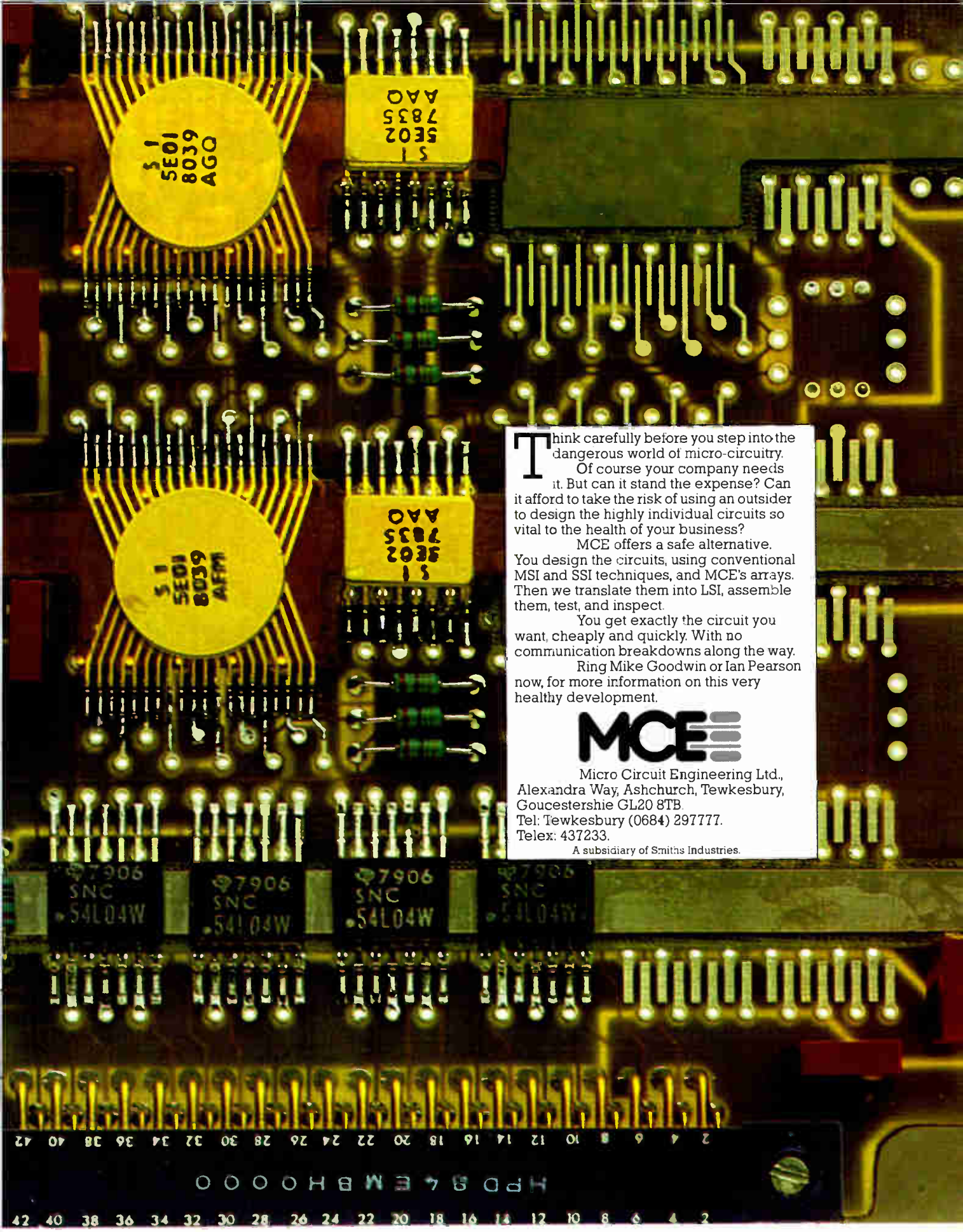

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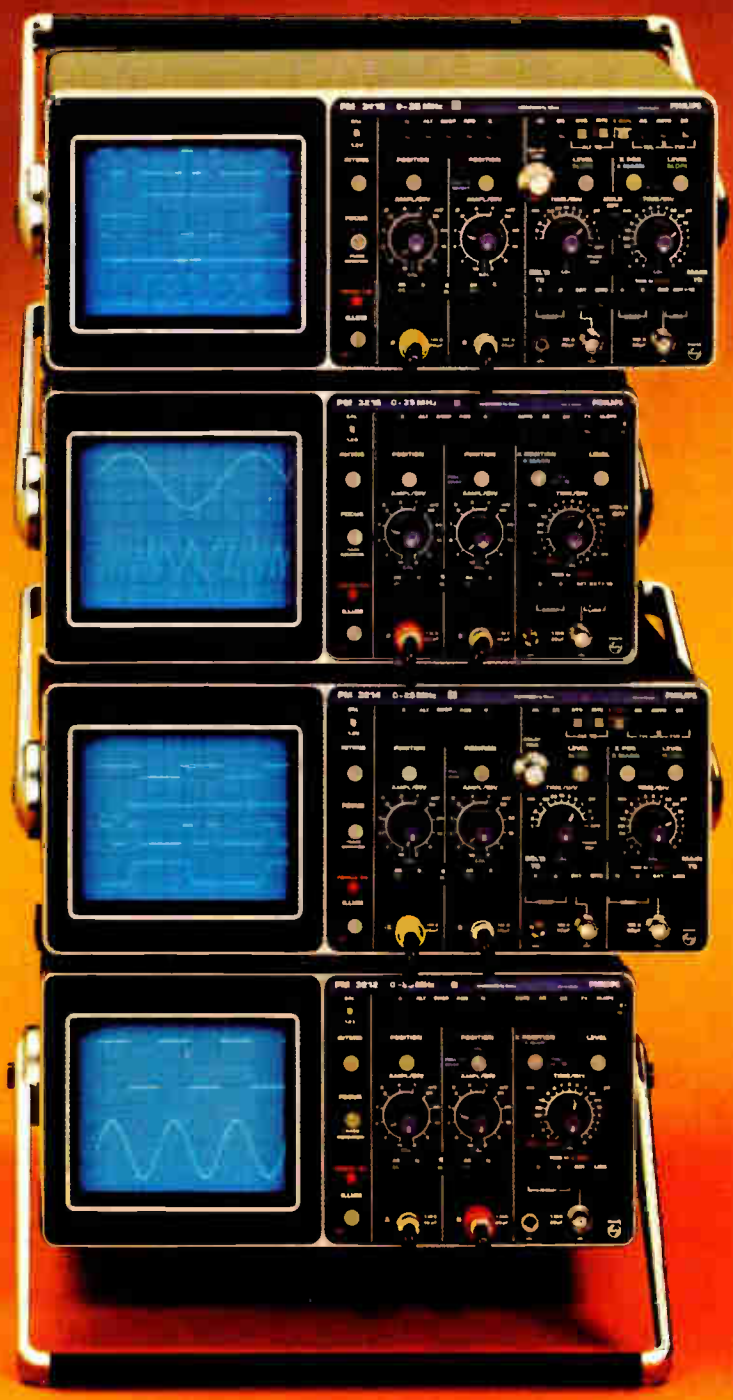

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Resonant ceramics lower microwave oscillator cost

by Robert Gallagher, Paris bureau

Dielectric ceramics based on zirconium, titanium, and tin have resonant-frequency stability comparable to Invar's

In what could drastically reduce the price of microwave oscillators and filters for certain applications, the Microwave Components division of Thomson-CSF is about to begin marketing a line of dielectric ceramics comparable in stability to Invar. In addition, the company will be selling two dielectrically stabilized oscillators based on the materials.

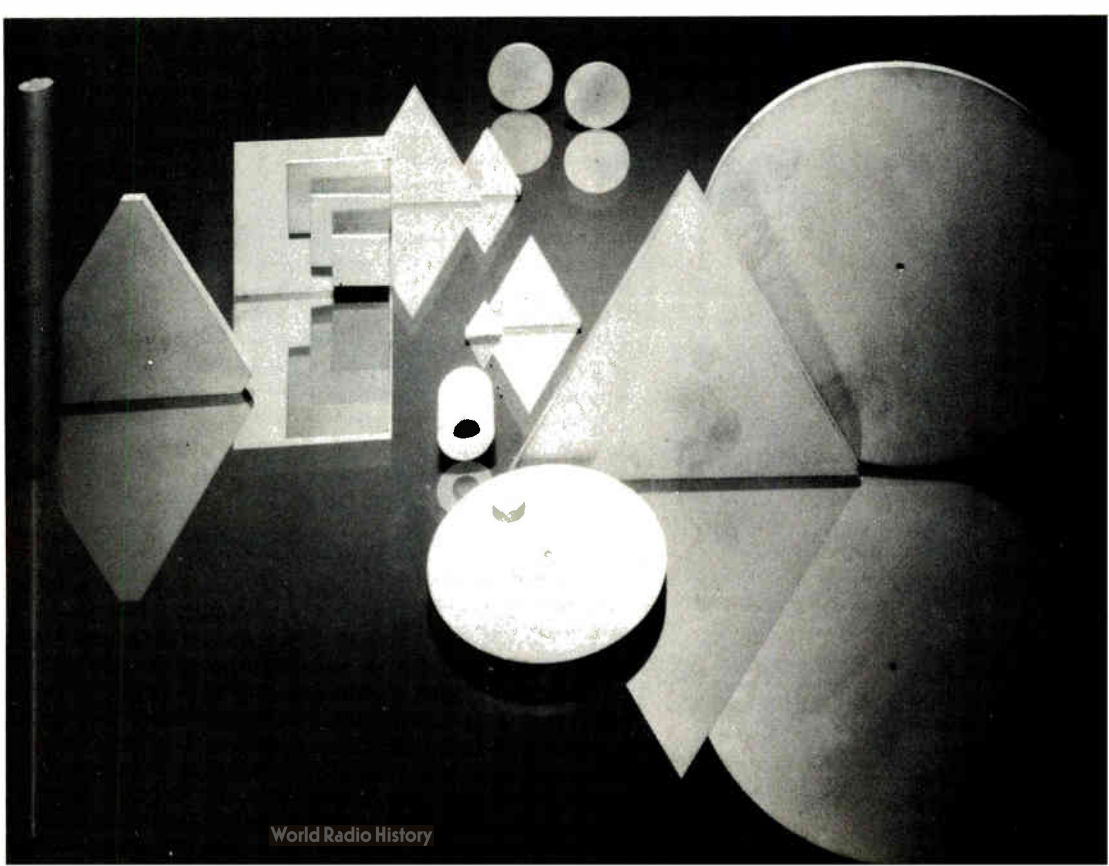
The ceramics are based on the ability of dielectric samples to exhibit electromagnetic resonances when the wavelength is shorter than the sample size. Because their resonant frequency is stable over time and temperature, they present an alternative to, say, Invar in waveguide filters.

The Thomson line consists of six ceramics, all of which are based on zirconium, tin, and titanium. They differ from each other in stability over temperature as a result of different ratios of zirconium to tin. Their common characteristics are a density of 5.2 ± 0.1, an expansion coefficient of 3 ± 2, a dielectric loss of 3×10^{-4}, and permitivity of 36 ± 1. The E2036, E2336, E2636, E2936, E1336, and E36 ceramics, have resonant-frequency stabilities from $-20°$ to $+80°$C of 0 ± 2, 3 ± 2, 6 ± 2, 9 ± 2, -3 ± 2, and ± 10 ppm, respectively.

"There are very few such materials available, but one is a barium-based ceramic developed at Bell Laboratories," points out William Simonet, an engineer at Thomson's central research laboratory who worked on the materials' development. "This material can be very good indeed if it is well made, but it has the disadvantage of being manufactured at a temperature very close to its fusion temperature. Also, there are some stages at which it is water-soluble."

Thomson has developed two oscillators using the materials and plans to add substantially to that line. The TH 5129 and TH 5130 dielectrically stabilized oscillators operate at from 8 to 12.4 and 13 to 17 GHz, respectively, over a temperature range of $-40°$ to $+80°$C. They both feature very low fm noise (-100 and -80 dB/Hz, respectively), and come with an integrated voltage regulator. Pulling for the oscillators is 10^{-4} and output is 10 mW. Short-term instability is 10^{-7}.

The price of one of these oscillators is about $1,250 in small quantities or as little as $785 in large orders. The materials are priced according to the form in which they are purchased: blocks, as they come from firing; cylinders to be cut and finished by the customer; or already finished to specifications. "To make a 10-GHz resonant cavity with Invar could cost as much as $2,000," explains Simonet. "With these ce-



ramics we are talking more in the area of $50 to do the same job."

Thomson-CSF Microwave Components Division, 101 Blvd. Murat, 7581, Paris Cedx 16, France [441]

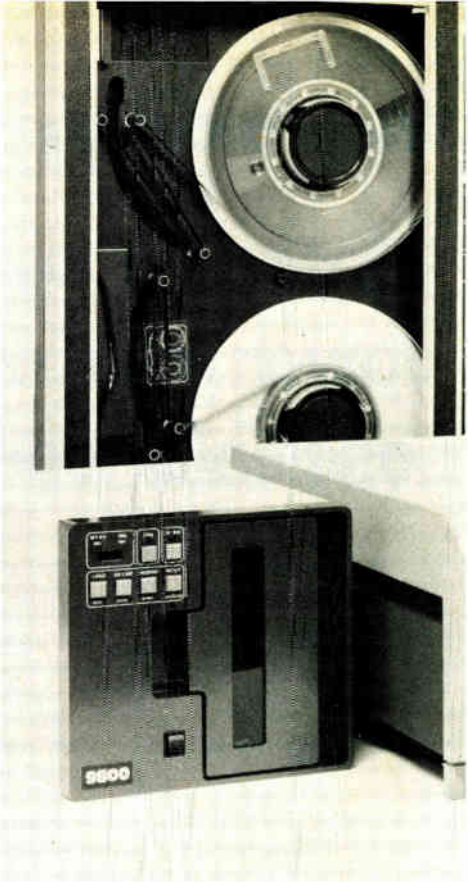
Line of 100-in./s streamers backs up Winchester drives

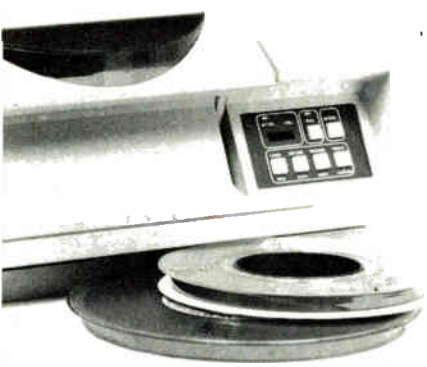
Winchester-drive disk storage will find a complement in a line of streaming magnetic-tape drives from SE Labs (EMI) Ltd., the Thorn EMI group's computer-peripherals company. SE Labs markets Fujitsu Ltd.'s range of Winchester-technology drives according to a recent agreement.

The ½-in. Emistreamers range in capacity from 15 to 61 megabytes unformatted and all stream at 100 in./s. The IBM/ECMA 1,600 b/in. phase-encoded format for ½-in. tape is used; models in the line share an industry-standard interface.

The top of the line is the 8900, which runs at 50 in./s in conventional start-stop operation in addition to streaming. It is based on the successful model 8800 tape transport, which can be upgraded in the field to 8900 specifications.

With the automatic threading and front loading of models 9900 and 9800, reels become as easy to handle as floppy disks. The two drives have a capstanless tape path that contacts the oxide at only the head and a sapphire cleaner. Without a capstan, these drives cannot match the 8900's 8-ms start-stop time. And their start-stop operation is at only 25 in./s. Nominal access time for the 9900 is 29 ms at 25 in./s and 176 ms at 100





in./s. The small 9800, accepting only 7-in. reels, has a nominal access time at 25 in./s of 80 ms and of 320 ms at 100 in./s. The larger drives take reels up to 10½ in. in diameter with standard IBM hubs.

The low-cost 9800 comes with a power supply and a formatter in a package the size of two 8-in. floppy-disk drives. A 7-in. reel of 1-mil tape stores 15 megabytes; the capacities of Mark II versions of this unit are expected to top 50 megabytes.

All three ½-in. drives have built-in self-diagnostics. A four-character alphanumeric display on the front panel conveys diagnostic messages as well as an indication of operational status. Six registers are allocated for error-logging, status, and diagnostic data, which can be displayed to the operator or transmitted over the drive's interface.

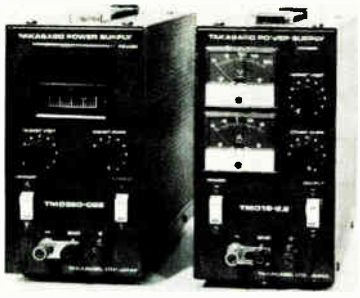
The firm is also offering a ¼-in. tape drive, the Streamer 9700, as part of a deal with Data Electronics Inc. of San Diego, Calif. The 30- and 90-in./s unit stores 10 or 20 megabytes on a 3M-type cartridge.

SE Labs offers interfaces, controllers, and host adapters for its tape and disk drives. Apple and Pet microcomputers are supported, as well as minicomputers from Hewlett-Packard, Digital Equipment Corp., and Data General.

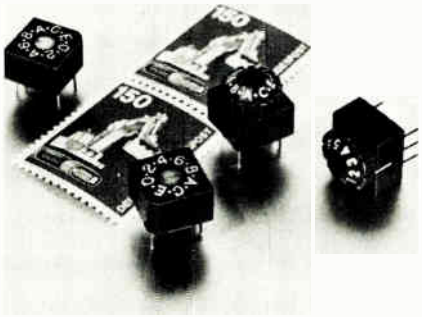
SE Labs (EMI) Ltd., Data Products Division, Spur Road, Feltham, Middlesex TW14 0TD, England [475]

The ZRA4025 solid-state relay incorporates snubber circuits and features zero-voltage switching. It blocks 400 V and carries 25 A or a single surge of 225 A. Control is at 3 to 32 V, and input impedance is 1,500 Ω. FR Electronics, Wimborne, Dorset BH21 2BJ, England [442]

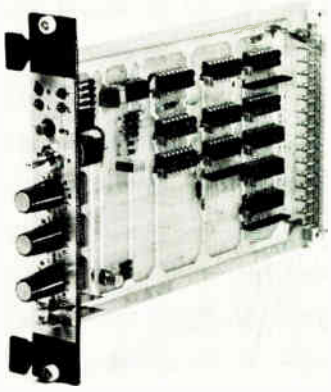
New products international



Constant-voltage or constant-current dc power supplies have outputs of 0 to 70 V for the TMD series and 0 to 360 V for the TM series at 0 to 5 A. They are used in factories for experimental, inspection, and production-line jobs. Takasago Ltd., 662 Futako, Takatsu-ku, Kawasaki 213, Japan [443]



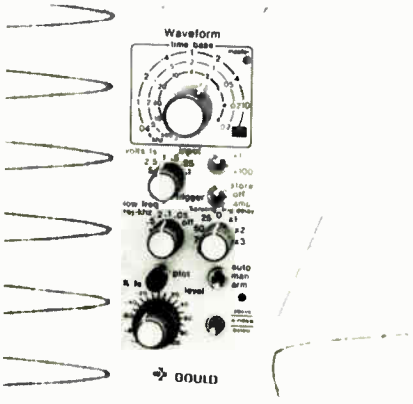
The series KDS code switches can be soldered or plugged into dual in-line sockets. They have 10-position binary-coded decimal or 16-position hexadecimal coding. Maximum contact resistance is 50 mΩ. Spezial Electronic, P. O. Box 1308, D-Bueckeburg, West Germany [446]



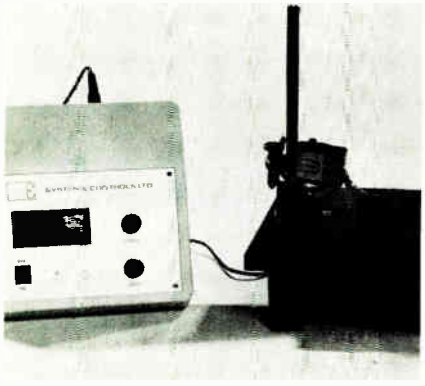
The test and service module KUAX 653 traces the logic states of programmable controls and indicates these states with light-emitting diodes. The addresses of the appropriate inputs, outputs, and clocks of the controls are preset by switches. Kuhnke GmbH, D-2427 Malente, West Germany [449]

The SP110 preamplifier for the ES1000 electrostatic recorder has a guarded floating input that operates up to 500 V above ground and a 6-kHz frequency response for an amplitude of 50 mm. Gould Instruments Division, Roebuck Road, Hainault, Essex 1G6 3UE, UK [444]

The 218HF optical chopper produces 100% modulation up to 20 kHz in optical beams almost 25 mm in diameter. It consists of a compact chopping head, cable, and control unit for lock-in amplifiers. Bentham Instruments Ltd., 14 Arkwright Rd., Reading, Berks. RG2 0LU, UK [447]

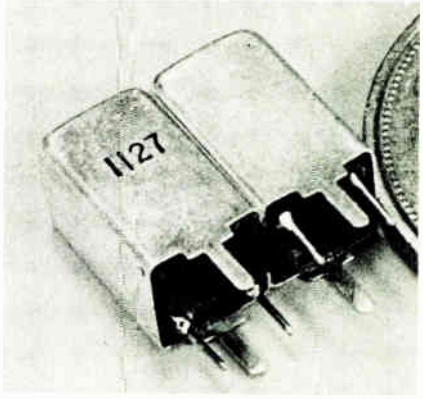


The model 13-4616-10 functions as a waveform-storage module and high-frequency dc amplifier. It produces hard-copy waveforms at frequencies up to 20 kHz on the Gould 2000 and 200 series direct-writing recorders. Gould Instruments Division, Roebuck Road, Hainault, Essex 1G6 3UE, England [450]



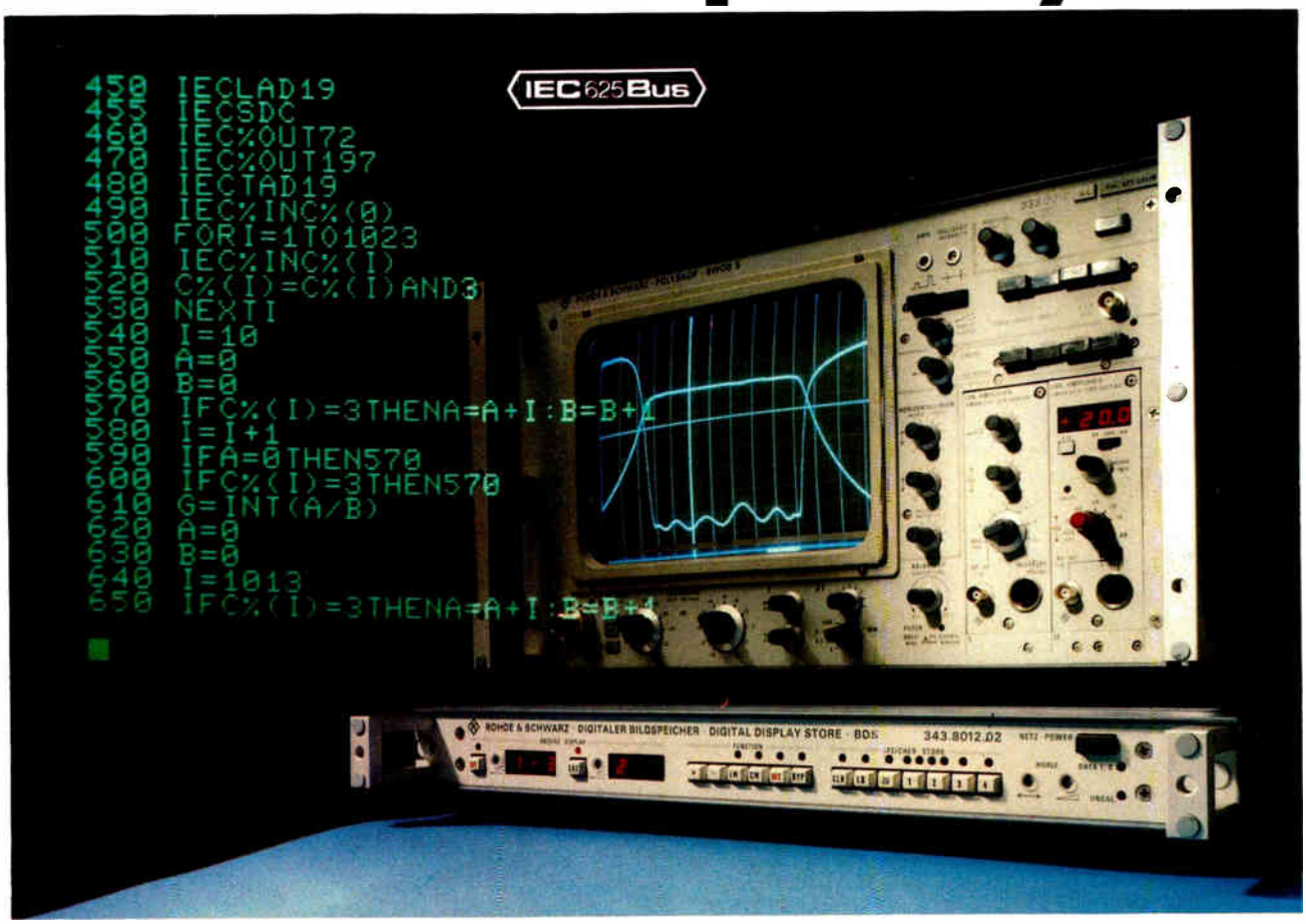
This portable digital meter gauge operates from a battery or main supply, has two imperial and metric magnification ranges from ±200 μm to ±0.200 in., and works with the firm's half-bridge transducers. Systems E Controls Ltd., 1 New St., Leamington Spa, Warwickshire CV31 1HP, UK [445]

Micromat drills printed-circuit boards in a 315-by-470-mm pattern. It has insert and delete functions, subroutines, step and repeat, and a user-friendly control panel. It can drill at up to 60,000 rpm. Dorniver Ltd., The Green, Wellingborough Road, Rushden, Northants. NN10 9YN, UK [448]



Toko's 7HW series of miniature helical filters is used in ultra high-frequency receivers and portable paging equipment. They have an insertion loss of better than 4 dB and cover the 380-to-500-MHz range. Ambit International, 200 North Service Rd., Brentwood, Essex CM14 4SG, England [452]

Polyskop SWOB 5 with extra capability



The operating ease and performance of the compact sweep tester Polyskop SWOB 5 (now up to 1.3 GHz) have been enhanced even more through a new digital display store and a log-amplifier plug-in.

Digital display store BDS
Even at slow sweep rates the BDS permits simultaneous, flicker-free display of two test curves plus associated information like frequency markers and level lines. Storage of four sweep curves is possible, and the contents of any two memories can be added and subtracted, thus enabling compensation of frequency-response errors for instance. The optional **average-value memory** averages 4,8 or 16 successive sweeps, making it possible to suppress random interference on the sweep curve (e. g. noise). If the BDS is used with its optional **IEC-bus interface**, the contents of all memories can be read out, converted and read in again by a desktop controller.

The **log amplifier SWOB 5-E3** (right in the photo) has a digital level display and the following new features:

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- automatic setting of reference levels
- signalling of excessive interfering-signal levels
- gain of active demodulator taken into account in level measurements

The measured value indicated can be absolute in dB (V) and mV (with auto-ranging) or relative in dB, and for relative measurements the reference level can be set anywhere between 0 and −100 dB (V).

Ask for the new data sheets SWOB 5 and BDS

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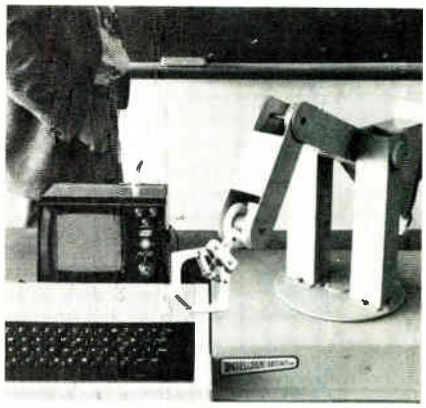
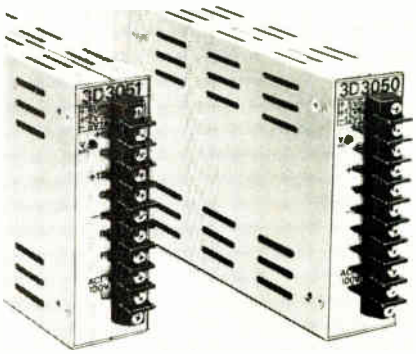


The Small Arm Robot uses six stepping motors and a solenoid controlled by a microcomputer-compatible card. It has a reach of 0.45 m and placement accuracy within 1 mm; it can lift 250 g. Sands Whiteley Research & Development Ltd., Cambridge Road, Orwell, Royston, Herts., England [453]

Micro-Professor is a Z80-based microcomputer learning set with a 2-K-byte read-only-memory monitor, 2-K-byte random-access memory, 24 parallel input/output lines, system clock, and user's manual. Multitech Industrial Corp., 977 Min Shen E. Rd., Taipei 105, Taiwan, Republic of China [454]



The Series 3D switching regulated power supplies come in single-, double-, triple-, and quad-output versions rated at 30 to 150 W. They have over-voltage protection, in-rush current suppression, and remote sensing and control. Delpak Electronics Ltd., 13 Hazelbury Crescent, Luton LU1 1DF, UK [455]

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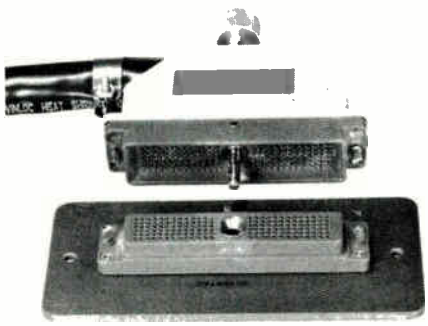
ZANUSSI

Circle 226 on reader service card

New products international

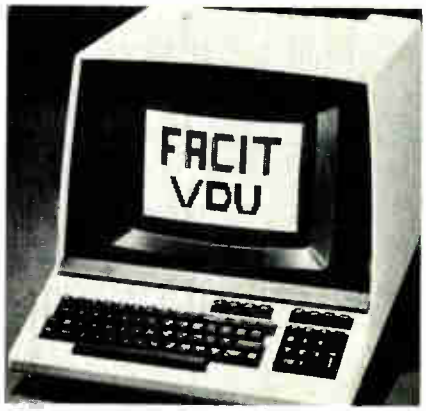
The model 117B precision noise figure meter measures noise in amplifiers and receivers from 0 to 30 dB in six ranges. It covers frequencies from 5 MHz to 40 GHz when used with various noise sources. Magnetic AB, Gardsfogdevägen 18 A, Box 20036, S-161 20 Bromma, Sweden [456]



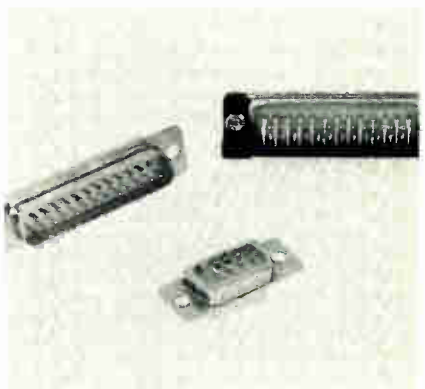
The Hypertac HDL connector incorporates 128 low-insertion force contacts, central latching, and an optional cable hood. It is compatible with the Cannon 156-way DL zero-insertion force connector. Hypertac Connectors, Chronos Works, North Circular Road, London NW2 7JT, England [457]

These drawer units are for free standing and 19-in. rack mounting of a variety of microprocessor boards, plug-in Eurocards, and Vero logic boards. They are available in one-, two-, and three-Eurocard versions. Vero Electronics Ltd., Industrial Estate, Chandler's Ford, Hampshire S05 3ZR, England [459]

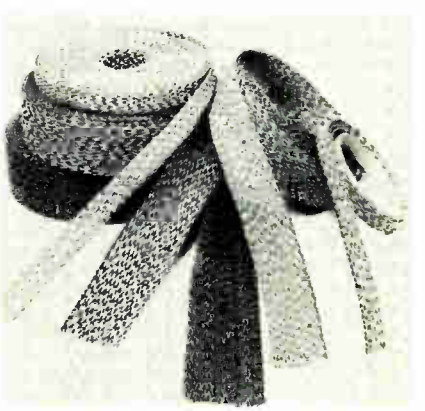
New products international



The 4411 video terminal has a European character set, full editing and format-handling functions, and semigraphics. It is intended for small businesses, computer-aided design and manufacturing, laboratories, and storerooms. Facit Data Products, S-105, 45 Stockholm, Sweden [460]

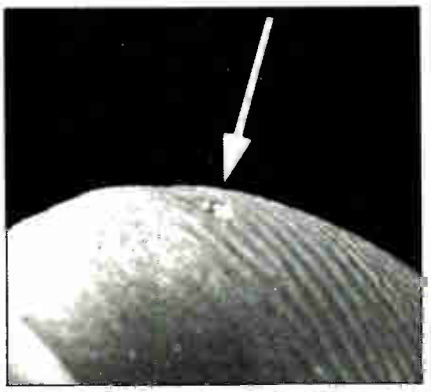


These D subminiature connectors have 9, 15, 25, 37, or 50 contacts and come in solder-bucket and supported right-angle versions. They are compatible with Greenpar's insulation-displacement D-style connectors. Greenpar Connectors Ltd., P. O. Box 15, Harlow, Essex CM20 2ER, England [461]



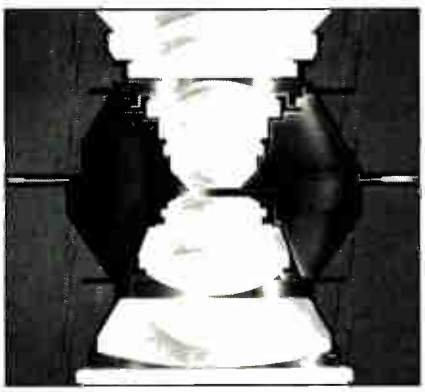
The 361 series of cables operate at from −50° to 260° C and are insulated to withstand 250 or 500 V. They resist solvents and are color coded. Wire sizes range from 30 to 20 American Wire Gauge. Tekdata Ltd., Westport Lake, Canal Lane, Tunstall, Stoke-on-Trent ST6 4PA, UK [462]

'Our optical know-how now also belongs to you.'



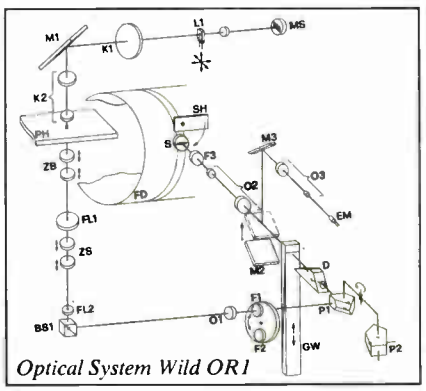
Example 1:
This is one of the world's smallest lenses

The accuracy and precision of the way we work at Wild Heerbrugg is demonstrated by the fact that this is where one of the world's smallest lenses was ground and polished. It has a spherical radius of only 0.515 mm. ■



Example 2:
Wild lens systems determine satellite tracks

For the survey photographs used to determine the flight paths of satellites and to establish the global geodetic network for tracking them, the US Coast and Geodetic Survey and NASA required ground-based metric cameras made by Wild Heerbrugg. The high-performance lens systems used in these were developed and manufactured in Heerbrugg. ■



Optical System Wild OR1

Example 3:
Wild Heerbrugg develops unique zoom system

The skill of Wild specialists is documented by the optical image-transmission and rectification system used in the Wild OR1 orthophoto instrument. For this instrument, a zoom system was developed with a 1:56 spread factor whilst maintaining colour fidelity and geometrical accuracy. See for yourself what this know-how of our optics specialists can do to improve the performance of your products with Wild optics. That's top performance in optical technology which can only be achieved by specialists and receives recognition world-wide. That's know-how and potential for your own products, too. ■

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Dr B Gaechter, Wild physicist

J Behringer, Wild optics production technician

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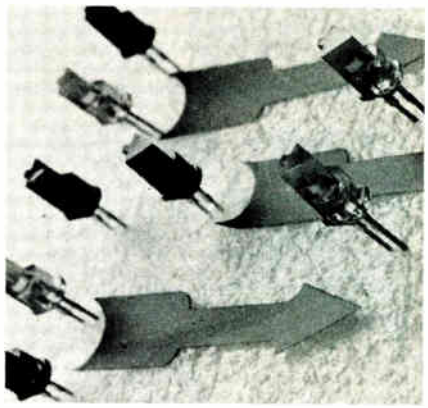
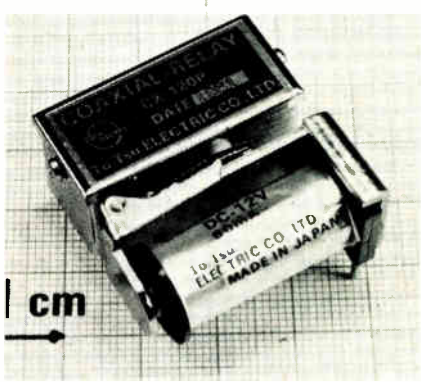


The Pic light-emitting diode comes in 15 versions with rectangular, round, square, triangular, and arrow-shaped planar surfaces. They are available in red, green, and yellow with a light intensity at 20 mA of at least 0.63 millicandelas. Siemens AG, P. O. Box 103, D-8000 Munich 1, West Germany [463]



The CX-120P relay for coaxial-cable switching mounts on printed-circuit boards. It has a low-voltage standing-wave ratio to over 1 GHz and an insertion loss of only 0.2 dB at 2.5 GHz. Toyo Tsusho Co., 3F Daini Azuma Bldg., 1-14 Kanda-Sakuma-cho, Chiyoda-ku, Tokyo 101, Japan [464]

The D611 digital thermometer measures temperatures from −43° to 120°C with an accuracy within ±0.1°C±1 count. It can measure the difference of two temperatures and temperature change over time. Takara Thermistor Instruments Co., 2-12-13 Shibuya, Shibuya-ku, Tokyo 150, Japan [465]

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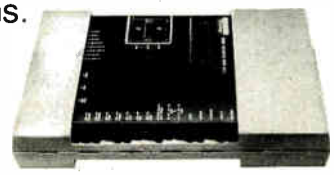

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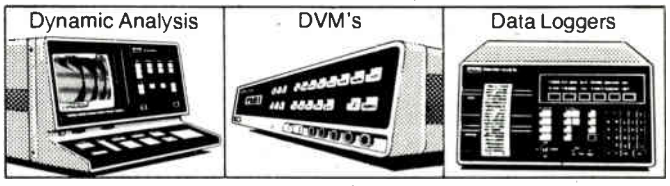

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USA:– Sangamo Weston Inc.,17972 Sky Park Circle, Irvine, Cal. 92714
Tel: 7146417137

Sweden:– Vesslevagen, 2-4, Box 944, 5-18, Lidingo 9
Tel: 4687652855

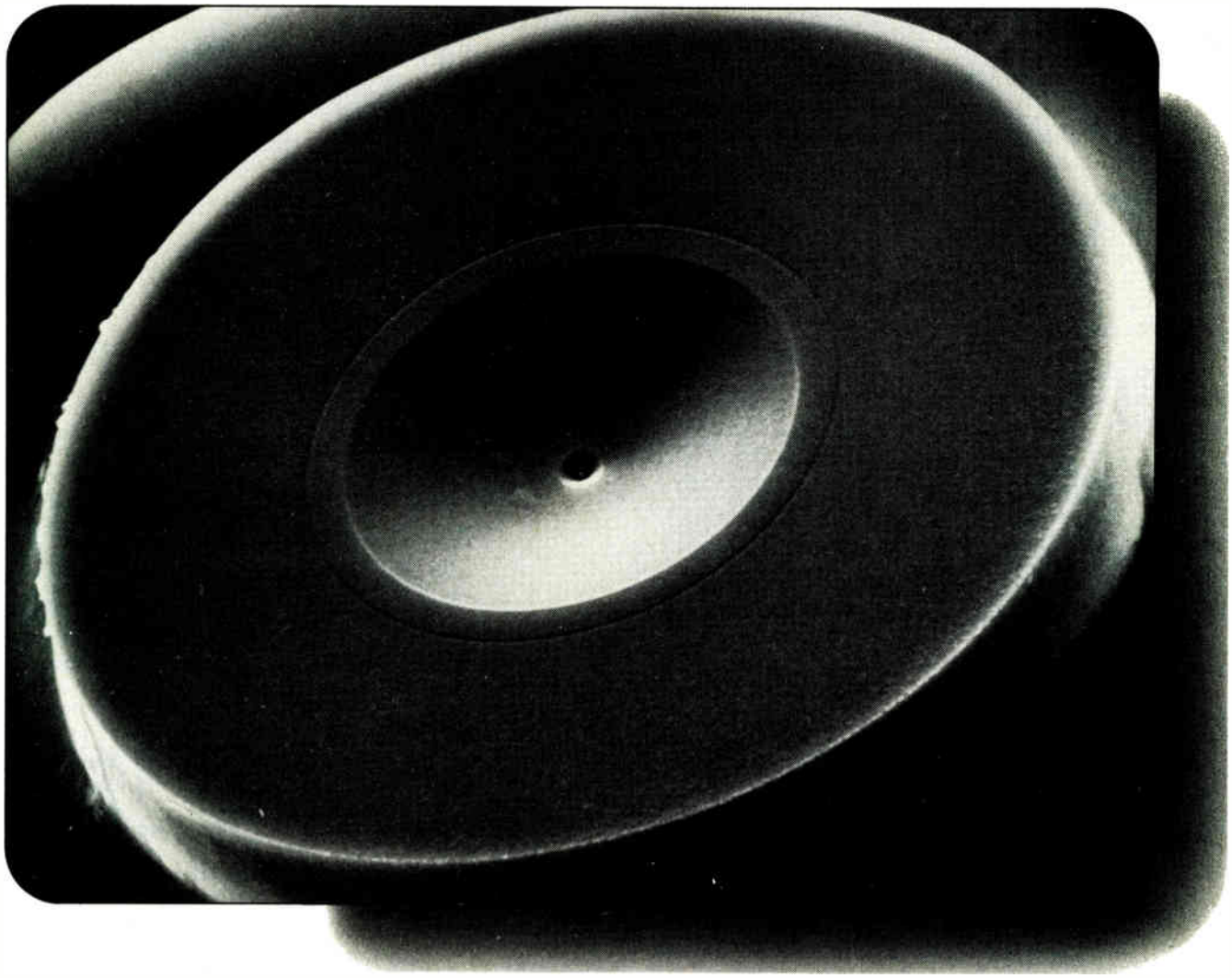
Circle 230 on reader service card

Meeting heavy demands for lightwave transmission

The promise that emerging lightwave communications technology offered just a few short years ago is about to be fulfilled as telecommunications authorities the world over upgrade or expand their networks with optical fibre systems. And Philips technology has contributed much to this state-of-the-art.

For example, Philips originated and developed the plasma-activated chemical vapour deposition (PCVD) method of manufacturing high quality fibre possessing a refractive index profile closely approximating the theoretically desired parabolic form.

Unlike other CVD methods, PCVD employs a non-isothermal microwave plasma to stimulate low-temperature reaction of the gases $SiCl_4$, $GeCl_4$ and O_2 within a tube of pure silica glass. The plasma reaction zone is produced by a microwave resonator that passes to-and-fro along the entire length of the tube, a very even and thin layer of oxides being deposited at each pass. In this way many hundreds of layers can be deposited to achieve a graded index fibre profile that



An enlargement of the etched surface of an optical graded index fibre (50μ core and 125μ cladding diameter).

PHILIPS

very closely resembles the ideal parabola.

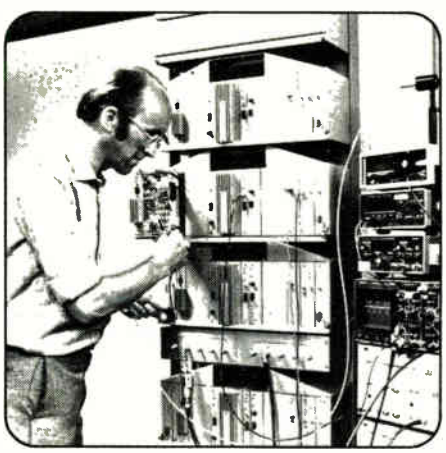
Exceptionally high bandwidth measurements are obtained on continuous production runs of these fibres, typically 850 MHz per kilometer at 850nm wavelength, with a lowest value of approximately 600 MHz.Km, and a top value of 1200-1300 MHz.Km.

Philips also achieved a major breakthrough in the complex PCVD manufacturing process by speeding up deposition of the layers without any loss in fibre quality. Instead of the standard deposition speed of 0.2 gramme/ minute, new techniques enable speeds up to one gramme/ minute to be reached, thus reducing the time taken to prepare silica glass preforms from 25 minutes to only five minutes per fibre-kilometer.

Increasing optical fibre quality at lower production costs is one of the many ways in which Philips technology is helping to meet the heavy demands for lightwave transmission. Here are some of the practical applications.

Overhead optical fibre cable now provides a cost-effective solution to the problems of television and FM radio reception in mountainous regions. A six-core NKF optical fibre cable system has been installed on a 2.8 kilometer pole-route to connect the villages of Aste and Beon, in the French Pyrenees, into the local CATV network. One of the first overhead optical fibre routes in the world, it provides the population of this remote area with FM audio reception and a choice of four colour television channels.

Circle 231 on reader service card



Lightwave telephone transmission. In addition to Philips all digital PRX/D exchanges, Saudi Arabia has ordered 140M/bits optical fibre systems to be integrated into the existing 2M/bits PCM networks in the Jeddah and Riyadh multi-exchange areas. Six-fibre cables, with a capacity of 1920 calls per fibre, will be used in the repeaterless routes, which total some 45 system kilometers. When completed it will be one of the first operational 140M/bits optical fibre transmission systems in the world. Circle 232

Optical fibre detection. The Philips SEM505 scanning electron microscope employs a unique optical fibre detection system within the specimen chamber. In the backscattered-electron mode, the system achieves the highest possible detection efficiency for highlighting topographic and/or atomic number contrast. When used for cathodoluminescence detection, a light-gathering lens focuses the signal on the fibre bundle. Light impulses from the detectors are routed to photomultiplier/-preamplifier combinations via optical switches. The system provides an exceptionally high degree of flexibility as well as a very fast reaction time. This ensures that TV-rate images can be obtained, even at low accelerating voltages, in all detection modes. Circle 233 on reader service card

Write for more information to your local Philips organization or to Philips, C.M.S.D.-Marketing Communications, VOp, Room 22, Eindhoven, Holland.

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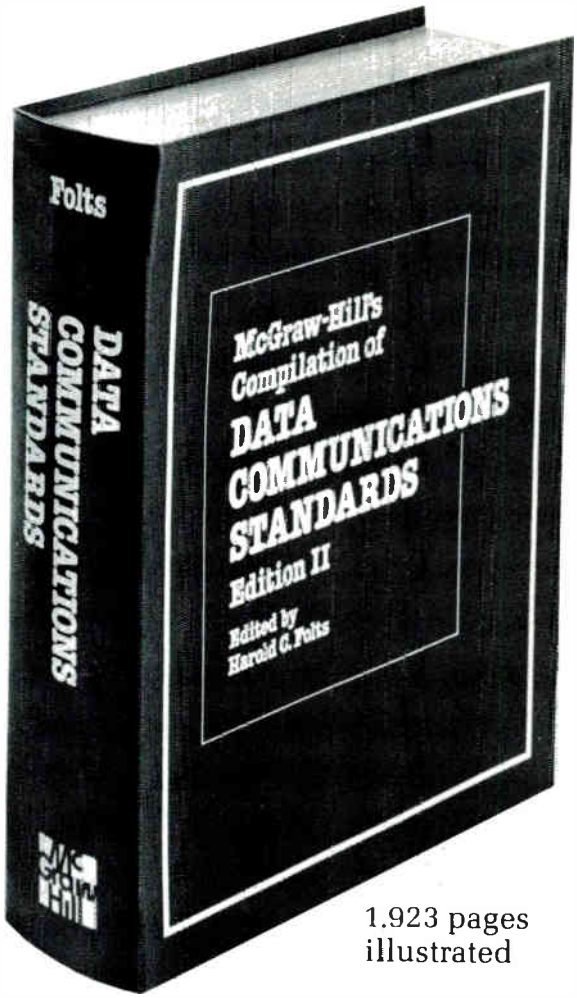

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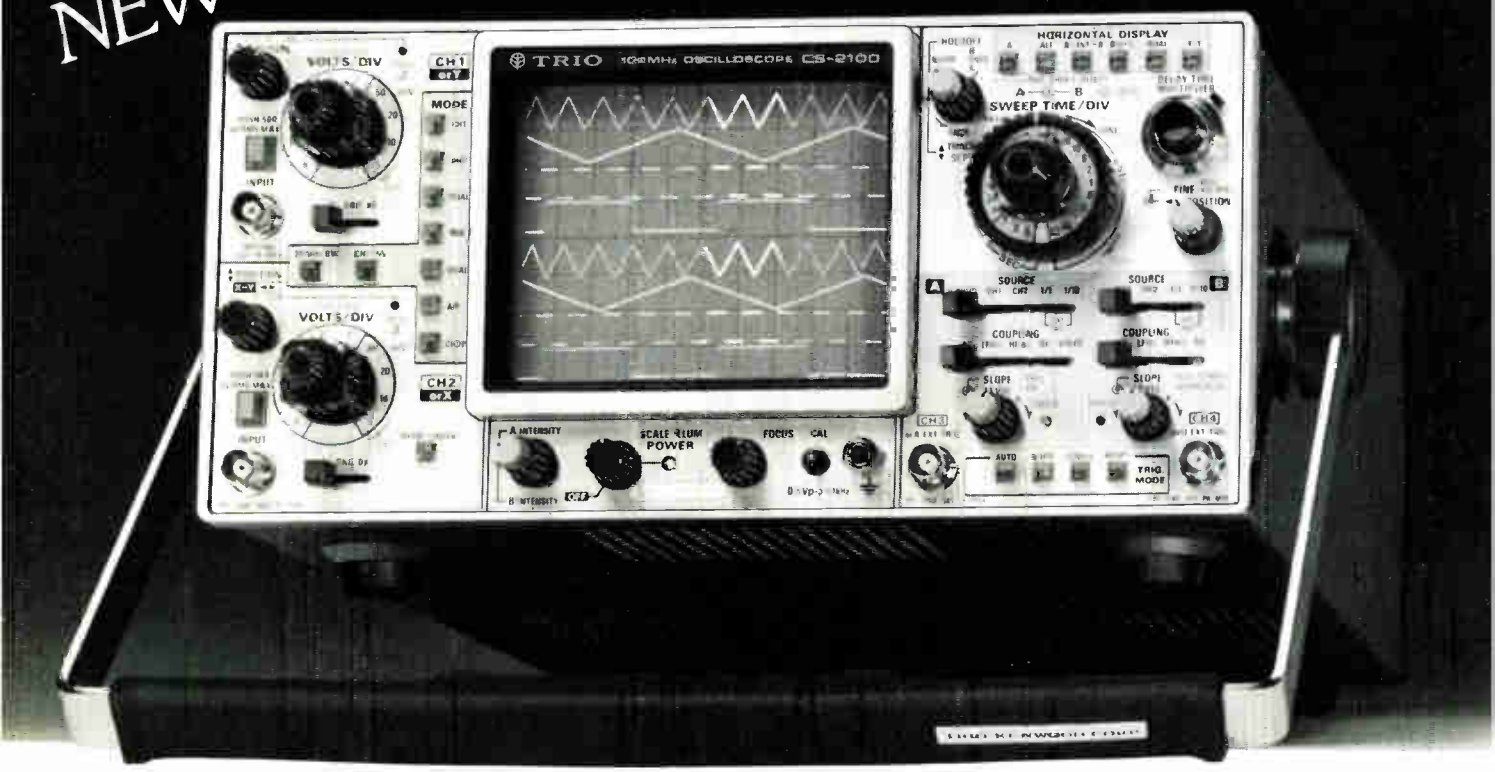
TRIO

A New Page has been Added to 100MHz Oscilloscope History!

NEW



4 Channel 8 Trace Display

100MHz 4 Channel Oscilloscope

CS-2100

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Circle 234 on reader service card

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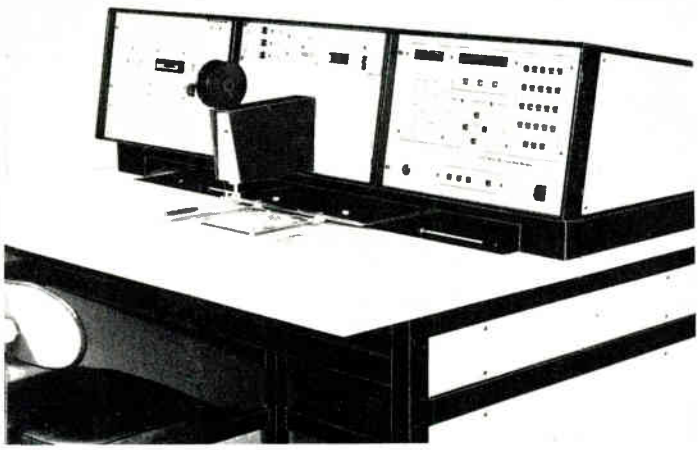

This low profile wiring technique allows, on standardized PC boards, packaging densities comparable with 6 to 8 layer boards. Compared to other techniques, the cost advantages at small or medium series and custom tailored circuit productions for military or industrial requirements are very substantial. The high economy and flexibility that this wiring technique offers, explains its great success. The new CNC85 computer controled wiring machine now adds further economy to circuit productions. For full details call or write to ASU.

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Circle 236 on reader service card

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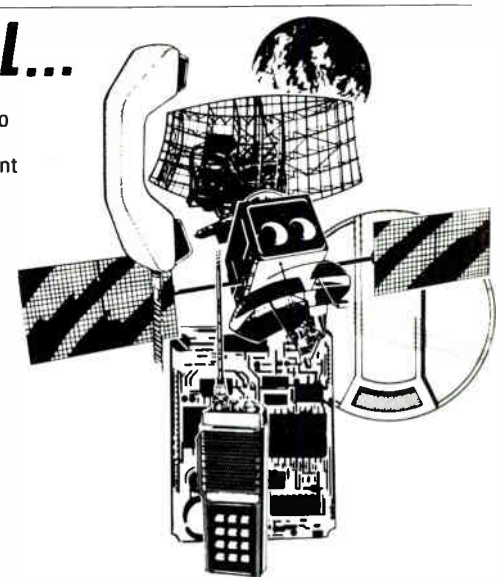

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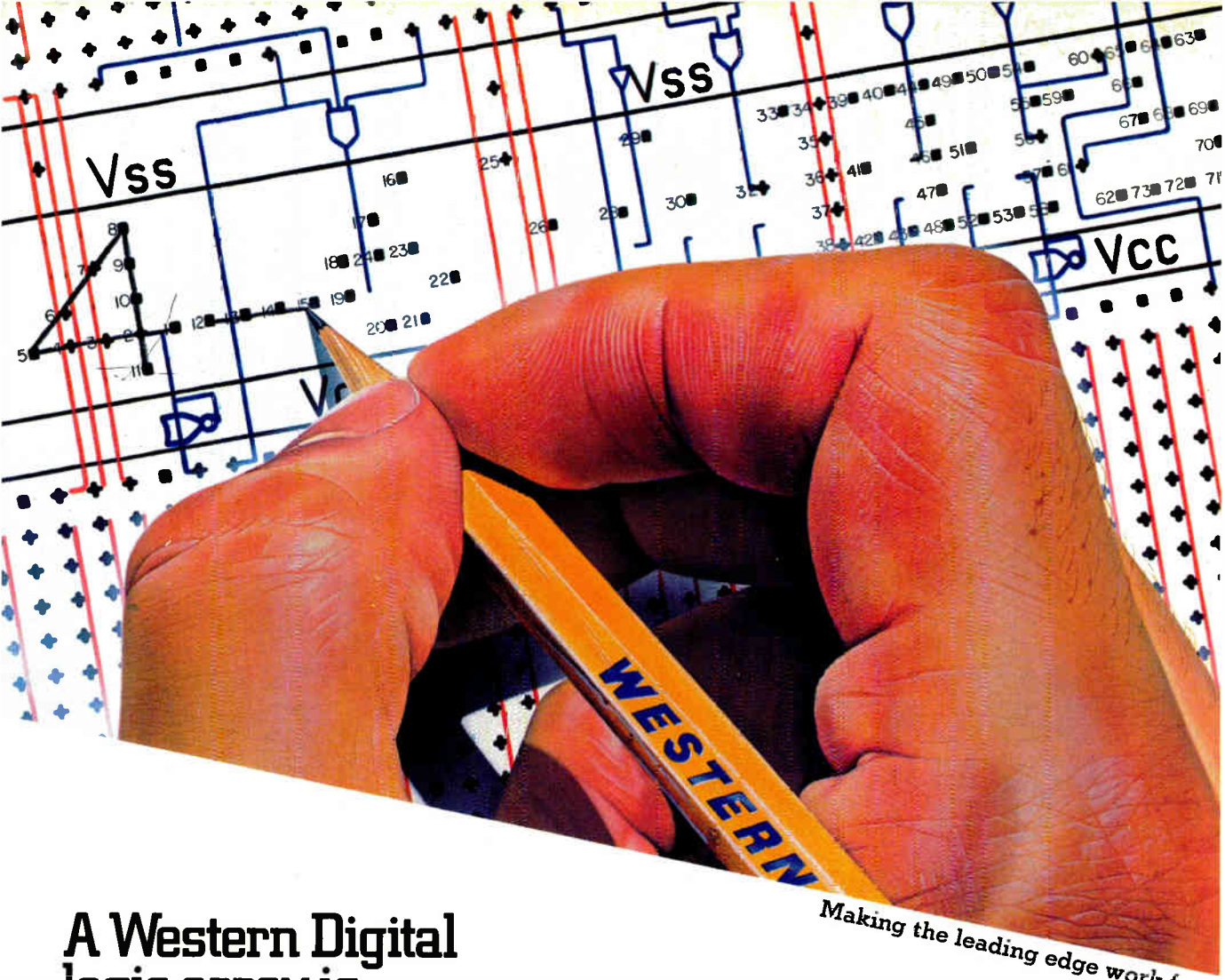

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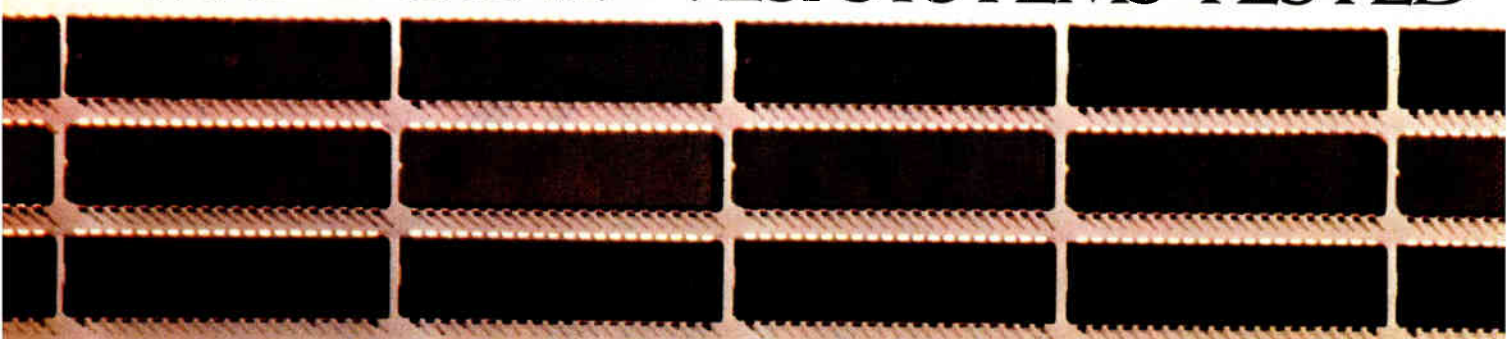

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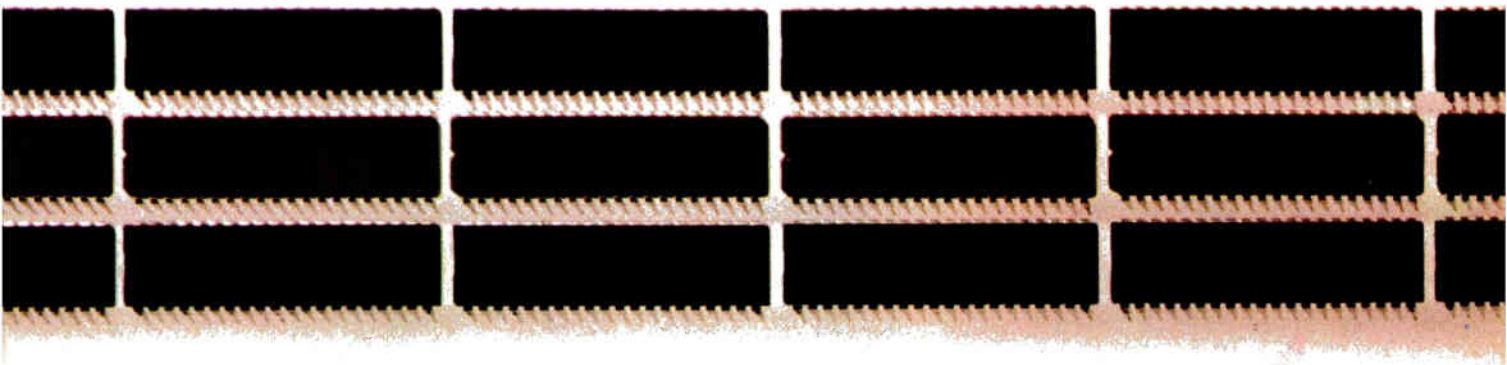

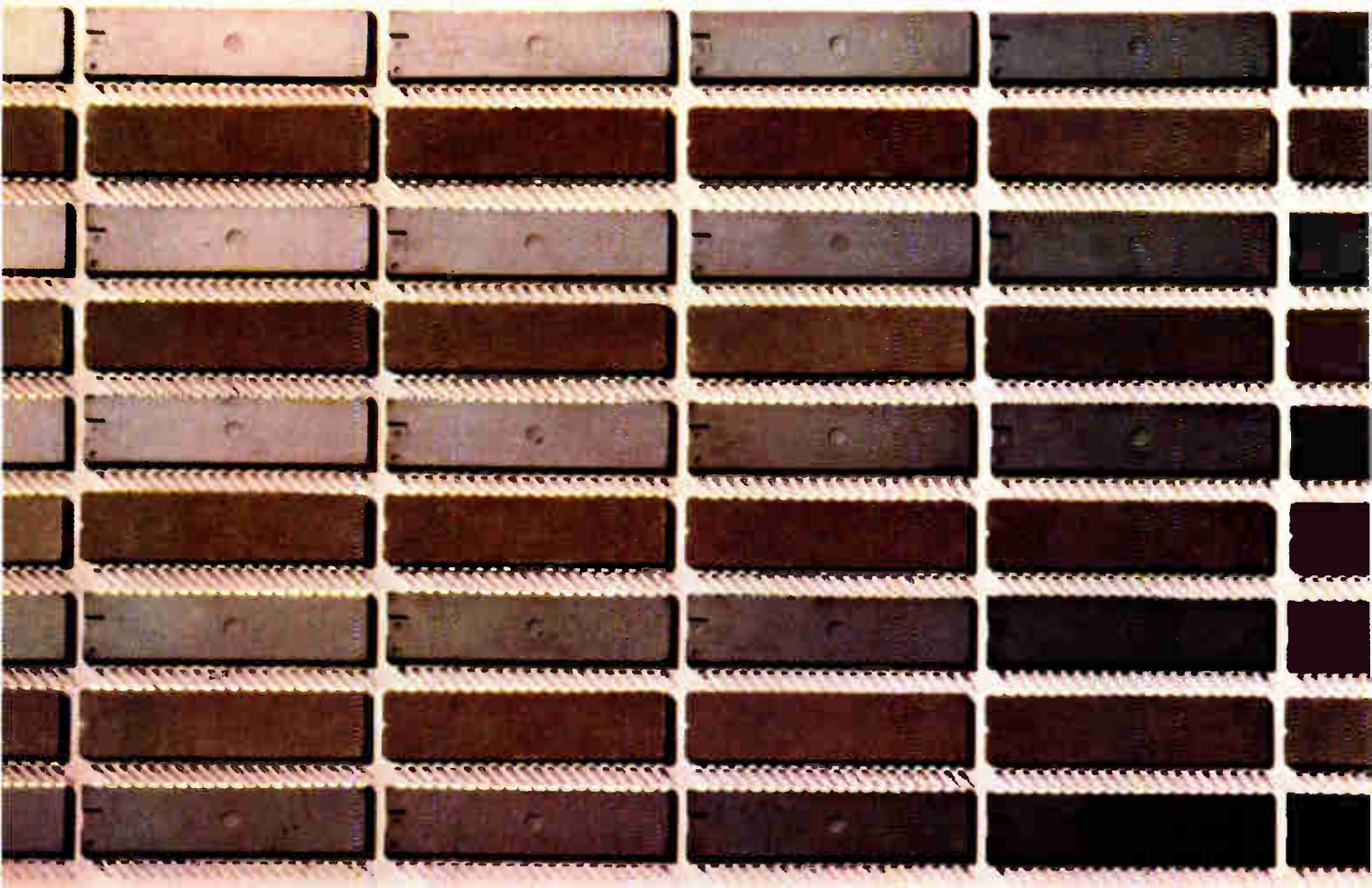

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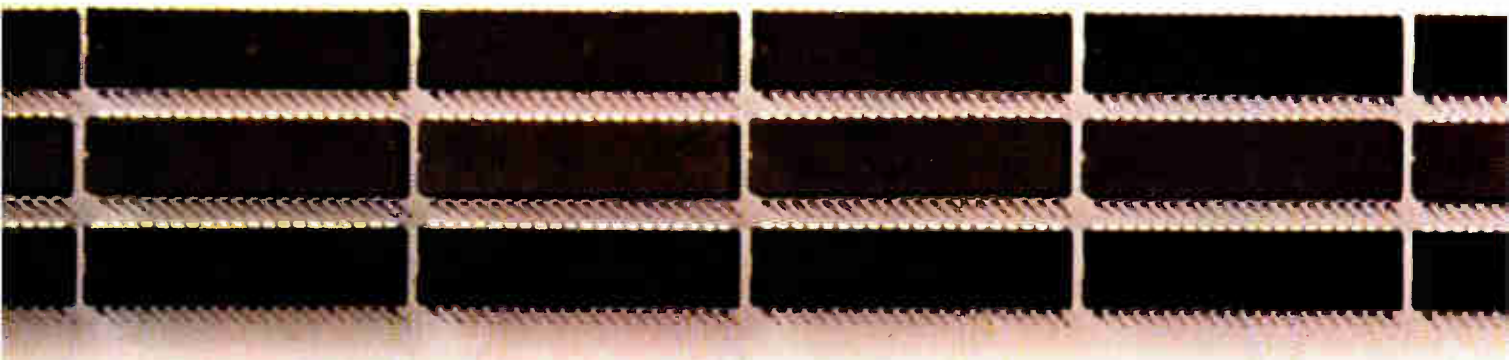

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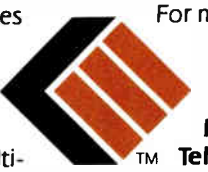

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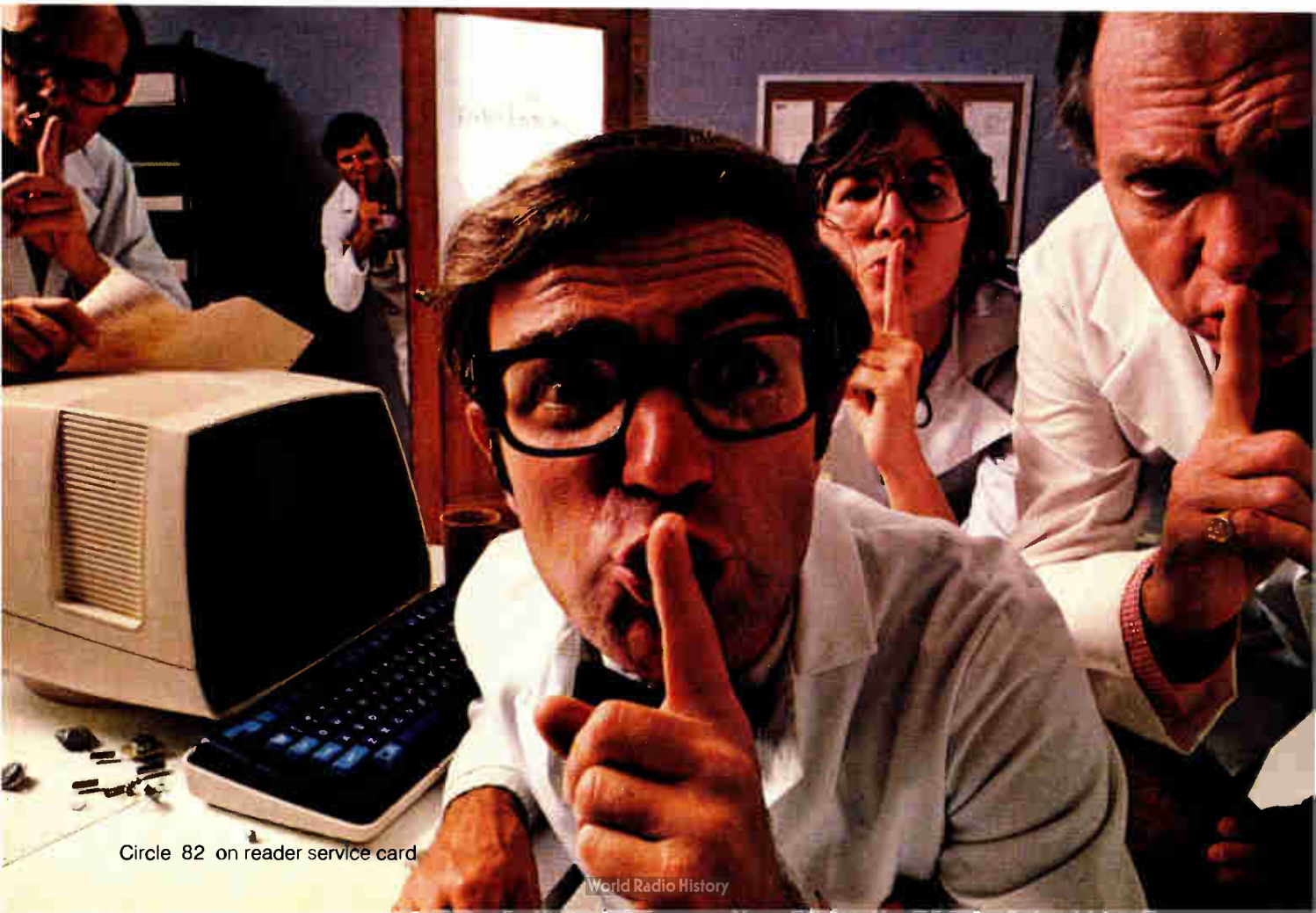


Circle 82 on reader service card

Japanese map computer domination

Ten-year R&D effort leading to fifth-generation systems for the 1990s is aimed at leapfrogging U. S. technology

by Tom Manuel, Computers & Peripherals Editor

The Japanese have set out to leapfrog U. S. computer technology and become the world's leading suppliers of advanced computer systems. After two years of study and research, the Japanese Information Processing Development Center—Jipdec—has hammered out a body of ideas, plans, and recommendations for projects that will culminate in what it calls a fifth-generation system by 1990.

The plan for research and development during the coming decade neatly integrates many of the innovative ideas from researchers in the U. S., Japan, and the rest of the world, extending and fitting them into the new system [*Electronics*, Nov. 3, p. 71].

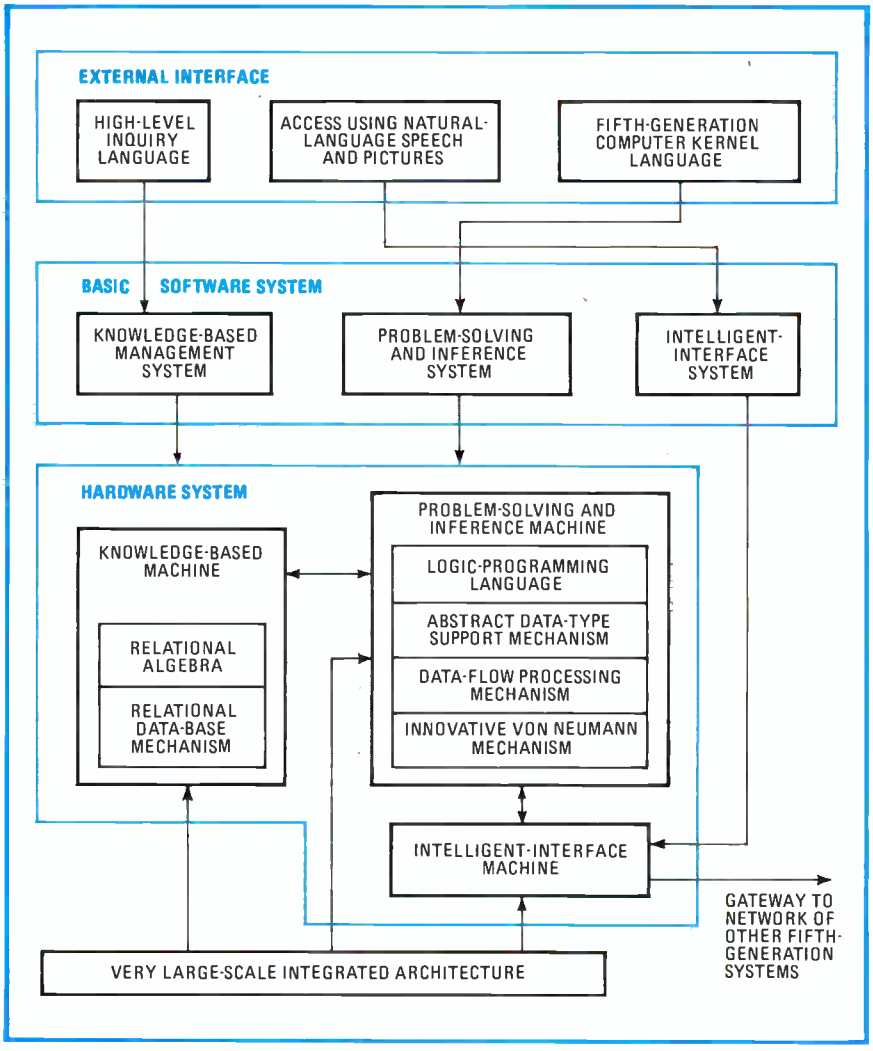
What makes the goal entirely believable is the Japanese ability to turn such efforts into a national project. That gives them, in effect, a national computer policy that is concentrated, organized, and possibly government-backed in a way that other countries cannot match.

Problem solver. To meet Japan's needs, the computer of the future, in addition to having a higher performance at lower cost, must be able to handle many more general problem-solving tasks than today's machines. In addition, the systems must be as natural for people to use as it is for them to speak. Access is to be through natural language, everyday speech, and pictures. The system that will perform this feat is being called the intelligent-interface machine (see figure).

Another of its three basic functions will be the system's ability to learn, associate, and infer, just like people. The computer will be able to clarify even vague requests and then, by using its vast store of information or that available from other computers, make judgments that will enhance the thinking capacity of its human masters.

In other words, the computer could carry on an intelligent question-and-answer session with a person. The basic function that will perform this feat is called the problem-solving and inference system, with a separate machine to implement it.

The third basic capability will be



Planned system. The intelligent-interface machine will offer natural-language access, the ability to learn and infer, and an understanding of the data it is storing.

the ability to use stored information—the computer will be able to understand the contents of the data base instead of just being able to store it, retrieve it, and pass it on. These knowledge bases—as opposed to data bases—will feed the problem-solving function.

This part of the tripartite brain will be called the knowledge-based management system. It too will have its own specialized machine, like the other two, to use advanced very large-scale integration.

In all sizes. Fifth-generation computers are slated to come in sizes ranging from small personal to large mainframe computers. It should be no surprise that they will be interconnected with local and global networks. Some new techniques to be used are new architectures like data-flow machines, artificial-intelligence concepts, and languages such as Lisp and Prolog along with machines optimized for them.

Jipdec has recommended 26 R&D themes, each with several projects. The themes are grouped into seven categories (see table). Each theme has target specifications.

For example, a personal work station would be required to perform 2 million instructions per second, have from 0.5 to 5 megabytes of memory, and include 100 megabytes of disk storage with an average access of 1 millisecond. Other specifications include what is referred to as a super high-speed processor to perform from 1 billion to 100 billion floating-point operations per second and have a memory capacity of 8 to 160 megabytes.

Big numbers. Designers hope to create the problem-solving and inference function so it will have a performance of 100 million to 1 billion logical-inference operations per second (one logical inference equals 100 to 1,000 instructions). Another example is the specifications for a natural-language processing system. In addition, the knowledge-based management function should retrieve a unit of knowledge in several seconds from a knowledge base of 100 to 1,000 gigabytes.

VLSI technologies, first with 1 million transistors per chip and then up to more than 10 million, are to be used. A design-automation system for these integrated circuits will also be developed.

Newer high-speed device technologies such as gallium arsenide and Josephson junctions are excluded from the program because the researchers believe that such devices will not be ready for general use by 1990. However, they do maintain that the progress of these devices will be closely watched so that they can be incorporated into the project at some intermediate stage should they prove sufficiently practical and capable of superior performance.

The design-automation system is to consist of three parts: the software for automated design of VLSI, a computer system to run it—called System 5G—and the 5G personal computer that will be a logic-programming work station for designers. In the initial stage—the first five years—of the project, the planners intend to implement the Hierarchical Specification Language now being used at the Musashino Electrical Communication Laboratory of the Nippon Telegraph & Telephone Public Corp.

The HSL system has several modules that are integrated into a total design system. It contains a language for describing a circuit, compiler, data base, timing simulator, logic simulator, circuit simulator, test-pattern generator, placement and routing program, and design-rule checker.

Logic designer. Also part of the design-automation project is the development of the logic-programming work station. No existing personal computer satisfies the requirements of high-speed processing of voice, graphic, and digitized image input and of performance as a personal inference machine using languages like Lisp or Prolog. One of the fastest conventional general-purpose computers—one capable of 40 million instructions per second—is planned to be the host computer for the design automation system until the first models of fifth-generation computers are available. □

SCOPE OF THE FIFTH-GENERATION PROJECT

Basic-application systems
- Machine-translation system
- Question-answering system
- Applied speech-understanding system
- Applied picture- and-image-understanding system
- Applied problem-solving system

New advanced architecture
- Logic-programming machine
- Functional machine
- Relational-algebra machine
- Abstract data-type support machine
- Data-flow machine
- Innovative von Neumann machine

Development-supporting technology
- Development support system

Very large-scale integrated technology
- VLSI architecture
- Intelligent VLSI computer-aided design system

Systematization technology
- Intelligent-programming system
- Knowledge-based design system
- Systematization technology for computer architecture
- Data-base and distributed data-base system

Basic-software systems
- Knowledge-based management system
- Problem-solving and inference system
- Intelligent-interface system

Distributed-function architecture
- Network architecture
- Data-base machine
- High-speed numerical-computation machine
- High-level man-machine communication system

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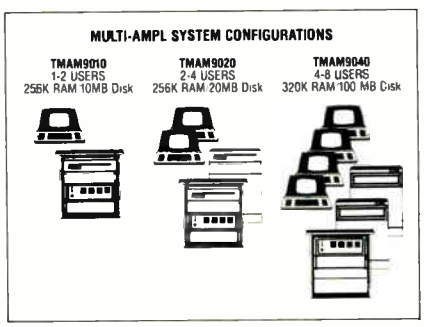

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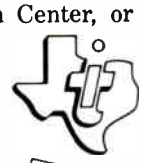

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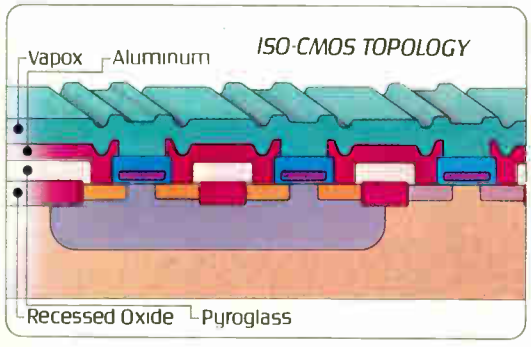

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BUILDING BETTER COMMUNICATIONS

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Data communications

DES chips find a new niche

Authentication of messages may provide more sales for manufacturers of digital encryption-standard devices

by Wesley R. Iversen, Chicago bureau

When the National Bureau of Standards published the data encryption standard (DES) in early 1977, at least eight semiconductor manufacturers leaped to produce dedicated DES chips or chip sets. Additional vendors jumped in at the system level, with black boxes designed to capitalize on what all agreed was to become a booming market for DES chips and equipment.

Unfortunately, that estimation turned out to be grossly in error. Despite the vendors' best efforts, few commercial data-processing managers were convinced of the need to encrypt their data messages, and the expected DES market explosion never materialized. "Two or three years ago, we were predicting that the total market would be in the hundreds of millions of dollars by now. But I'd guess now that it's only a million-dollar business, if that," laments Jack J. Hill, privacy products manager for Rockwell International Corp.'s Collins Telecommunications Products division in Cedar Rapids, Iowa.

According to International Resource Development Inc., a Norwalk, Conn., research firm, the market for data, facsimile, and text encryption equipment will amount to just $18 million this year, rising to only $44.9 million by 1991. Instead of the broad mass market envisioned, DES chip and equipment manufacturers will have to be satisfied with "niche markets" for their products, declares International Resource.

Ironically, the next market niche to develop for DES chips may be spurred by the enactment soon of a different standard. The proposed standard developed by the X9.E8 working group of the American National Standards Institute covers the "authentication" of funds-transfer wire messages and other communications in the wholesale banking business. Expected to receive final approval within the next six months, the so-called "financial institution message authentication standard" specifically calls for use of the DES algorithm as part of its methods.

No coding. Data authentication differs from encryption in that it does not involve encoding of the message itself. Instead, authentication is used in applications where the sender and receiver are not concerned with the secrecy of the message *per se*, but rather with assuring that the message is not altered during transmission. An additional concern is that bogus messages sent by unauthorized parties be not accepted as authentic. Though sophisticated authentication schemes have been used in military applications for some time, they have not found wide use in the commercial sector.

In the proposed ANSI standard, the DES algorithm is to be used in the generation of a message authentication code, or MAC, that is unique to the message being sent. An eight-digit number in hexadecimal format, the MAC is derived by passing the message or portions of the message

How the DES works

The data encryption standard can provide user authentication, data authentication, and data security in many ways. Some devices meet one or two of these objectives while others meet them all. While data security has been the major use of the DES until now, "no great practical or theoretical advances are needed to apply it to user or data authentication," says Carl M. Campbell, president of Transaction Security Products Inc., a consulting firm in Newton Square, Pa.

What are known as nonreversible transformation techniques provide only user authentication. In this approach each authorized user of a system is given a code word. Each terminal in the network using the authentication system has DES capability and transforms the user's code word into another code word. The system's host processor stores each user's transformed word. A simple comparison is thus sufficient to authenticate the user.

For data authentication that can also provide user authentication but no data secrecy, DES check digits are convenient. In this approach a check field is added to the message by the sender and verified by the recipient. The appended digits are generated by a DES key known only to the sender and recipient.

In one implementation of this approach, Campbell says, "each group of data bits is passed through the DES algorithm after being combined with the output of the previous pass." The final DES output (the check field) is a residue that is a cryptographic function of the entire message. This technique cannot prevent the repetition or deletion of a message. One way to solve this problem is to include a DES—protected sequence number with each message.

-Harvey J. Hindin

to be sent through the DES algorithm with a secret 56-bit key that is agreed upon by the sender and the receiver. Either the DES-cipher-feedback or cipher-block-chaining mode may be used.

Once the MAC has been calculated by the sender, it is appended to the message and transmitted with the message to the receiver. Upon receipt of the message, the receiver recalculates the MAC using the agreed-upon secret key. If the result is identical to the MAC received with the message, then the message is accepted as authentic. If the MACs do not match, then the message is rejected as having been altered or sent by someone using the wrong key. Since only the sender and the receiver share knowledge of the secret key, the MAC serves as an electronic signature of sorts.

Asking for DES. Since the proposed standard specifies use of the DES algorithm, the manufacturers of DES encryption equipment are cautiously eyeing the potential market for bank authentication gear. Motorola Inc., Scottsdale, Ariz., for example, will develop prototype equipment "by the end of next year or sooner" designed to implement the ANSI authentication standard, says Jerry J. Hogg, system development manager for the firm's Info-Guard 4100 product line. With firmware modifications, some of Motorola's 4100 DES encryption equipment could be used for authentication applications. But Hogg notes that bankers are also looking for new types of devices such as dedicated, low-cost handheld or desktop authentication terminals that could be used by smaller correspondent banks or bank customers. However, Motorola is mindful of the disappointing performance of the DES encryption market and will likely go slowly in introducing products.

One company that plans to go after funds-transfer authentication business in a big way is Atalla Corp., a 10-year-old San Jose, Calif., firm that currently supplies a variety of security hardware devices to the banking industry. At next month's Bank Administration Institute money-transfer development conference in New York, Atalla plans to formally unveil a new version of its TRAC (transfer authentication code) system that is designed to implement the proposed ANSI standard. The system includes small authentication terminals priced at $950 each for remote use as well as a $16,000 wire-room security module that would be used at bank headquarters, interfacing with a bank's main computer, says chairman John M. Atalla.

The small TRAC terminals will rely upon Intel Corp.'s 8294—a DES peripheral chip designed for low-speed encryption requirements—under control of an Intel microprocessor. Equipped with a 10-key pad and an 8-digit display, the terminal will allow users to employ a MAC manually by keying in appropriate portions of the message to be sent together with the secret key. For automated MAC generation and comparison, the TRAC wire room security module will employ faster DES chips supplied by Western Digital Corp., Newport Beach, Calif., and by Motorola, Atalla says.

More uses. Though the wholesale banking business may offer the nearest-term potential, other applications may also crop up. In retail banking, a different ANSI group is working on an authentication standard covering automated teller machines and other consumer devices. And at the NBS, encryption specialist Miles E. Smid points out that authentication could also be useful for ensuring software integrity. For example, a MAC calculated on the basis of information contained in a particular file could be periodically recalculated to ensure that the file had not been tampered with. Authentication techniques could also be used to ensure that an operating system or other program had not been altered.

Authentication may also find uses in local area networking. Xerox Corp.'s Office Systems division, for one, is known to be working on a device referred to as an "authentication server." Though officials at the Dallas division are close-mouthed about the project or a potential product introduction date, the unit could eventually be offered to provide a message-authentication function on Ethernet systems. □

Components

Chip resistors gain support

U. S. companies gear up to make the small, light thick-film devices, as a second domestic maker introduces an automatic insertion system

by Roderic Beresford, Components Editor

Against the backdrop of a thriving Japanese market for general-purpose thick-film resistors, American firms are preparing to turn out the tiny leadless components. In Milwaukee, Allen-Bradley Co. has announced its first chip resistors, manufactured on an automated production line and destined for high-volume applications in automotive and consumer electronics.

At the same time, and perhaps not coincidentally, the Dyna/Pert division of Emhart Corp. in Beverly, Mass., has made public its CHPS automatic insertion machine, the result of a several-year development program designed to come up with a tool geared especially to handle leadless components. It joins the Onserter system from Universal Instruments Corp. of Binghamton, N. Y., on the domestic equipment front, and with other sources of the components likely here before long, the domestic market is a good bet to put in a strong showing.

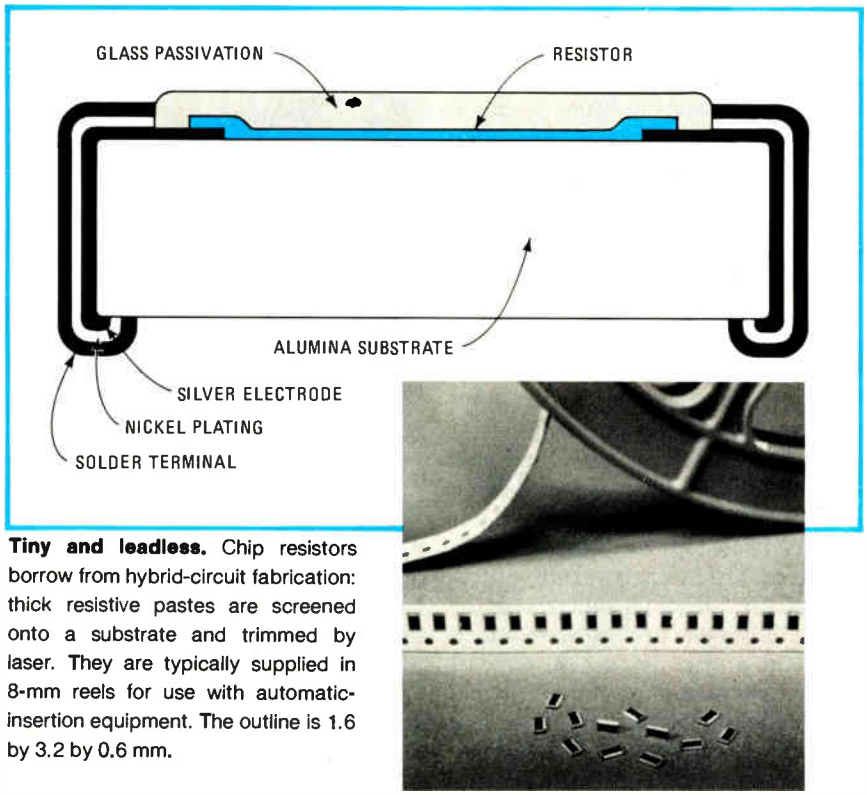
Marriage. The thick-film technology for chip resistors is essentially the same used for many years in high-reliability hybrid circuits. The projected heavy use of these chips will represent a marriage of these proven techniques with automated mass production to establish a component with prices closer to carbon-film resistors, but with greater reliability. The small, light chips are well-suited to automatic placement and wave-soldering onto printed-circuit boards, implying many indirect savings over leaded components.

Indeed, such a market is already geared up in Japan. About 1.8 billion units were sold last year, with Matsushita Electric Industrial Co. and R-Ohm Corp. the major suppliers. According to a report from Sal Guastella, product manager at Panasonic Co., the U. S. marketing and distribution arm of Matsushita, worldwide demand for general-purpose chip resistors is likely to top 7 billion units in 1985.

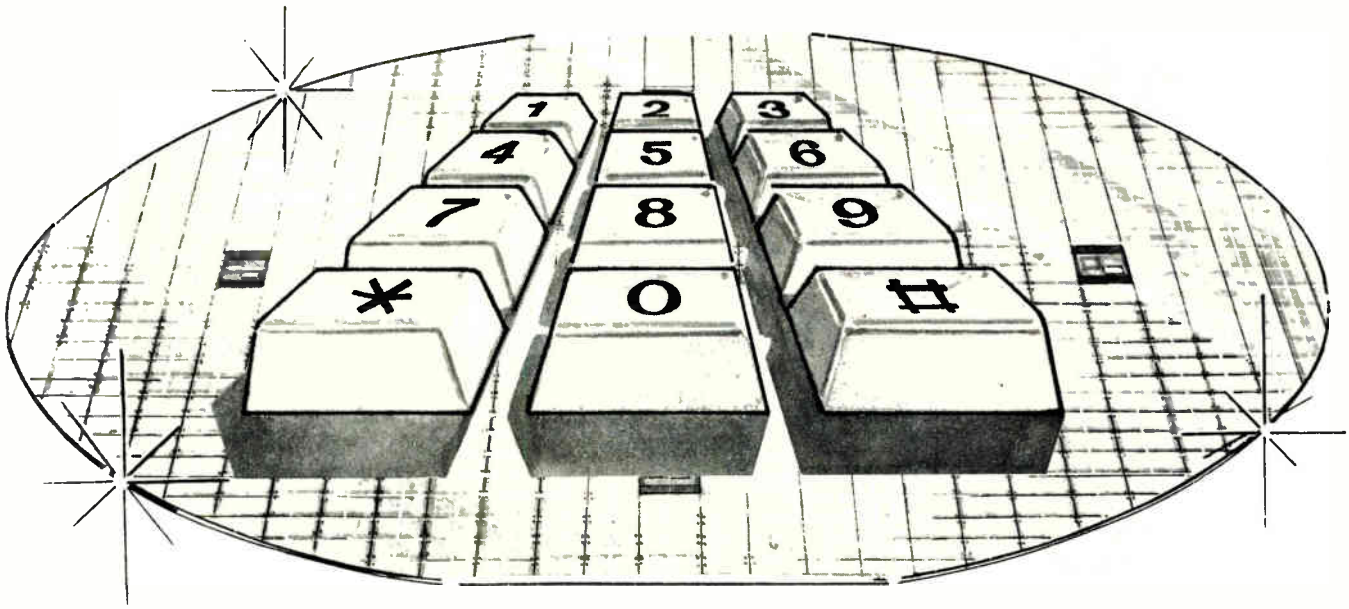
Embryonic. At Allen-Bradley, director of marketing Chet Grimsley paints a similar picture. He notes that "the chip resistor market is now in its embryonic stage in this country. By the end of the decade, we expect chips will be the largest-volume resistive component, totaling some 7 to 8 billion units."

Some, if not most, of this growth will be at the expense of discrete carbon-film or carbon-composition products that are larger and less reliable. Allen-Bradley does see the low-end carbon-composition resistors—for which it is now the only domestic source—as still viable for some time to come. One reason is that chip resistors today typically cost a few cents, compared with fractions of a penny for carbon types.

Still, the move toward chip resistors is more evidence that the domestic resistor industry is in something of a transitional period. TRW Inc. is scheduled to close its carbon-composition facility in Philadelphia in December and, perhaps not surpris-



Tiny and leadless. Chip resistors borrow from hybrid-circuit fabrication: thick resistive pastes are screened onto a substrate and trimmed by laser. They are typically supplied in 8-mm reels for use with automatic-insertion equipment. The outline is 1.6 by 3.2 by 0.6 mm.



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ingly, last month announced a joint venture with Koa Denko Co. of Ina City, Japan, calling for manufacture in Japan of resistor networks and other thick-film components.

Back in this country, TRW appears to be the next major supplier that will enter the leadless-component business. At its Boone, N. C., plant, limited production is under way of leadless versions of the ceramic-metal resistors that TRW has for years supplied in discrete form.

As John MacWilliams, marketing manager for the company's Resistive Products division, says about the market, "Leadless components represent such a revision of present circuit-board assembly techniques that they are unlikely to catch on as quickly as some would think. Tremendous capital investments and long equipment lead times are necessarily involved in this move."

For high-volume users, this is likely to be less of a drawback. "The automotive companies, especially Delco, are very interested in reducing board sizes under the hood," Allen-Bradley's Grimsley says. "Even today, smaller-volume applications could be using chips, since there is some insertion equipment available in the range of $25,000." In any case, chips have several compelling advantages for manufacturers.

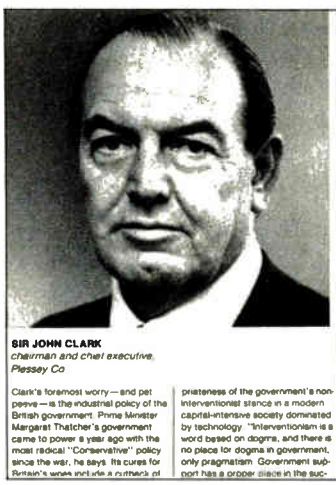
Small and neat. The first thing that chip resistors offer is a very small and regular outline. The present standard is 1.6 by 3.2 by 0.6 millimeter, and the payoff is increased component densities on boards.

Even now, further improvements are in the works. Panasonic will introduce chips half this size early next year. The regularity of their structures is also a boon to automated design because standard rectangular shapes are more convenient in computer-aided layout.

The second attraction of these tiny chips is reliability. This is no surprise, with the technology so close to that conventionally employed by hybrid circuit makers (see figure).

The resistors are built on high-purity alumina substrates by screening on resistive paste, which is laser-

Important editorial



SIR JOHN CLARK
chairman and chief executive, Plessey Co

Clark's foremost worry—and pet peeve—is the industrial policy of the British government. Prime Minister Margaret Thatcher's government came to power a year ago with the most radical "Conservative" policy since the war, he says. Its cures for Britain's woes invite a number of problems of the government's non-interventionist stance in a modern capital-intensive society dominated by technology. "Interventionism is a word based on dogma, and there is no place for dogma in government, only pragmatism. Government support has a proper place in the suc-

Concern for the economy tempers industry leaders' overall optimism for 1981

Government's attitude toward business, deepening shortage of professionals, and sharp competition for world markets also loom as obstacles

JOHN W. ZEVENBERGEN
president, John Fluke Manufacturing Co

The economy, the shortage of engineers, Government action—these top the list of concerns for a majority of electronics executives looking ahead to 1981, and Zevenbergen is no exception. "I don't see the U. S. economy straightening out until April," he says. "And the European economy is still headed downward, which will slow the instrumentation industry's recovery." But Zevenbergen does anticipate a boom after

KAZUO IWAMA
president, Sony Corp

If only there were enough engineers to go around, Iwama would be a man without a care in the world. Sony plans to hire 400 engineers and scientists next spring, but has difficulties in recruiting them because of competition from such other technology areas as the machine tool, office machine, and automotive industries.

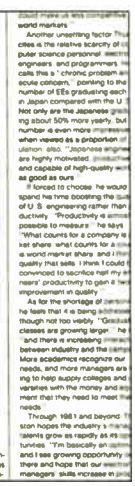
Iwama considers himself fortunate that Sony has no plans for large-scale software development in 1981 because software engineers are in even shorter supply. Still, he points out, there has been such a shortage for about 10 years, and Sony still has managed to develop new products and increase sales on old ones in that period.

On the bright side, says Iwama, is

WILLIAM R. THURSTON
president, GenRad Inc

My chief concern is uncertain demand. Electronics traditionally acts behind other sectors of the economy.

Thurston is as worried about management reactions to a slowdown as he is about the slow down itself—ex-



world markets.

Another unsettling factor cites is the relative scarcity of puter science personnel, electr engineers and programmers. calls this a "chronic problem acute concern," pointing to the number of EEs graduating each in Japan compared with the U. Not only are the Japanese grad ing about 50% more yearly, but number is even more impressive when viewed as a proportion of ulation; also, "Japanese engine are highly motivated, productive and capable of high-quality work as good as ours."

If forced to choose, he would spend his time boosting the qua of U. S. engineering rather than ductivity. "Productivity is almost possible to measure," he says. "What counts for a company is hat share; what counts for a co is world market share, and I think quality that sells. I think I could b convinced to sacrifice half my en neers' productivity to gain a hal improvement in quality."

As for the shortage of person he feels that it is being addressed though not too visibly. "Graduate classes are growing larger," he s "and there is increasing interac between industry and the campus More academics recognize our needs, and more managers are ing to help supply colleges and versities with the money and equ ment that they need to meet the needs."

Through 1981 and beyond, Th son hopes the industry's manag talents grow as rapidly as its opp tunities. "I'm basically an optimi and I see growing opportunity t there and hope that our electron managers' skills increase in prop

Electronics worldwide editorial breaks all important technical and business news.

Take Sir John Clark...

"The private sector in England is being slaughtered. Government support? I would place the French ahead of everybody."

Or GenRad's William R. Thurston...
"What counts for a company is market share, what counts for a country is world market share."

Or Kazuo Iwama of Sony...
"Japan has more consumer electronics engineers than any other nation, making it strong in both development and production technology."

Or Pasquale Pistorio of SGS Componenti Elettronici...
"Semiconductor growth is so strong and people so cautious that demand and supply will be rebalanced in 1982."

Or Hughes Aircraft's John H. Richardson...
"Suppliers view the defense marketplace as a less attractive place to do business than other market sectors."

Or Unitrode's George M. Berman...
"The Europeans and Japanese are tough rivals, and that's good. We don't need protection from them. We need wider markets."

Such concerns as the economy, the shortage of engineers, government action, international economics, are addressed by top management in electronics companies throughout the world each December in Electronics Annual Executive Outlook.

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trimmed to the required value. Wraparound edge terminals and a glass passivation layer are applied, completing the sealed, leadless assembly. The components have low parasitic inductance and also hold the potential for good accuracy and temperature-drift specifications.

Allen-Bradley's introduction, designated type BC, claims 1% tolerances and drifts of 100 parts per million/°C. Thus, the successful transfer of sophisticated thick-film techniques to mass production may eventually lead to chips displacing some precision discrete resistors.

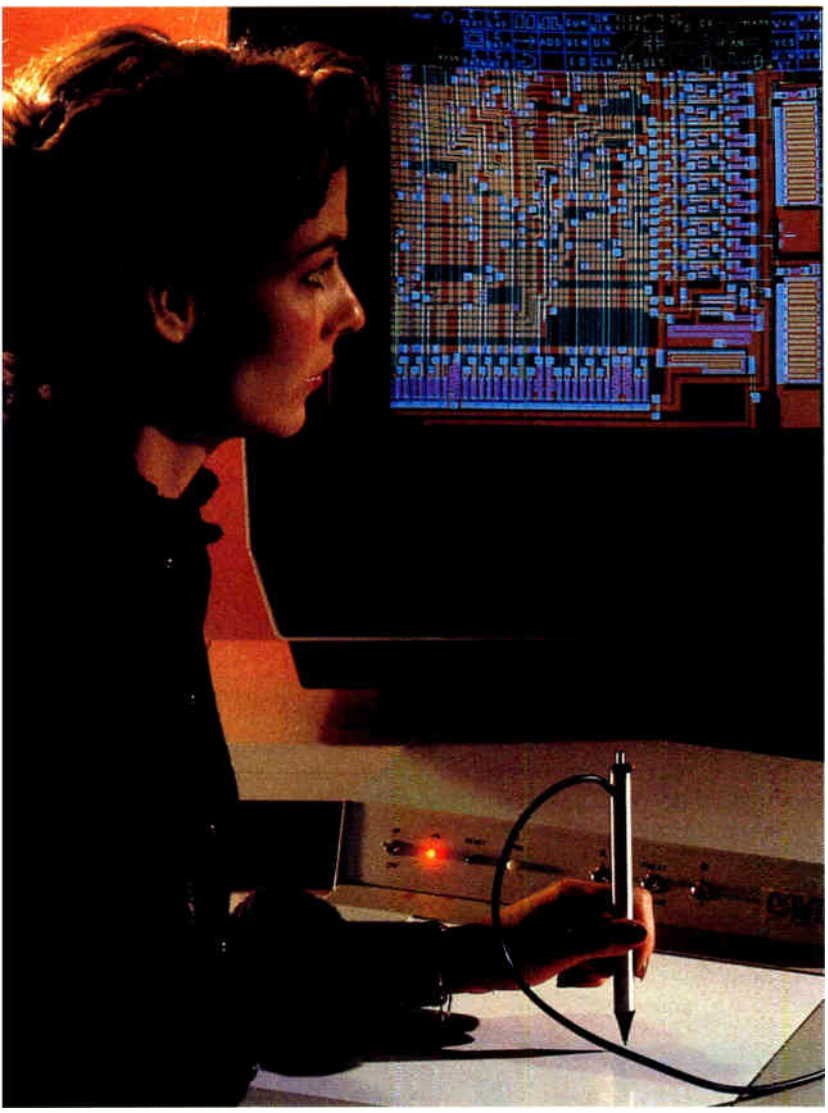
Automation the key. But the clincher is automated pc-board assembly of leadless components. The high-volume users have been waiting for the automatic-insertion equipment that can handle the chips, whether they are supplied in tape reels or in bulk. Although several Japanese companies have been marketing such machines, Dyna/Pert's recent introduction is the second from a major U. S. supplier.

Universal Instruments began offering the Onserter—insertion equipment to handle leadless components—last May. According to Robert Groening, program manager for hybrid processing equipment, "as far as sources in this country, Universal and Dyna/Pert are it."

Dyna/Pert's CHPS system was shown to a group of component manufacturers last spring and to the public at Productronika in Munich last week. With up to six placement heads per X-Y table, the machine can place the leadless, rectangular, or cylindrical components at rates up to 60,000 per hour. What's more, the machine can store up to 600 different component values.

"The transport mechanism was a major design hurdle that we carefully protected with patents," says Neil McLean, marketing manager at Dyna/Pert. "The basic requirement is to move a tiny component over some feet of track at speeds around 100 miles per hour and decelerate it safely into the placement head." The system is expected to cost less than several less sophisticated units but have the same throughput. □

Performance



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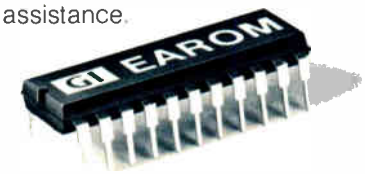

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Careers

U. S. asked to help produce more EEs

AEA tells Congress that Government should join industry to help alleviate shortage of teachers and graduates

by Ray Connolly, Senior Editor

Some electronics engineers and computer scientists forced to look for new jobs because of the national economic downturn find it hard to comprehend manufacturers who claim there is a continuing shortage of electronics engineers and computer scientists—and that it will become more severe each year through 1985.

Nevertheless, that is the case that the American Electronics Association is bringing to Washington.

On the premise that sometime next year President Reagan's economic policies will produce an end to the existing recession, the AEA is pushing the Congress and the White House to develop a national education program to produce more electronics engineers and computer scientists. The association hopes this will offset the shortfall it says will number 129,000 by 1985, or about 25,000 annually [*Electronics*, June 30, p. 24].

The AEA, one of the more vocal disseminators of the shortage scenario, first made its case earlier this month before the Joint Economic Committee with testimony by Southern Methodist University's F. Karl Willenbrock. He is a former president of the Institute of Electrical and Electronics Engineers, member of the National Academy of Engineering, and one of the 12 members of the AEA's blue-ribbon committee on engineering education. The following week, the full AEA committee met in Washington to prepare for a meeting with George Keyworth, the science adviser to the President.

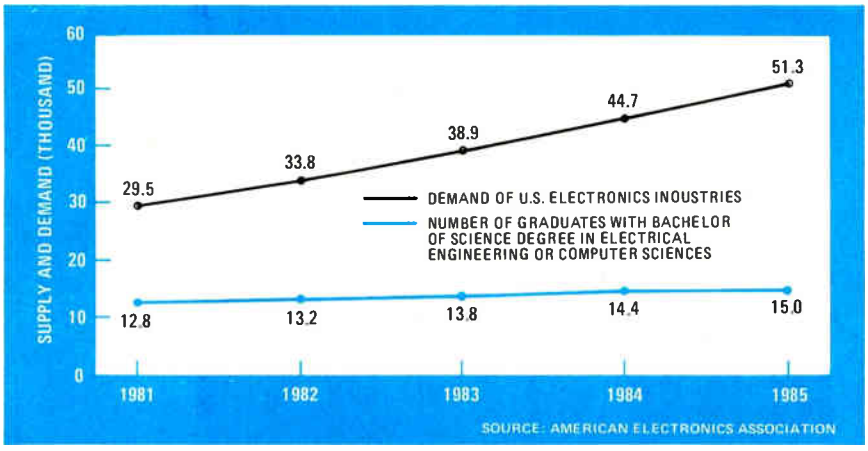
Countering those moves, however, is a two-day session on manpower by the IEEE scheduled to begin Nov. 16 in Washington. In a classic example of the opposing views of management and labor, IEEE officials were preparing for their sessions with some members averring that the shortages of professional manpower are overstated. The depth of the job pool of available EEs is not completely clear at this point, but unemployment does exist.

"Engineering shortages pose a particular dilemma for defense contractors," Willenbrock told the congressional hearing. "When the President was asked recently by reporters where companies would find technical workers if the defense budget passes, his optimistic reply was 'Give industry the money and it will find the people.' ".

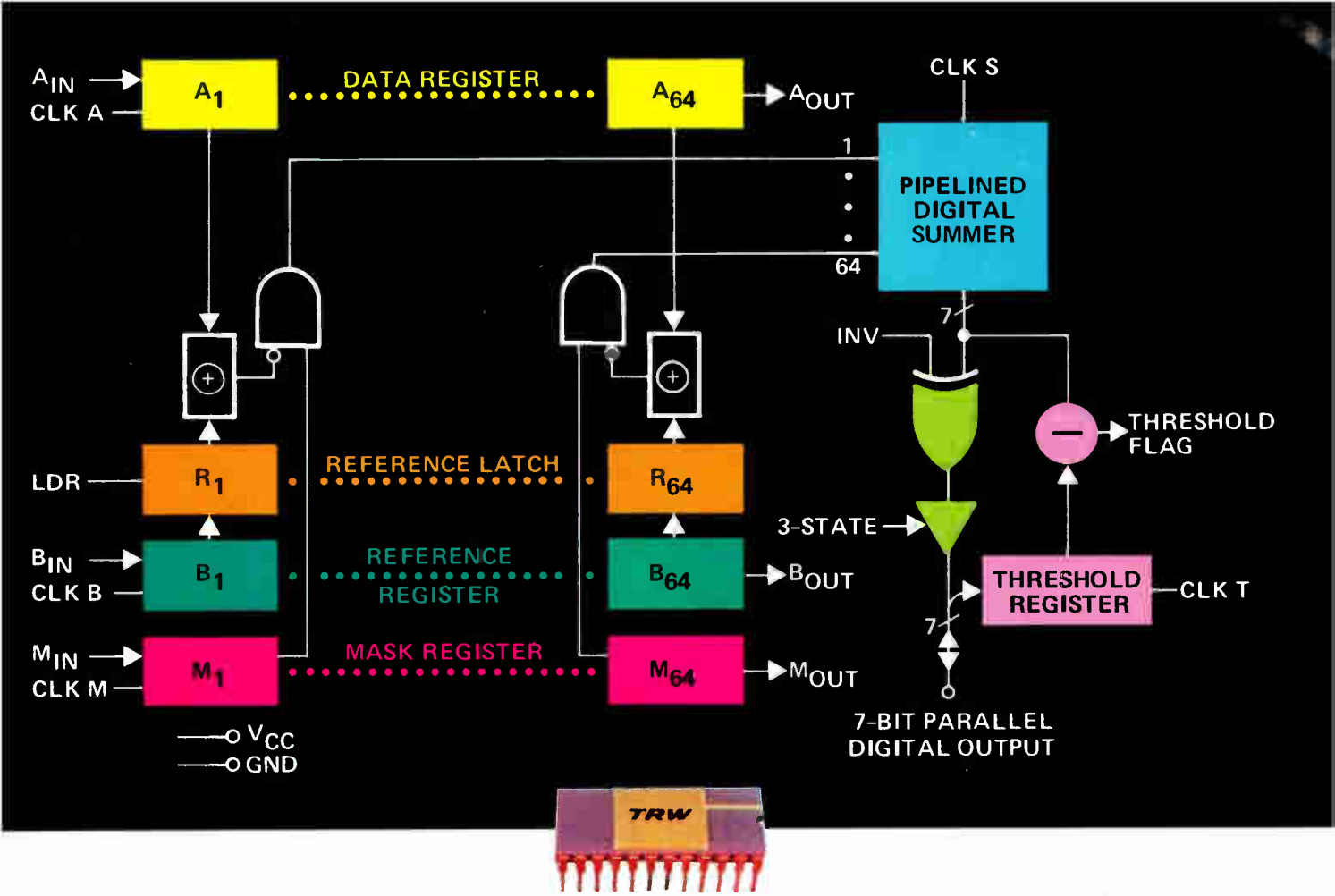
Willenbrock clearly dissents from that view, noting that "to win defense dollars, company proposals must demonstrate that competent technical talent is already on board or 'at hand.' A lack of engineers prevents many companies from bidding altogether."

Surplus students. What distresses Willenbrock and his AEA associates is that the nation's engineering schools "have far more applicants today than they can accommodate, and the quality of those candidates is probably superior to any that we ever had." Supporting Willenbrock's contention is an AEA study by Pat Hill Hubbard, engineering education manager for the association, which cites a National Opinion Research Center survey showing that, after business schools, "engineering is the second most-favored career choice of today's high-school seniors."

A severe shortage of engineering and computer-science faculty in the nation's schools is the crux of the problem that will continue to hold down the number of new engineering graduates, argues the AEA (see table). While engineering-faculty vacancy rates average 10% to 15%, forcing many schools to admit only one of every three applicants, the problem is even more serious in electronics education. Faculty shortages in solid-state electronics, computer



Diverging lines. The AEA projects that colleges will supply only 43% of the 1981 demand for new graduates in the electronics industries. The figures on needs are from 671 companies.



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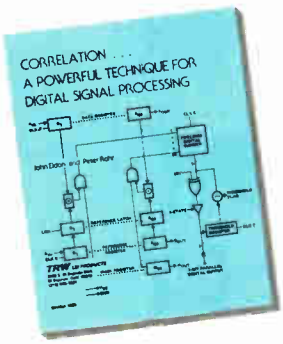

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engineering, and digital systems are close to 50%, estimates one National Science Foundation official.

Lure of the dollar. Industry's high entry-level salaries—$20,000 to $24,000 annually for graduates with baccalaureates—are the principal disincentive for them to continue working for a doctorate and enter teaching, where a full professor averages $33,295 per academic year. New graduates can earn far more in industry than the $15,900 average for instructors.

In the face of this, it is no surprise to the AEA's Hubbard that only 8% of Stanford University's new Ph.D.s chose to enter teaching last year, compared with 50% a decade earlier. "Faculty salaries are the most serious problem," she says, "and need to be addressed immediately."

Further compounding the problem of the shrinking pool of doctoral students in engineering schools, the association adds, is the number of EE doctorates being awarded to foreign students. They received one third of the 523 Ph.D. EE degrees awarded in the U. S. last year, according to NSF figures. Of these 171 recipients, some 66% were on student visas and are likely to return home.

The AEA and its blue-ribbon panel, chaired by William J. Perry, former under secretary of defense and now partner in the California firm of Hambrecht & Quist, now await the outcome of their parley with the President's science advisor. First estimates on Capitol Hill are that industry will get a sympathetic audience but not much more from an Administration that is already cutting sharply Federal aid to education programs.

Nevertheless, SMU's Willenbrock sees one possible solution at the Federal level through an industrial alliance with NSF. "The NSF does have a lot of clout, and there is no reason why it should not work closely with industry."

Additionally, Willenbrock looks favorably on the prospect of greater support for education from the Department of Defense, as well as closer linkage between industry and the nation's universities. □

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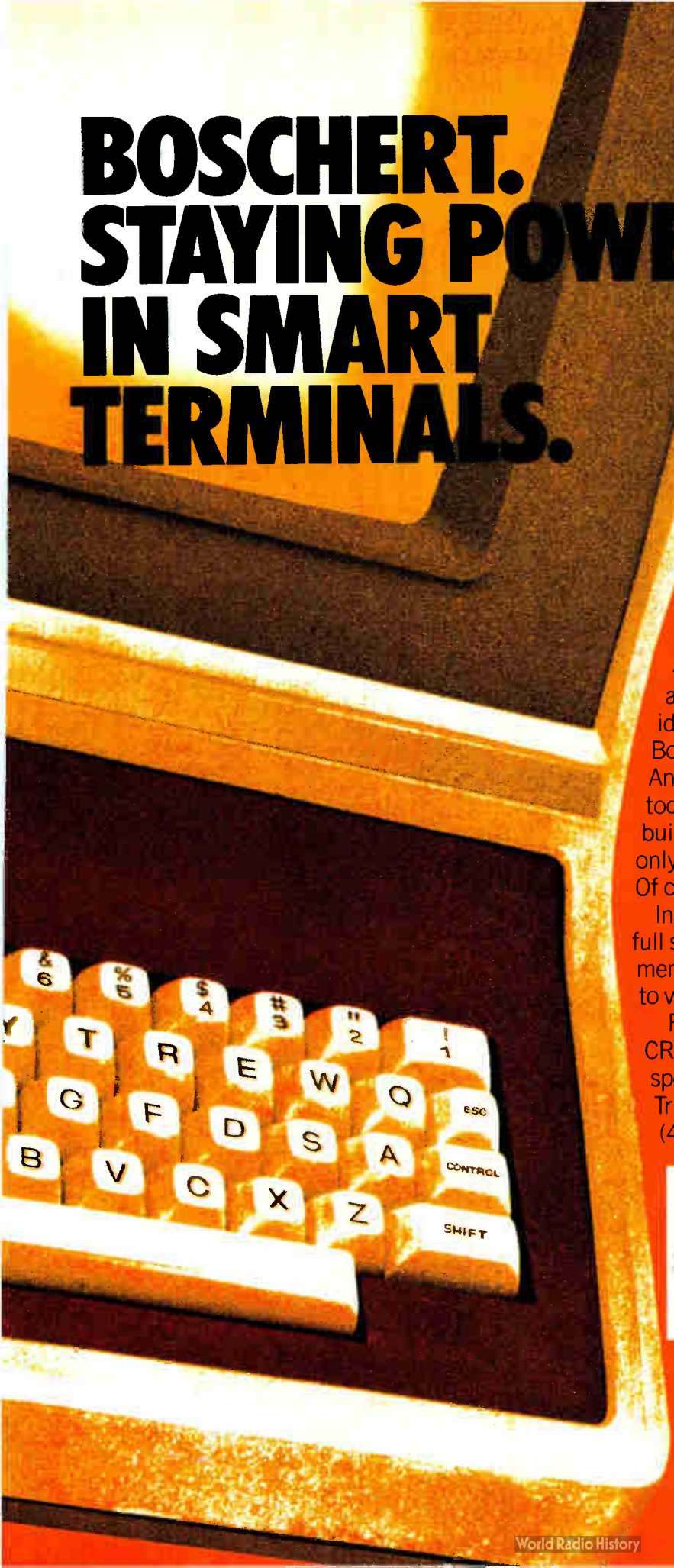

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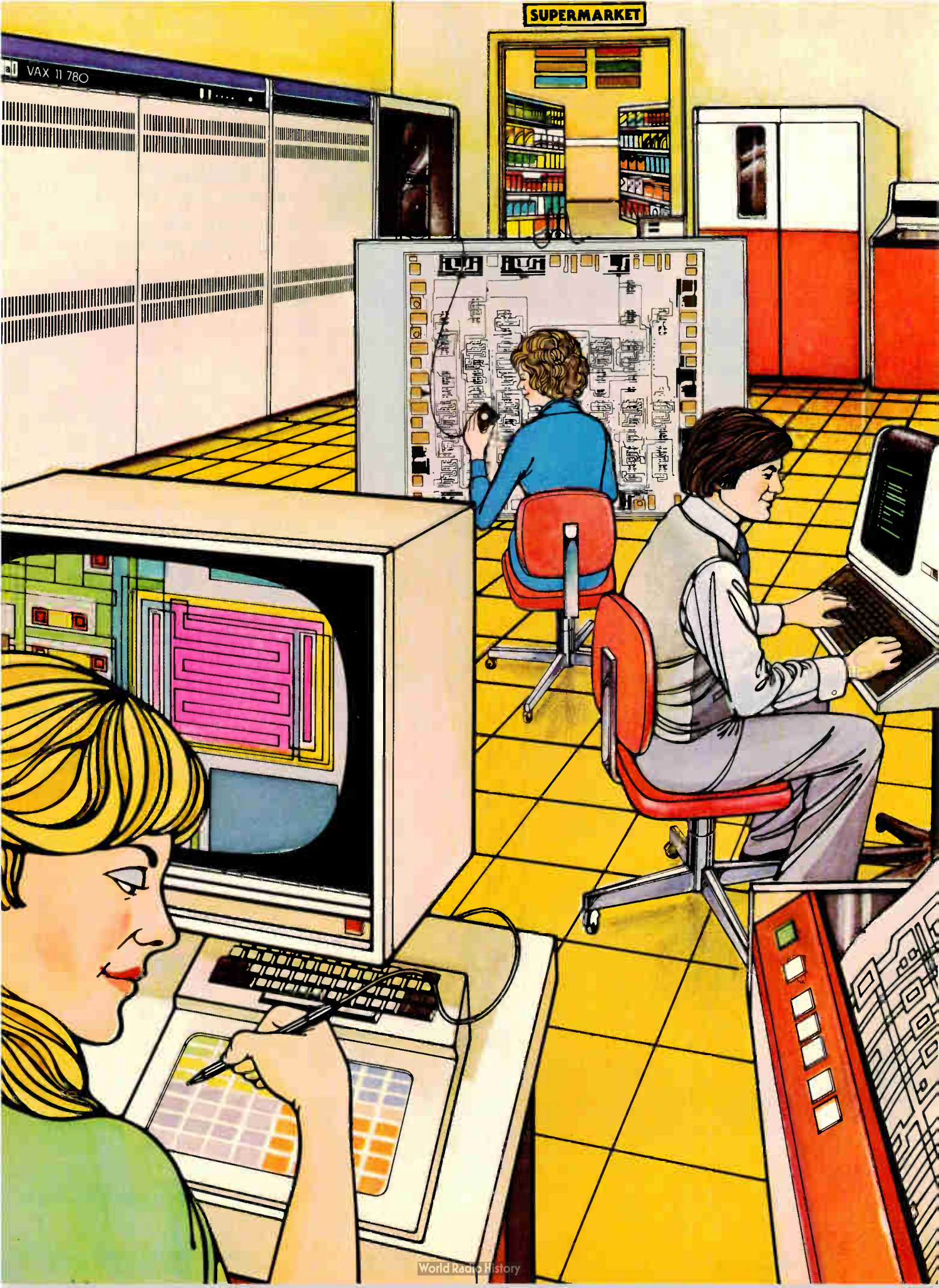

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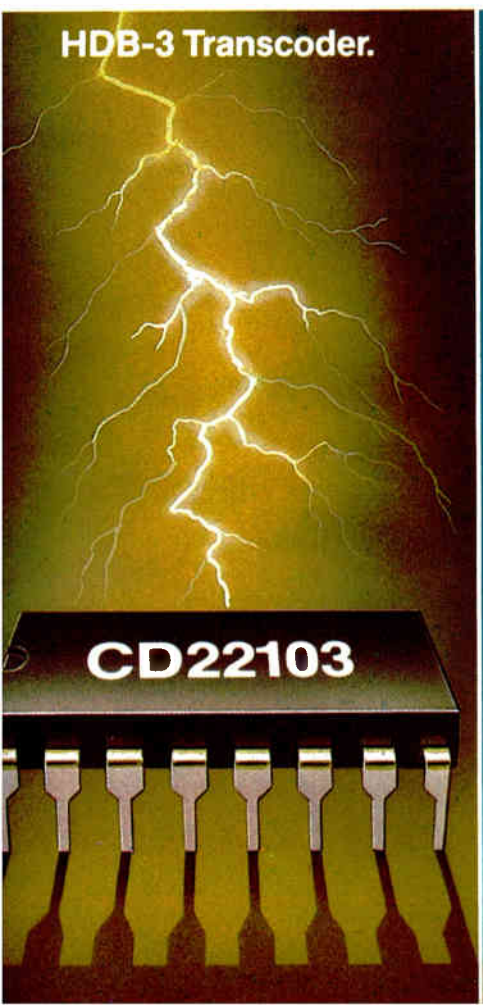

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'S IN PRINTING

Design AUTOMATION

☐ Profound changes are occurring in the microelectronics industry. More and more people are becoming involved in integrated-circuit design. Besides the usual IC houses—the Intels, the Motorolas, the TIs—users of chips, such as system companies, are increasingly seeing the need to design and build their own devices. Everywhere, the number of people required to design, lay out, and check logic masks and electrical performance is soaring.

The challenge is to put entire systems, consisting of thousands of transistors, onto silicon. In the view of many, a decent level of productivity in developing very large-scale ICs will be attained only with computer-aided design or, as some prefer to call it, design automation.

Design automation aids are on the way, too, in the form of creative new layout methodologies, software packages for simulation and test-vector generation, and turnkey graphics work stations. The articles in this series detail some of the newest of these tools, most of which hail from companies recently formed with specific solutions for the VLSI designer in mind.

The article from Calma Co. that kicks off the series on page 108 is a bit different. It explains how VLSI happened and what attitudes will be needed to keep it going. In particular, it states that chip design has begun to cost more than production.

At the standard-parts houses, numerous technical people are needed to deal with the incredible complexity of the VLSI circuits once they are defined—not to mention the teams required to dream up new ones. Also the difficulty in creating new VLSI chips is being exacerbated by their application-specific nature, which stems from their being entire systems (see figure).

Though these specialized VLSI circuits represent production volumes that are unattractive to the vendor of volume parts, original-equipment manufacturers need the economies afforded by integration. To remain competitive, in fact, systems companies need their ICs faster than ever. This speedy turnaround is possible only through design automation.

Common thread

Design automation is the common denominator of the production of semicustom logic such as gate arrays, silicon foundries, and the IC structuring principles espoused by Carver Mead of the California Institute of Technology in Pasadena and Lynn Conway of Xerox Corp.'s Palo Alto, Calif., Research Center [*Electronics*, Oct. 20, 1981, p. 102]. Gate arrays aid design automation by making an IC's physical characteristics a foregone conclusion: only the last layers are personalized with application-specific wiring.

The unique advantages of gate arrays have nurtured a burgeoning demand [*Electronics*, Sept. 25, 1980, p. 145; Oct. 20, 1981, p. 116]. LSI Logic Corp., a Silicon Valley start-up that will provide gate-array designers with a new level of design automation, predicts that the market for semicustom logic will grow from the $90 million of 1980 to $1.5 billion by 1985. An exclusive article on its entry-level offering—the LDS-I interactive development system—will appear in the next issue of *Electronics* as the series continues.

Gate arrays or standard cells

Some feel that arrays may ultimately be supplanted by custom ICs as design automation equalizes the two approaches' modes of logic entry and as silicon foundries become a reality. Some sophisticated arrays already demand personalization of three interconnection levels, inflating the number of custom masks toward that needed for a fully custom IC.

Standard cells are used to automate the design of custom chips. These cells are drawn from a database library and arranged on a die for a more compact layout than arrays can provide. Two new commercially available standard cell systems will be described in this series. One, from Zymos of Sunnyvale, Calif., begins on page 114; the other, from Alphatron of Cupertino, Calif., will appear in the next issue.

Standard cells run the gamut from gate arrays to fully custom chips. Some, like the polycells developed by Bell Laboratories, demand strict placement of power buses and also cells of a particular height. Other systems require areas to be reserved for wiring channels.

Whereas these approaches have gate-array–like features, other standard-cell systems place no restrictions on cell placement and in a few cases will even massage a cell's shape to fit into a given area. In the Gaelic VLSI design system from

The enormous complexity of very large-scale integrated chips is mandating the switch from manual design to computer aids. With VLSI systems, a top-down approach is required to organize their layout, simulation, and testing. Such a hierarchical approach is not a nicety; it is a necessity for continued productivity in the IC industry

by John G. Posa, *Senior Editor*

Compeda Ltd. of Stevenage, Herts., England, cells can have a mixture of sizes—that may or may not abut—and connections can be made from any cell point to any other.

The ease with which the design of a custom IC can be automated depends, in part, on process technology. For example, integrated injection logic can be laid out in a far more regular fashion than emitter-coupled logic can. This observation led the Centre National d'Etudes des Télécommunications of Paris to invent multi-drain MOS: with its I^2L-like topology, multi-MOS technology formed the basis for the layout system described on page 111.

In designers' hands

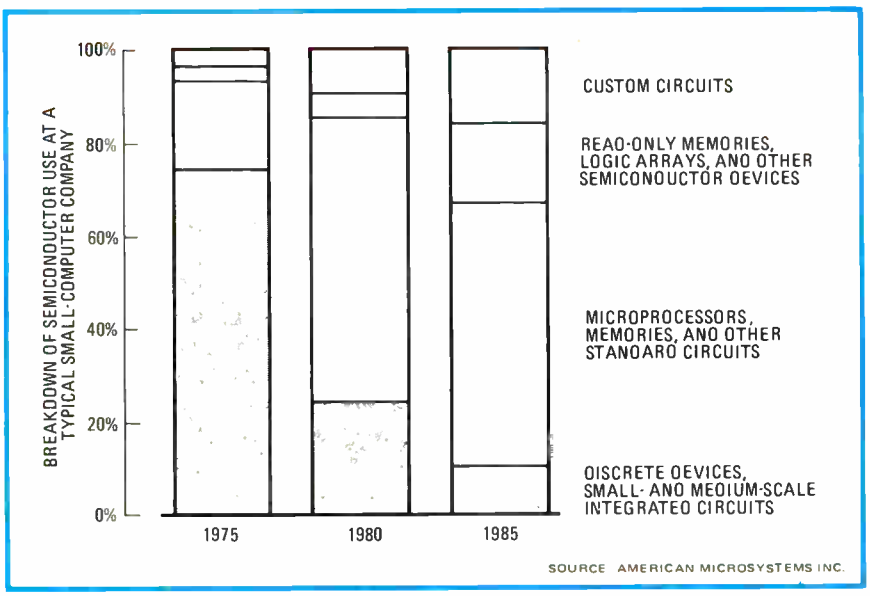
Mead and Conway believe, along with a growing community of others in the IC industry, that automation is not yet really in the hands of the chip designer. Some believe that the current crop of CAD equipment from such well-known firms as Computervision, Applicon, and Calma is essentially drafting equipment. David Ryan, vice president of the Gerber Scientific Inc., a Hartford, Conn., maker of low-cost CAD systems for printed-circuit design, says that today's large, expensive, and overly general CAD systems will be obsolete in five years.

The producers of the CAD equipment are bending to change such impressions. Many are upgrading their host processors to 32 bits to handle more data and more distributed work stations. Calma is taking a bold step with its Sticks package, a dynamic symbolic system that allows gridless, hierarchical layout and automatic circuit compaction [*Electronics*, Nov. 3, 1981, p. 41].

The general trend toward distributed computing is fueling the drive to decentralize design automation. The system from Valid Data Systems of Sunnyvale (p. 117), includes a logic simulator that separates logic verification from timing analysis, allowing VLSI designs to be handled on smaller computers than mainframes.

Avera Corp., a new company located in Scotts Valley, Calif., partitions the design of a VLSI circuit into individual tasks so that it can be distributed among a group of engineers. Its approach will be explained in the next issue of *Electronics*. Other novel design stations include one from Daisy Systems Corp. of Santa Clara, Calif., [*Electronics*, Nov. 3, 1981, p. 176] and another due from Cadtec Corp. of Palo Alto, Calif.

Metheus Corp., a new Hillsboro, Ore., company made up of engineers from Intel and Tektronix, is also committed to VLSI design-automation tools for the product engineer. Its entry system, due next year, will include software routines for chip testing as well as for design. These will indeed be an accomplishment, for test-vector generation is still viewed as a black art and is often left for the circuit designer to develop empirically. Help is on the way, however, as the article in the next issue from Fairchild Camera & Instrument Corp.'s San Jose, Calif., facility will explain. □



Going custom. Just a few years back, standard circuits made up the bulk of the electronics in applications like small computers. Custom and semicustom chips are catching up.

Design AUTOMATION AUTOMATIC

CAD tools must change to meet the needs of VLSI

Application-specific chips demand greater man-machine interaction

by Benjamin K. Lee and Casey Jones, *Calma Co., Santa Clara, Calif.*

☐ Very large-scale integrated circuitry has arrived only two decades after the birth of the IC. It evolved from the techniques used to design and produce the medium- and large-scale ICs of the 1960s and 1970s, when manufacturing costs were, by and large, the semiconductor industry's greatest burden.

In recent years, however, the costs of circuit design and layout have come to dominate (see "The decline of standard components," opposite), and chip design can only become more difficult in the current decade. Now more than ever, the industry needs cost-effective design tools that address the type of design and the needs of the designer. Only the computer can handle the level of complexity involved, and in fact new computer-aided design tools are already coming to the rescue.

Dull tools

The design of VLSI parts not only requires many steps—from problem definition to final testing—but within each step, also, the amount of information involved is so staggering that today's tools cannot handle its complexity. They are specialized equipment, concentrating on a limited aspect of the design process, and as they are not integrated, they prohibit the exploration of global tradeoffs. Moreover, few available tools encourage man-machine cooperation in a meaningful way.

The lack of coordination results from the historical division of the IC design effort into separate steps, with narrowly focused tools and designers assigned to each. For instance, functional simulators were once at the disposal of only the system designers, and test-generation software was available only to the test engineers.

Dividing the problem, however, was not enough to conquer it. Worse yet, the division has blindered designers, forcing them to attempt optimization without regard to its impact on the overall circuit. Some of them speak in terms of instruction sets, others in terms of design rules. Layout designers often do not know the impact of parasitics on circuit performance, just as logic designers often do not create testable circuits. Global strategies that take both computer architecture and chip layout into account are too few and far between.

Even if designers have a wish to collaborate, lack of a common data base may curtail it. The reason is that design tools were developed by programmers, and their offspring speak only their parents' language. Written in different languages, the tools usually run on different computers. Incompatible data may make it impossible to determine if, say, the circuit simulated with the logic simulator is in fact the same circuit simulated via the circuit simulator.

In the early days of CAD, not only was a design divided among engineers, but man and machine were viewed as two very different types of problem solvers. People and computers think differently, so tasks were divided into these mutually exclusive domains as well. Awed by the capabilities of computing machinery, manufacturers did not know quite how to utilize its power.

Will man meet machine?

This isolationist attitude derived, in part, from the traditional separation of personnel from computers. The computer resided in the computing center, the engineers in offices. Communication was awkward, as messages were punched into cards and submitted to a receiving window in the computer center for processing. The computer responded via reams of printouts, returned through the same window. Where this setup still exists, frustrated engineers can also be found, their creativity inhibited by the lengthy iterations needed to complete a design.

Even the most current design tools reflect these past technologies and market trends. Computer-aided design stations, with their attendant graphics terminals, are a case in point. Prior to their introduction, designers did their layout on Mylar sheets and checked it manually. Rubylith was then cut and checked again, only for new

errors to be introduced as the old ones were corrected. In short, the manual checking provided no assurance that a circuit would work. As fine geometries spawned larger dice, the shortcomings of this method became ever more apparent to designers.

CAD graphics systems were originally designed to produce the patterns on an IC mask, with the computer capturing the data to drive a pattern generator. Handling data in this way did provide many advantages over manual methods. The data could easily be massaged through interactive editing commands, and design-rule checking could be automated. The tremendous success of these systems is evidenced by their rapid proliferation.

Engaging with complexity

However, times have changed to the point where much of this equipment is woefully inadequate for VLSI. With circuits comprising millions of rectangular regions, laying down each rectangle by hand is no longer practical. Design tools have not kept pace with semiconductor technology. The strengths of yesterday's equipment have turned into weaknesses, and past weaknesses have turned into major stumbling blocks.

To deal with the complexity of VLSI, the industry needs to redirect its emphasis. Higher density and shorter design times must go hand in hand. Though automatic placement and routing algorithms fail to minimize chip area, the payoff is a shorter design cycle. Procedural design—after the manner of silicon compilers—will become a workhorse. This approach promises a VLSI circuit in an afternoon.

Using the tools

Apart from radically new tools, existing ones must be used more effectively. For example, the use of static symbolic layout with available interactive graphics systems can greatly expand productivity. This kind of layout is easy to set up and does not require new software as it is strictly a design methodology. American Microsystem Inc.'s symbolic interactive drawing system, SIDS, is a well-known static symbolic system.

The ASAP, or advanced symbolic artwork preparation, method developed at Hewlett-Packard Co. is another example of the improved productivity possible with present tools. Applying symbolic methods to a 10-year-old in-house system, HP reported a tenfold increase in layout efficiency without sacrificing chip density.

Even more optimistically, in viewing the totality of IC

The decline of standard components

The standard integrated circuit is no longer viable. Universal functions provided by logic gates, memories, and microprocessors, with their wide appeal and mass-market outlet, were ideal jellybean parts. Though the semiconductor industry possesses the technology to build almost any circuit that the mind can conjure up, it is unable to identify any universal very large-scale integrated circuit beyond the microprocessor.

No longer can semiconductor development costs be recovered solely by producing circuits in quantities. Economy will now be found in quality: the value added to a final product via proprietary circuits. Although these circuits will be the specialized components of an end product, their design must not impede product introduction. In today's market, product life cycles are shorter. Timing to hit a market window is no longer merely a desire; it is a necessity. Thus, VLSI tools must streamline designs to maximize the economic impact of the technology.

Still, the fact that economy is no longer strictly with quantity does not spell death to all jellybeans. A new type—the consumer circuit—has been introduced. Fabricated in relatively high volumes, it is more application-specific than standard components. Examples are digital watch chips and ICs for automobiles.

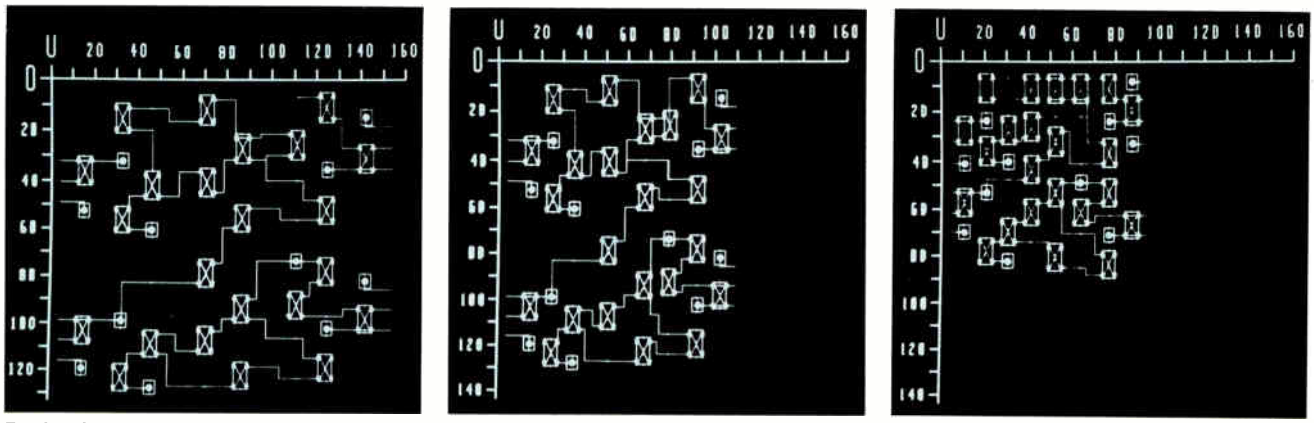
But beyond the consumer circuit, VLSI components will become increasingly specialized. Among the new VLSI designers, even consumer-circuit engineers will become a minority. Most future designs will be tailored so closely for specific systems that only those who are intimate with the end application will be able to identify the needs, justify the economics, and design the circuits. These low-volume chips will definitely not be jellybean components.

There are two types of low-volume designs. Typically designed by computer companies for their own computers, the first type emphasize high density. Hewlett-Packard Co.'s silicon-on-sapphire chip set for its HP3000 computer system is a good example. The market, in units, for HP's computers is certainly smaller than the one for the digital watches made by Casio.

A second kind of low-volume IC puts more stress on the quick turnaround required for timely market entry. Logic arrays and chips based upon polycells are examples here. Although these design alternatives have been around for years, it took fine-line lithography and its ability to crowd a die with logic to make them economical.

With arrays and polycells, plus automated placement and routing, a major part of the design cycle is reduced. In the case of logic arrays, prefabrication and the stockpiling of the preprocessed wafers further reduces manufacturing time and amortizes the manufacturing cost. The upshot is timely market entry, more than offsetting the cost of low-volume production.

Even though engineering costs are not amortized by low-volume circuits, the value they add to the end product justifies their existence. In view of the number of functions that designers are now able to put on a chip, the printed-circuit alternative would be altogether more expensive. Besides, custom ICs improve on electrical performance and dramatically reduce physical dimensions, making certain products possible.



Design by computer. Even with the wealth of computer-aided design equipment available today, powerful tools are just now reaching the hands of designers. This sequence shows how a circuit entered with Calma's new Sticks package is automatically compacted.

design, researchers at the California Institute of Technology feel there is an underlying structural pattern to VLSI circuit layouts. So they are developing new design equipment that exploits this concept. One of these, a silicon compiler called Bristle Block, also makes tremendous strides in providing a compatible computing environment and data base to span much of the IC design spectrum. The tool allows a designer to deal with both computer architecture and chip layout, facilitating global tradeoffs between them.

Natural languages

These and other new tools are more expressive and natural to use. After all, designers, engineers, layout people, and programmers should feel comfortable with their own system involvement. Engineers think in terms of symbols: logic symbols, circuit symbols, and stick diagrams. They are concerned with drawing circuits at a very high level of abstraction, which does not mesh well and ought not to be bogged down with the rules of construction and manufacturing. Symbolic layout systems speak the engineers' language.

Programmers, on the other hand, can relate to silicon compilers and the compilers for programmable logic arrays that are already in widespread use. They, too, will be designing VLSI circuits and will be more comfortable compiling their written programs into finished layouts.

Layout people think in terms of the materials that make up the masks: metal, polysilicon, and diffused areas. Modern CAD graphics systems do allow users to tailor their language to reflect layout, but many designers continue willy-nilly to employ programming terms that are alien to their craft. For instance, to draw a metal line, the designer should be able to indicate "metal"—not "layer 5."

When a design tool is endowed with humanlike attributes, conversation becomes natural, expressive, and stimulating. It encourages a designer to think of new possibilities and inspires him or her to explore. Sticks, a dynamic symbolic layout system from Calma, is such a tool (see figure). As with a static system, it understands symbols, but Sticks does more [*Electronics*, Nov. 3, 1981, p. 41]. When a designer wishes to connect one symbol to another, he need only place the interconnection within a visual tolerance for the system to automatically attach the wire to the intended symbol. He need not worry about the precise size of the spacing between symbols, either, as the program will correct the spacing later—but not on the designer's time. Because of a concept called spacing synthesis, design-rule errors no longer exist. Sticks removes the tedium from design and encourages the designer to explore.

This kind of harmony should go beyond machine helping man to include man helping machine. There are some circuit-design problems that are uniquely suited for people to solve, such as pattern recognition, which involves spatial relationships.

A well-crafted tool for cell placement and routing allows the designer to help the machine interactively. Placement and routing problems belong to a class of complexity known as nondeterministic-polynomial hard, or NP-hard. To prevent the exponential expansion of the time spent in computation, heuristic techniques are used. An interactive algorithm allows man to supply the heuristics, to guide the problem-solving process so as to arrive quickly at a more nearly optimum solution.

Can VLSI be saved?

VLSI is in trouble, and only computer-aided design can save it. It can be used to its fullest only when tools are devised that truly deal with its complexity, treat the entire design spectrum comprehensively and cohesively, and make optimum use of man and machine.

The tools will come from those who understand, those who make it their business, and those who can rally corporate resources. Moreover, the future clearly belongs to those designers who can remove the barrier between imagination and reality. □

Multi-MOS structure speeds layout of VLSI chips

Concept expedites design by using symbolic gates with multiple outputs; basic layout can be digitized and manipulated in graphic form

by Jacques Majos and Marie Josée Martin, *Centre National d'Etudes des Télécommunications, Paris, France*

☐ The design of very large-scale integrated circuits need not be as formidably complex as it usually is. Though increasing cell densities are a contributing factor, the basic problem lies with the fundamental cells used to build up a circuit: they are too complicated, making layout tedious and design-rule violations inevitable.

The simplification of VLSI circuit layout depends on the use of a more manageable basic logic cell, so that it may be easily digitized and manipulated by computer to produce an entire design from the layout of a small number of cells. Some such methods already proposed [*Electronics*, July 31, 1980, p. 73] are based on a library of standard cells that have symbolized input and output signal points. Other approaches attempt to symbolize at the silicon level, with shapes that represent diffusions, polysilicon areas, and metal patterns. Programs for these usually ensure minimum spacing between elements.

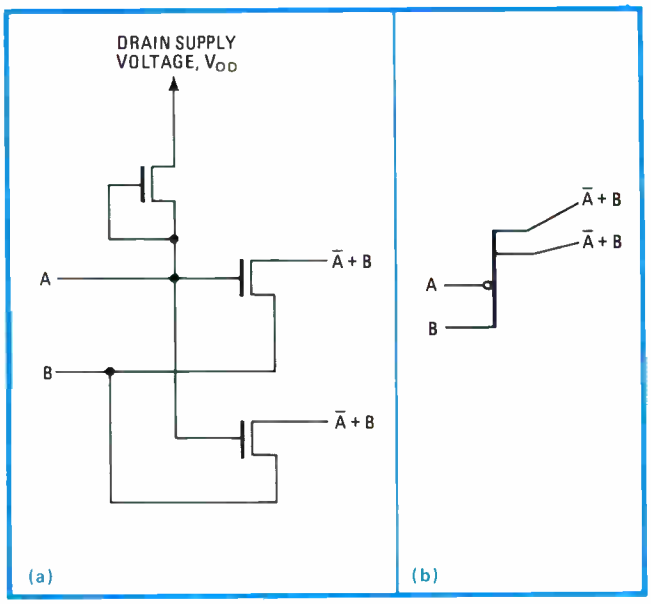
The multi-MOS, or M²L, approach draws upon both these ideas by using a very regular symbolic gate having multiple outputs. Design-rule requirements are automatically met and the symbolic representation resembles a standard logic diagram. In contrast to conventional structures, gate load currents may be adjusted by the designer without changing the shape of the cells or their placement. This means that highly capacitive nodes encountered after interconnections are made can be handled without a new layout.

Multi-MOS technology

The M²L approach, an extension of multidrain MOS [*Electronics*, June 5, 1980, p. 73], is ideally suited to symbolic layout. The M²L structure consists of multiple n-channel MOS driver transistors, with common gates loaded by a depletion-mode n-MOS transistor (Fig. 1). The number of enhancement-mode driver transistors depends on fan-out. Their sources (here, the B input) are connected either to the substrate or to a logic signal.

The outputs of the M²L gate are available on the drains of the driver transistors, but the function of the gate depends on the potential of the B input. If B is not connected to the grounded substrate, the multiple outputs of the M²L gate are equal to $\bar{A}+B$. When $B = 0$, the M²L gate is an inverter. It is possible to realize any logic function by connecting the outputs of M²L gates.

Attractive features of the M²L structure are its high packing density and high-speed performance. The table lists these properties for a fan-out of 2. The high packing density results from the common gate, which allows the drains to be tightly packed, and from the elimination of individual source contacts for each gate. In addition, the driver transistors are in parallel and their gate width is



1. Great for CAD. The symbolic layout system makes use of a multidrain MOS structure that is ideally suited for computer-aided design. The basic gate (a) has two inputs; when one is grounded, the gate is turned into an inverter. A simplified schematic is shown in (b).

THE SPEED AND DENSITY OF M²L GATES*			
Design rules (μm)	6	5	4
Maximum/ typical density (gates/mm²)	310/220	450/320	700/500
Speed (ns)	5	3.5	2
Speed-power product (pJ)	1.3	1.0	0.6

*Fan-out = 2.

constant. Minimum drain capacitance and a high current-sinking capability due to a high gate width-to-length ratio permit the high speed.

With conventional n-MOS silicon-gate technology, the MOS drivers are connected in series, and this poses a difficult problem for the integrated-circuit designer. When implementing a NAND gate, for example, the designer does not usually know the load capacitance and therefore cannot predict load current. Besides the load capacitance to get a particular propagation delay time, the width of the driver transistor must be varied for the proper low-level output voltage.

Controlling capacitances

When load capacitance is not known, the designer must draw upon experience to adjust the width of the MOS driver transistor and load current. Unfortunately, if the load capacitance is larger than that supposed, it can have disastrous effects on the surrounding layout. When the capacitance increases, load current also increases and the width of the MOS driver must be increased to obtain a correct low-level output voltage. This means the packing density decreases with high frequencies.

The M²L gate avoids such drawbacks because the MOS drivers are never connected in series for any logic function. If the elementary MOS driver can support the maximum current generated by the load device, then for any interconnection diagram, the low output voltage will be correct. With 6-μm design rules, load current ranges from 10 to 180 microamperes; but the designer can, at any time, change the current value without also being obliged to make area modifications.

When speed is not critical, the current value generally used is 25 μA or less. However, the MOS drivers must be able to drive 180 μA to make the low output level consistently equal to 0.4 volt. To make that possible, the width of the MOS drivers is set to 24 micrometers, and the closed polysilicon structure in Fig. 2 is used to minimize silicon area.

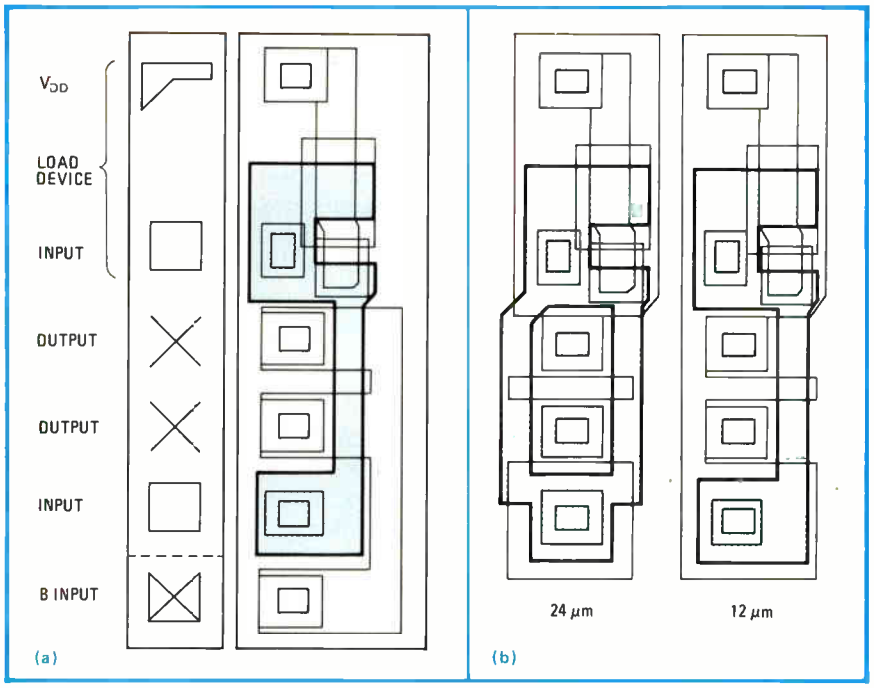
Since the closed structure increases input capacitance and degrades the speed-power product, the width of the MOS drivers is equal to 12 μm when the high current is not required. This width is obtained by using only half of the polysilicon structure for a maximum drive current of 90 μA; but in both cases, the same silicon area is used. When a load current in excess of 180 μA is necessary to drive a very high load capacitance, one or more M²L gates can be easily cascaded.

Symbolic layout and design

The geometry of the M²L gate facilitates a quick and easy symbolic layout. Because of the constant gate width and the position of the drains along the same axis, the overall width of the logic gate is also held constant. Length depends on the number of outputs and inputs.

Layout is done on an X-Y grid, the steps of which represent the design rule in micrometers. The rectangular symbolic gate is placed on the grid with the distance between the axis of two neighboring M²L gates equal to two grid steps.

The rectangle contains symbols representing that gate's inputs and outputs. In Fig. 2, the symbol placed at the top of the cell represents the position of the V_{DD} supply. The two grid steps below this symbol are occu-



2. Topology. The gates represented by the schematic of Fig. 1 are here shown in symbolic and mask-level forms. With two inputs to the gate, (a) is used. Load current is easily adjusted by varying the gate width of the MOS driver transistors (b).

pied by the depletion-mode n-channel transistor. A square is used to symbolize the gate's input. It can be placed at any point along the longitudinal axis of the M²L cell, from the origin (the lowest grid point) to the point just below the V_{DD} symbol.

Since the polysilicon gate is common to an M²L cell, two or more may be made available by simply adding squares at any point on the grid. This property is particularly attractive for implementing logic functions; it permits a cell to be used as a polysilicon interconnection.

A cross is the symbolic representation of a drain (or output). Outputs can be placed at any point on the grid except the two grid steps occupied by the load device. If the M²L rectangle includes n grid points from the origin (point 0) to the V_{DD} position (point n), an output can reside at any position from 0 up to position n-3. Again, the number of drains depends on the fan-out.

When the M²L gate is used with source regions not equal to 0 V, a different symbol for the source contact is used and it is placed at the origin of the M²L rectangle. With these symbols, the position of the cell's inputs and outputs depends only on cell-to-cell connections.

CAD implementation

The M²L structure permits complex circuits to be designed quickly. The total number of M²L gates will be equivalent to the number of standard NAND and NOR gates. The first task of the designer is to transform the logic function into the M²L form, then implement the symbolic layout. The design rules are automatically satisfied, as are load-current requirements. This leaves only the problem of interconnection, meaning the designer can concentrate entirely on wiring.

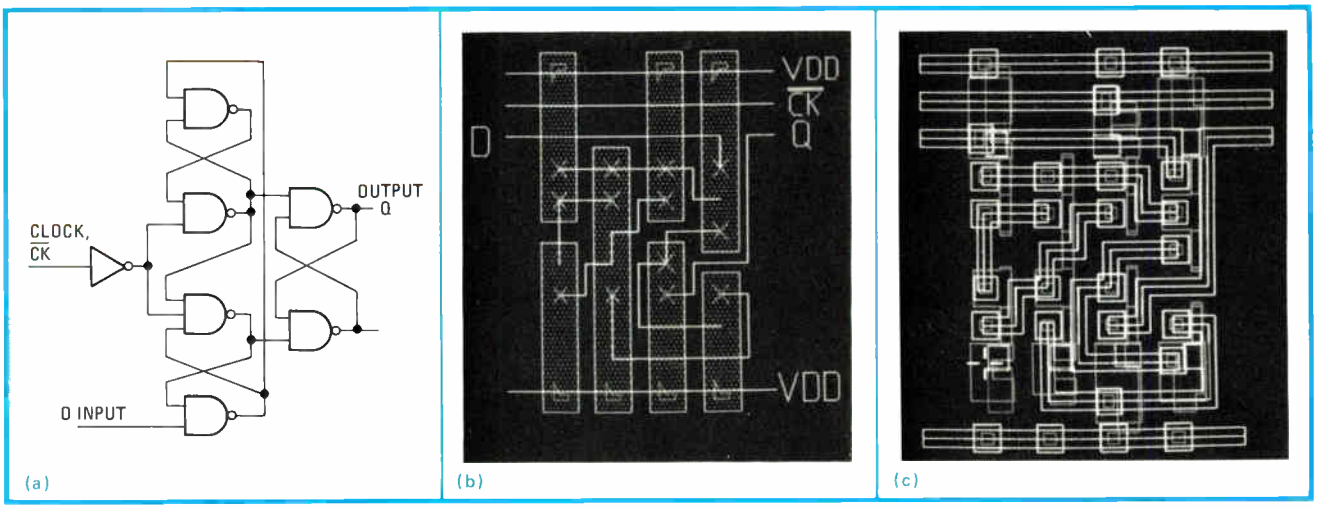
When implementing the symbolic layout, the designer may use two interesting properties of the M²L structure. As mentioned, an M²L gate can be used as an interconnection, thanks to the multiple gate contacts possible. Secondly, the designer may divide an M²L gate into two or more other gates whose inputs are wired together.

Once the symbolic layout satisfies the designer—that is to say, when a good packing density and a good interconnection arrangement have been obtained—the symbolic layout can then be digitized. With input and output symbols available on a menu, the designer points to a gate's origin and places the first symbol there. The second symbol may be placed along the X or Y axis. The relative position of the two first symbols automatically computes the orientation of that M²L gate.

After choosing the V_{DD} symbol, the symbolic contour of the M²L structure is automatically drawn. The designer then specifies the value of the load current and goes on to digitize another M²L gate. After a block of about 100 gates (and their interconnections) has been digitized, the designer asks the machine to draw the full mask layout; this task, too, is automatically carried out.

The M²L structure is an attractive tool for the IC designer, compared with traditional layout methods. Besides having excellent speed and packing density, the structure has many advantages, such as a symbolic representation that looks like a logic diagram that is independent of the design rules. When the design rules change, the symbolic data remains unchanged and can be compiled according to the new rules. In fact, the task of the designer is so easy that IC specialists are not required to implement or digitize the layout.

These advantages make the implementation of an n-MOS IC very similar to that of a printed-circuit board. The approach further offers very low cost and a fast implementation time. With the M²L structure, one man-year may be all that is needed for a 10,000-transistor chip, including the transformation of a logic diagram into the M²L scheme, the layout, and debugging. □



3. CAD implementation. This is how a logic diagram winds up as a mask layout using the multi-MOS system. A schematic (a) is converted into an M²L diagram, then digitized for the cleaner representation in (b), and from there transformed into mask data (c).

Design AUTOMATION AUTOMATIO

Multiuser IC cell library buys custom densities at gate-array prices

Use of standard circuit blocks for chip design apportions development costs, trims turnaround times

by William Loesch and Alex Young, *ZyMOS, Sunnyvale, Calif.*

☐ Computer-aided design can produce integrated circuits that promise to provide the benefits of custom design—improved performance, smaller size, higher reliability—at a cost and convenience much closer to standard circuitry. One such CAD setup is the system to be trademarked as ZyP. Available to subscribing designers, it is based on a library of standard MOS cells and offers cost savings over gate-array and fully custom approaches, as well as a low risk of design iterations and testing delays.

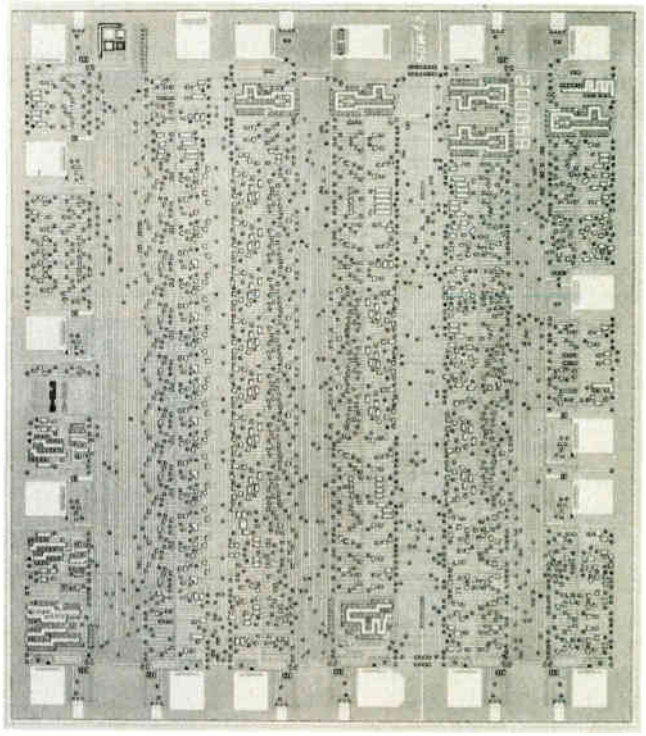
What's more, the system eases the design job: an engineer trained in board-level design needs no knowledge of device technology to fashion chips with custom circuit blocks. Its operation is analogous to a mathematical transformation that maps parameters from one coordinate system to another: a description of logical functions is transformed into lithography masks. Access is through an international timesharing communications network, or the design system may be installed in a computer at the customer's facility.

One of the primary advantages is the control the engineer has over the design schedule. The user need not depend upon the availability of in-house IC design engineers or the willingness of a particular vendor to undertake his project. Once the chip is designed with the CAD system, Zymos can provide prototypes within eight weeks.

Most importantly, this system does not require massive in-house investments in graphic-design aids, IC designers, or wafer-fabrication and test facilities to obtain the benefits of custom chip design and manufacturing capabilities. Instead, many users share these costs.

At the heart of the system are libraries of standard functions, or cells, that can be interconnected to form systems of any desired complexity—limited only by economics: the more cells added, the more the chip will cost to produce. Over 500 functions are available in the standard cell libraries that continue to be expanded and refined. There are three libraries, with cell designs optimized for silicon-gate n-channel and complementary-MOS and metal-gate C-MOS processing.

Many functions available in the libraries cannot be implemented with gate arrays: for example, memories, specialized input/output circuits, and analog building blocks such as operational amplifiers and comparators. Moreover, all of the cells in the standard libraries are



From the library. Board-level designers create semicustom ICs like this one by drawing logic functions from a collection of standard cells and specifying their placement. The hand-drawn cells let chips come close to the density and speed of fully custom layouts.

constructed to exploit a given IC process for the maximum possible performance.

Most cells allow a choice from a range of different transistor sizes so that speed can be traded for lower power when such a course of action is desirable. Users can also specify new cell designs to meet the performance requirements of their applications.

Cell libraries

The Zyp design system is a combination of existing CAD tools, original software, and cell libraries linked together to form a comprehensive and friendly design tool (Fig. 1). The key is the libraries that currently include inverters, buffers, gates, flip-flops, latches, binary comparators, and random-access and read-only memory cells. Also, several analog building blocks have been incorporated into the libraries, including op amps, comparators, and voltage references. Several cell types, such as shift registers, counters, RAM, and ROM may be expanded to the size required.

In addition, a novel logic building block, called a core microprocessor, is included in the cell library. It is a 4-bit central processing unit stripped of all RAM, ROM, and I/O. Its instruction set is very similar to the 8048's. With this cell, an engineer can build a custom microcomputer with user-defined RAM, ROM, and I/O functions, giving a programmable chip that has the optimal architecture for a given application.

Every cell has three different representations stored in a common data base for each library: device-level and logic-level simulation models and digitized artwork. In addition, every standard cell is described in a data sheet that gives the designer information about the logic function performed, the area consumed, the input capacitance, the intrinsic and load-dependent components of the cell delay, output current-driving characteristics (for buffer cells), and the proper syntax to access the logic simulation model.

Circuit design begins with a definition of the system logic, in the form of a logic diagram or a written specification. Based on the information in the data sheets, standard cells from the libraries are selected to implement all the logic functions in the system.

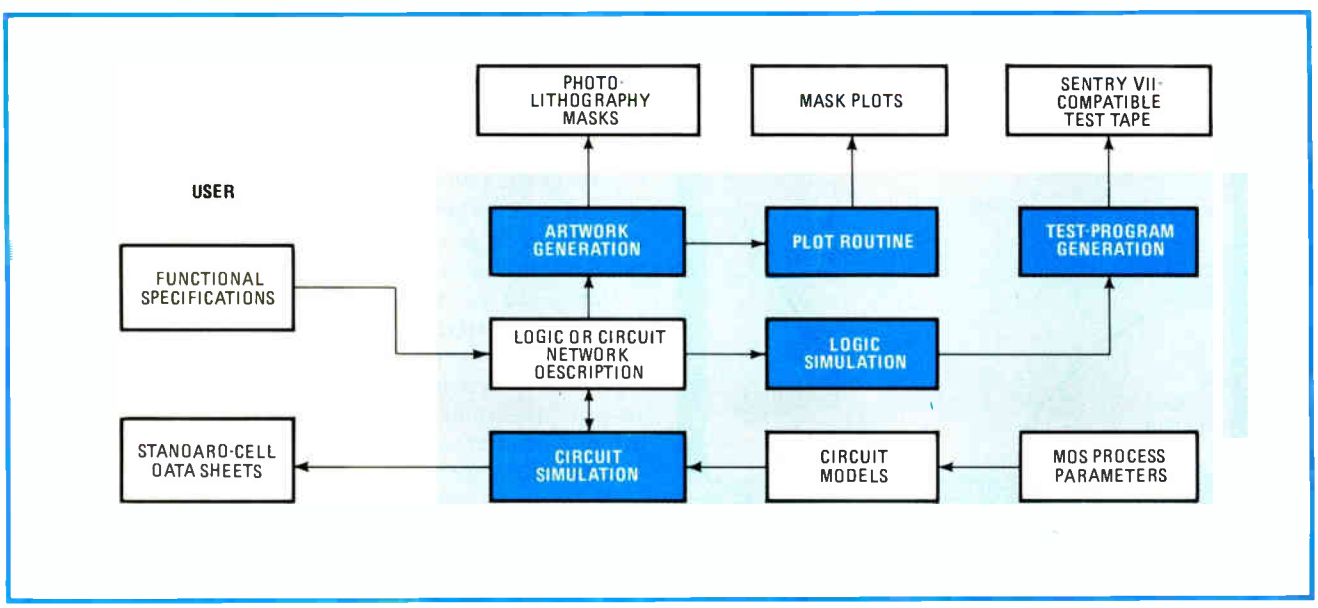
This process is similar to selecting standard 4000- or 7400-series parts from a data book to build a breadboard of a system design. If there is a logic function or linear building block that is required by the system and is not in the library, Zymos will design and characterize it and add it to the library. In addition, users with IC expertise may design proprietary cells.

Once cells have been selected, the user submits to the computer a network listing that specifies the desired interconnections among the cells. This design task is analogous to wire-wrapping a breadboard of standard C-MOS or TTL parts.

Simulating delays

At this stage, the engineer verifies the design with the logic simulator, which runs both zero-delay and accurate time-delay simulations of any network. Initially, zero-delay simulations might be needed to debug the logic design. This effort is similar to running a TTL or C-MOS breadboard at low speeds, where gate delays are negligible compared with the clock rate.

After the logic design has been checked, the logic simulator will provide an accurate timing simulation



1. All bets covered. The Zyp design system transforms logic descriptions from the user into masks for wafer fabrication. The software modules (color) are combinations of original programs and existing CAD tools. In addition to photomasks, the system provides test tapes.

based on the characteristics of the actual silicon implementation of the standard cell network. The net delay of each cell is modeled as the sum of an intrinsic delay and a load-dependent delay.

The intrinsic delay of a cell depends on its design and the temperature and voltage of operation, but not on the way the cell is interconnected in the network. The load-dependent delay accounts for capacitive loading and varies with the design, temperature, and voltage.

Initially, the logic simulator calculates the total capacitance at a given node in the network by adding the input capacitances of all the cells driven by that node, without regard for parasitic wiring capacitance. After the artwork has been generated, the interconnection capacitance at each node can be calculated and fed back to the logic simulator for a final check.

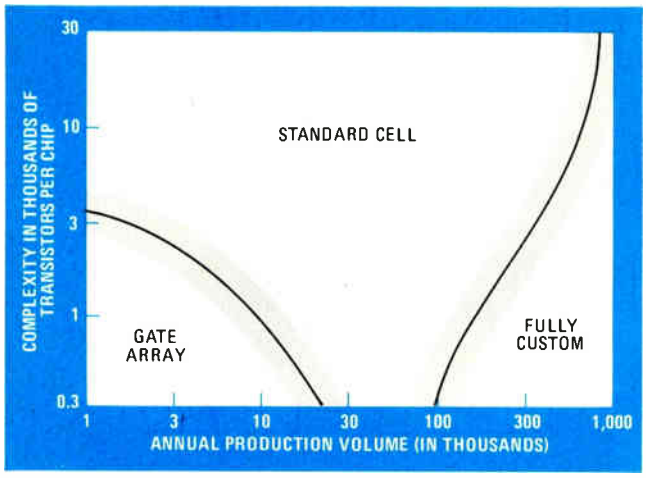
The logic simulator adds the load-dependent and intrinsic delay components at 25°C and 5 volts to find the nominal total delay. By using derating curves, this delay can be adjusted to predict performance at other ambient temperatures and power-supply voltages. Correlation studies show that the timing simulations and actual measured delays agree within about ±10% over a wide range of ambient temperatures (−55° to 125°C) and supply voltages (2 to 10 v).

Generating artwork

Once the system designer is satisfied with the network of standard cells, the network listing goes to the artwork-generation software. The initial output from this software is a cell-placement and routing diagram.

A Zymos technician works with this diagram on a computer to adjust the placement of certain cells, to specify the chip's aspect ratio for improvement of area efficiency or to fit the chip to a given package, and to minimize the interconnection capacitance on a given node to meet speed objectives. The artwork-generation software accepts each of these constraints and generates new placement and routing diagrams. Once placement and routing are set, a data-base tape is automatically prepared, from which masks are fabricated.

As mask tooling and prototype circuits are being fabricated, the output from the logic simulator is processed by software that creates a test pattern compatible with the Fairchild Sentry VII tester.



2. Best buys. The semicustom approach pays off for a wide range of production volumes when chip complexity increases. Gate arrays are least expensive only for simpler chips at low production volumes, and fully custom designs are justified only for the highest volumes.

Favorable economics

The direct development costs of a custom circuit using the Zyp system are much less than for a fully custom design and only slightly more than for a gate-array design. The indirect cost of turnaround time is substantially less than for the other approaches.

Zymos will deliver packaged, tested prototype circuits eight weeks after the user submits a verified logic description to the system. Assuming one month for verification of the design by the user, this system approach takes no longer than the 12 to 15 weeks specified for gate-array designs and is far faster than the 22 to 30 weeks required to turn a logic diagram into a fully custom chip.

Furthermore, because the circuit is built from well-characterized cells, the risk of a design iteration is greatly reduced. Because the system automatically generates a test program along with the mask tooling, another source of production delays is eliminated.

To minimize unit production costs, a design must minimize the area required for each transistor in the circuit. Since hand-drawn fully custom circuits offer the most efficient use of chip area for a given set of design rules, each standard cell in the design system is hand-drawn, giving the minimum possible area per transistor.

The Zyp system reserves space for interconnecting the cells and does not permit transistor placements there, so its ICs typically require from 10% to 20% more area per transistor than do fully custom designs. Still, this margin is substantially better than with the gate-array method, which usually gives 50% to 100% larger designs than a fully custom layout does.

Compared on the basis of production volume and circuit complexity, gate arrays and semicustom and fully custom designs each can make economic sense (Fig. 3). Gate arrays become more expensive than Zyp-designed systems as circuit complexity increases. The inefficient use of silicon area and associated high production costs of a complex gate array are the reasons.

As circuit complexity increases, the Zyp system becomes more economical than fully custom designs for an increasingly wide range of production volumes. The cost of designing a fully custom circuit goes up approximately exponentially with increasing complexity whereas the Zyp cost increases approximately linearly. □

Design AUTOMATION AUTOMATION A

Structured logic-design system is fast and affordable

Early simulation separate from timing verification speeds design; structuring the task hierarchically pares computing power needed

by Dean Miller and Jeff Rubin, *Valid Logic Systems Inc., Sunnyvale, Calif.*

☐ Separating timing verification from logic simulation and providing support for structured design methodology makes possible a fast, affordable set of computer-aided design tools for logic. More than 50% of the effort involved in the design of digital systems is devoted to this task, but CAD tools so far have been used primarily for hardware design. The CAD logic tools available have not fully satisfied the needs of the designer, and they have been relatively expensive to use because of the computing power they require.

The Scald (for structured computer-aided logic design) system can run on a variety of computers, as can the new CAD hardware tools. Because it permits full validation of the logic design before hardware implementation, it makes possible the building of more reliable integrated-circuit and board-level systems faster and cheaper than before.

Many benefits

A validation technique that will exercise circuits throughout the design process permits detection and correction of errors at an early stage. This reduces the time and cost required to develop a product and increases the likelihood that field units will be error-free.

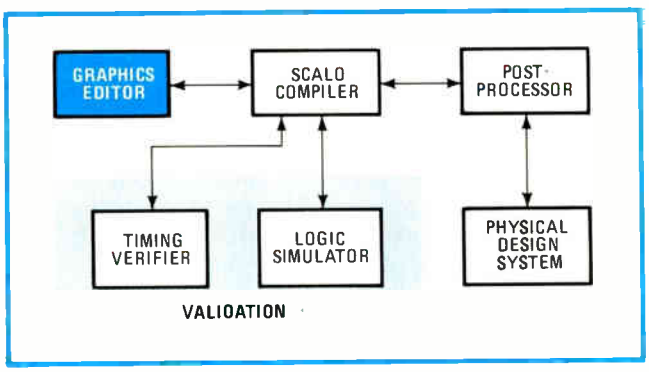
In one application, the Scald system uses a VAX-11/780 to simulate a typical system of 25,000 gate equivalents at a rate of four cycles a second. Using a larger IBM 370 or equivalent, the simulation speed is several times faster.

Logic simulation at this speed makes it practical to model large systems for relatively long periods of operation and hence to debug complex microcode as well as hardware. Debugging microcode during hardware design is important, since it may become necessary to make hardware changes to solve problems found in the code. Though design-automation tools potentially save development money by catching errors, they must not cost too much in time and money themselves.

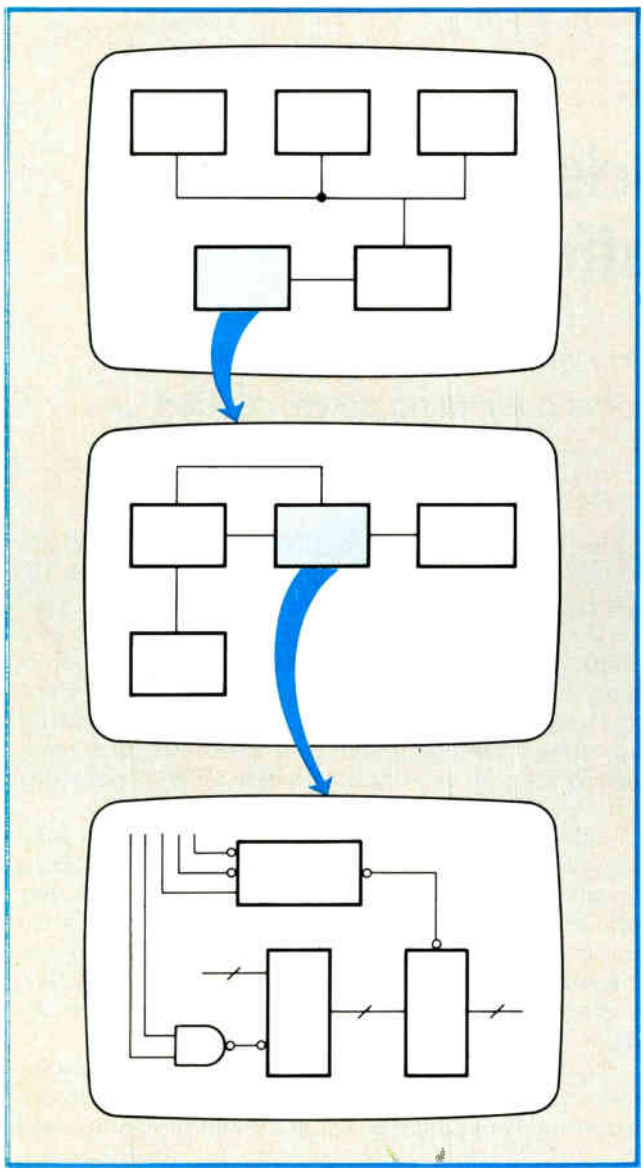
The Scald system, to be available early next year, will facilitate a structured approach to design, in which the task is broken down into distinct modules. It will separate logic simulation and timing validation as part of a complete logic design package (Fig. 1) with a graphics editor for entry of schematic drawings and on-going interactive editing for design refinement, a compiler for expanding schematics in terms of device libraries, and a postprocessor for creating a data base for layout of either printed-circuit boards or ICs.

Logic simulation, as it is being done today, is relatively expensive and difficult to use. Large mainframe computers, and even supercomputers, are run for long periods to simulate reasonably large systems at great cost in computer time. Creating and maintaining the simulator models is often cumbersome, and simulators, in general, are batch-processing oriented, lacking the flexibility of interactive systems.

The Scald system attacks these problems on many fronts. For example, the logic simulator is event-driven. Instead of evaluating the entire system design at small



1. Logic tool. The Scald design-automation system for logic design reduces the cost of building digital systems. Validation has been separated into two independent functions, simulation and timing verification, providing better results in less time.



2. Structured. Systems may be represented by a hierarchy of schematics starting with a top-level block diagram. Each module is defined by a schematic at a lower level. The result is a complex system with only necessary detail shown on any one drawing.

fixed time intervals, it repeatedly advances time by the appropriate amount to reach the next signal change. Event-driven simulators are inherently faster than fixed-interval units and take much less computing power.

The system allows designers to design at many different levels of complexity using a structured design approach. A structured logic design, like a structured program, consists of easy-to-understand hierarchically organized modules that communicate through well-defined interfaces. Modules are defined once and may be used many times throughout the design.

Hierarchy is a fundamental part of structured logic design—a hierarchical design is one in which each module is defined in terms of a set of lower-level modules (Fig. 2). Complexity can be reduced by designing a system from the top down, and lower-level modules can be designed and verified by several designers working more or less independently.

The front end of the system is the graphics editor. The designer enters schematics on a high-resolution cathode-ray-tube terminal by using a keyboard and a graphics tablet. Since the system supports hierarchical design, the first schematic entered actually may be a block diagram of the system and may refer to many modules yet to be defined. The designer then draws each of these modules and continues refining them until the design is expressed entirely in terms of components that can extend down to the device level.

Graphical language

The graphical input language lets the designer refer to multi-bit-wide components and buses as single entities. In one small example, to construct a 32-bit-wide register using four 74LS273 octal flip-flop chips, the designer simply draws one D-type flip-flop and marks it to be 32 bits wide (Fig. 3a). The system automatically ties together the clock and clear inputs and treats the data input and output lines as 32-bit buses. The schematic in Fig. 3b is what the designer would have had to enter if the system did not have the multiplying capabilities.

The compiler expands the design to form a data base that shows the interconnection of the components, drawn from a component library. It iteratively substitutes the appropriate module definition for each module referenced in the schematic until the design is expressed entirely in terms of components from the library. During the expansion, the compiler checks to see that module interface conventions are used consistently.

The postprocessor uses the expanded design to generate a data base for use by existing layout design systems that may handle a wide range of technologies. It can turn out interconnection and layout data for a pc-board design or an IC mask maker.

Even during the early design stages, the system user can validate the design by independently using the timing verifier and the logic simulator. Traditionally, logic simulation has been used to detect both timing and logic errors, and this eats up computer time.

Timing verification neatly separates the problem of verifying timing behavior from that of verifying logic behavior and consequently greatly enhances the logic simulator's efficiency. A timing error exists in a clocked digital system when, for example, a data signal does not have time to settle before a clock pulse occurs. In timing verification, it is primarily the timing, rather than the values, of the data signals that is of interest.

The timing verifier provides a complete check of the

Using the simulator

A simple logic simulation would be the circuit in the figure, a 4-bit Fibonacci-number generator. It generates numbers in the Fibonacci series; that is, numbers whose values are the sums of the preceding two numbers. The first two numbers in the series are defined to be 0 and 1, so the subsequent numbers should be 1, 2, 3, 5, and so on.

The purpose of the zero detector module is to generate a logic 1 on the Z output for use as a carry signal to the adder when all bits on both inputs are 0. The implementation details of the zero detector are not shown at this level.

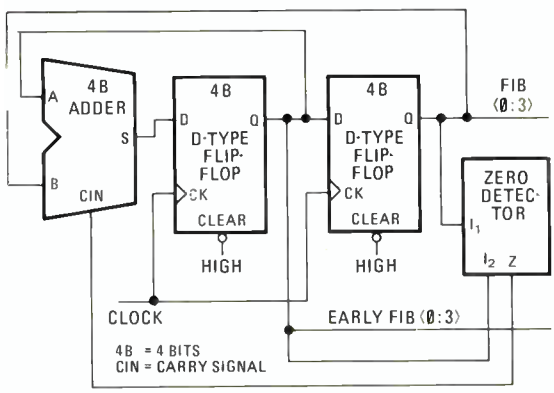
The circuit is initialized with the value of each output signal set to 0. Then the user tells the logic simulator which signals are to be displayed and for how long simulated time is to be advanced. The signals of interest are: FIB (the current value of the Fibonacci series) and EARLY FIB (the value that will become FIB one clock later). For this simulation, only these two signals are selected for display. The clock period (specified on another schematic) is 200 nanoseconds, and the user wishes to examine the state after each period. So the step is set to 200 ns.

The table shows the results of the simulation after several clock periods. Initially, both FIB and EARLY FIB were 0 and therefore the zero detector generated a carry input to the 4-bit adder.

After one clock period (at 200 ns), the first number in the series appears on FIB and the second appears on EARLY FIB. Since both inputs to the zero detector are no longer 0, the carry into the adder is set to 0. On each successive cycle, the value of FIB will be the sum of the preceding two values.

RESULTS OF SIMULATING 4-BIT FIBONACCI NUMBER GENERATOR

Time (ns)	FIB	EARLY FIB
0	0	0
200	0	1
400	1	1
600	1	2
800	2	3
1,000	3	5



timing behavior of a clocked digital system based on timing specifications of components in the library. It ensures that the design is free of race conditions, setup and hold-time errors, pulse-width errors, and clock glitches. It easily verifies incomplete designs, providing continuous feedback about timing problems as the design progresses.

Working from libraries that define ranges of possible device delays in schematic form and from an optional data base that defines interconnection delays, the verifier checks the timing behavior of a design for all possible sets of delays. A design that verifies correctly has no possibility whatever of including any timing error—regardless of which devices or batches of devices will be used in the system—as long as every component used meets its library specifications.

This validation approach capitalizes on the independence of timing and logic verification. A circuit is determined free from timing errors for all possible input conditions, not just for some small set of cases selected by the designer or forced by the initial state of the digital system. Simulators that combine timing verification and logic simulation must contend with a much longer testing process because the entire logic-simulation sequence must be rerun each time a timing change is made.

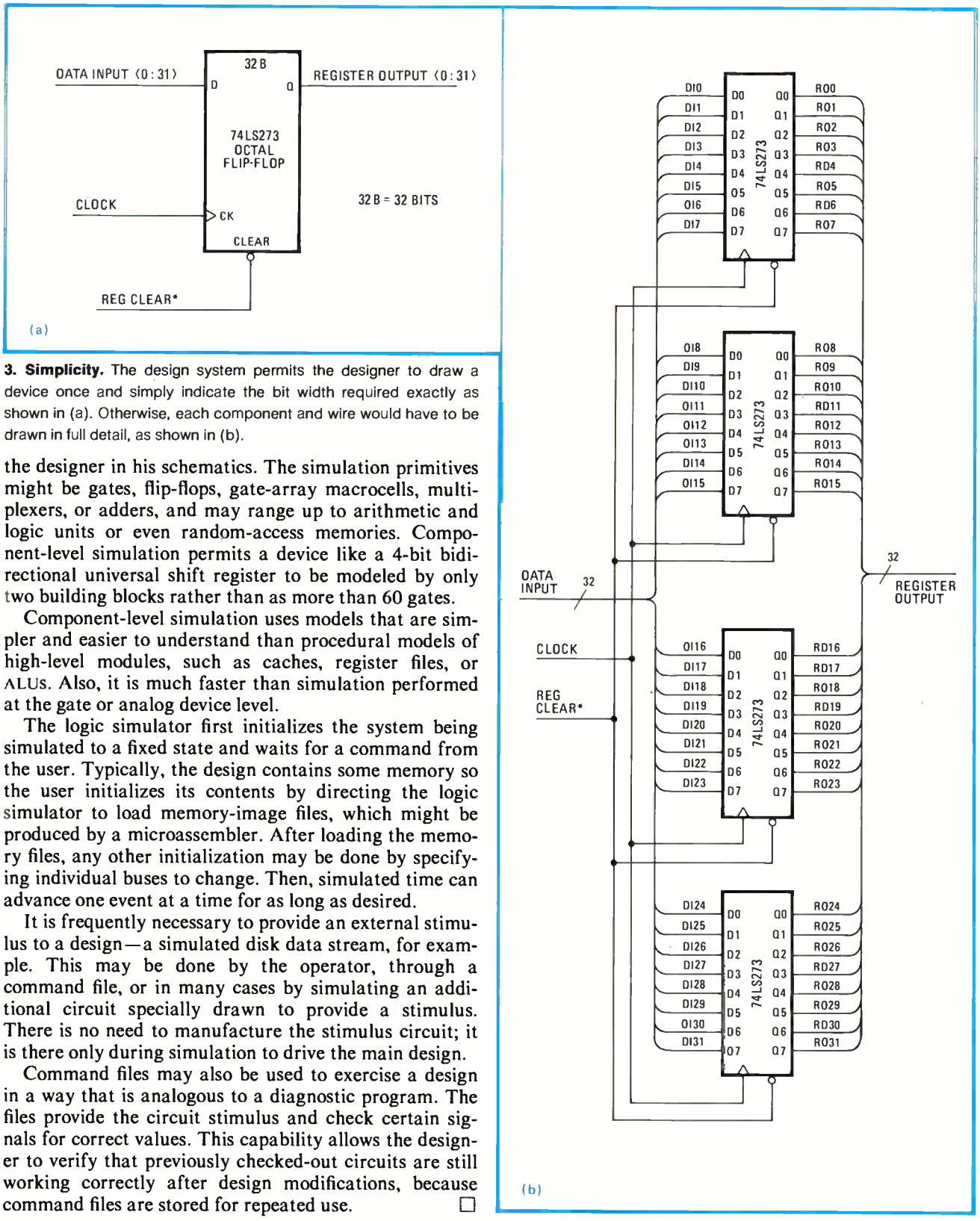
After the timing is verified, the only question that the logic simulator need answer is whether the logical behavior is correct for one set of delays. The logic simulator efficiently simulates designs, expressed as schematics in the common data base, using models that are natural for the designer. It provides an interactive user interface that helps locate logic errors quickly.

Interaction

The interactiveness of the simulator gives the designer the power to change the debugging plan dynamically in response to new information. It eliminates the need to devise a complete scenario for the simulation run before its initiation and avoids much superfluous output since the designer can restrict the display to contain just the signals of current interest.

The level of detail of the simulator building blocks greatly affects both simulation speed and ease of use. The Scald system simulates at the component or device level, which is an appropriate level for the simulation of large system designs.

In this approach, the building blocks used by the simulator are roughly at the same level as those used by



3. Simplicity. The design system permits the designer to draw a device once and simply indicate the bit width required exactly as shown in (a). Otherwise, each component and wire would have to be drawn in full detail, as shown in (b).

the designer in his schematics. The simulation primitives might be gates, flip-flops, gate-array macrocells, multiplexers, or adders, and may range up to arithmetic and logic units or even random-access memories. Component-level simulation permits a device like a 4-bit bidirectional universal shift register to be modeled by only two building blocks rather than as more than 60 gates.

Component-level simulation uses models that are simpler and easier to understand than procedural models of high-level modules, such as caches, register files, or ALUs. Also, it is much faster than simulation performed at the gate or analog device level.

The logic simulator first initializes the system being simulated to a fixed state and waits for a command from the user. Typically, the design contains some memory so the user initializes its contents by directing the logic simulator to load memory-image files, which might be produced by a microassembler. After loading the memory files, any other initialization may be done by specifying individual buses to change. Then, simulated time can advance one event at a time for as long as desired.

It is frequently necessary to provide an external stimulus to a design—a simulated disk data stream, for example. This may be done by the operator, through a command file, or in many cases by simulating an additional circuit specially drawn to provide a stimulus. There is no need to manufacture the stimulus circuit; it is there only during simulation to drive the main design.

Command files may also be used to exercise a design in a way that is analogous to a diagnostic program. The files provide the circuit stimulus and check certain signals for correct values. This capability allows the designer to verify that previously checked-out circuits are still working correctly after design modifications, because command files are stored for repeated use. □

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Circle 122 on reader service card

Bi-FETs expand applications for general-purpose op amps

by Jim Williams
National Semiconductor Corp., Santa Clara, Calif.

With their excellent low-power consumption and low drift, bipolar field-effect-transistor operational amplifiers easily outperform general-purpose (741-type) op amps in a variety of applications [*Electronics*, Nov. 3, 1981, p. 134]. A low-power voltage-to-frequency converter, a battery-powered strip-chart preamplifier, and a high-efficiency crystal-oven controller can also benefit from those qualities of the 441 op amp.

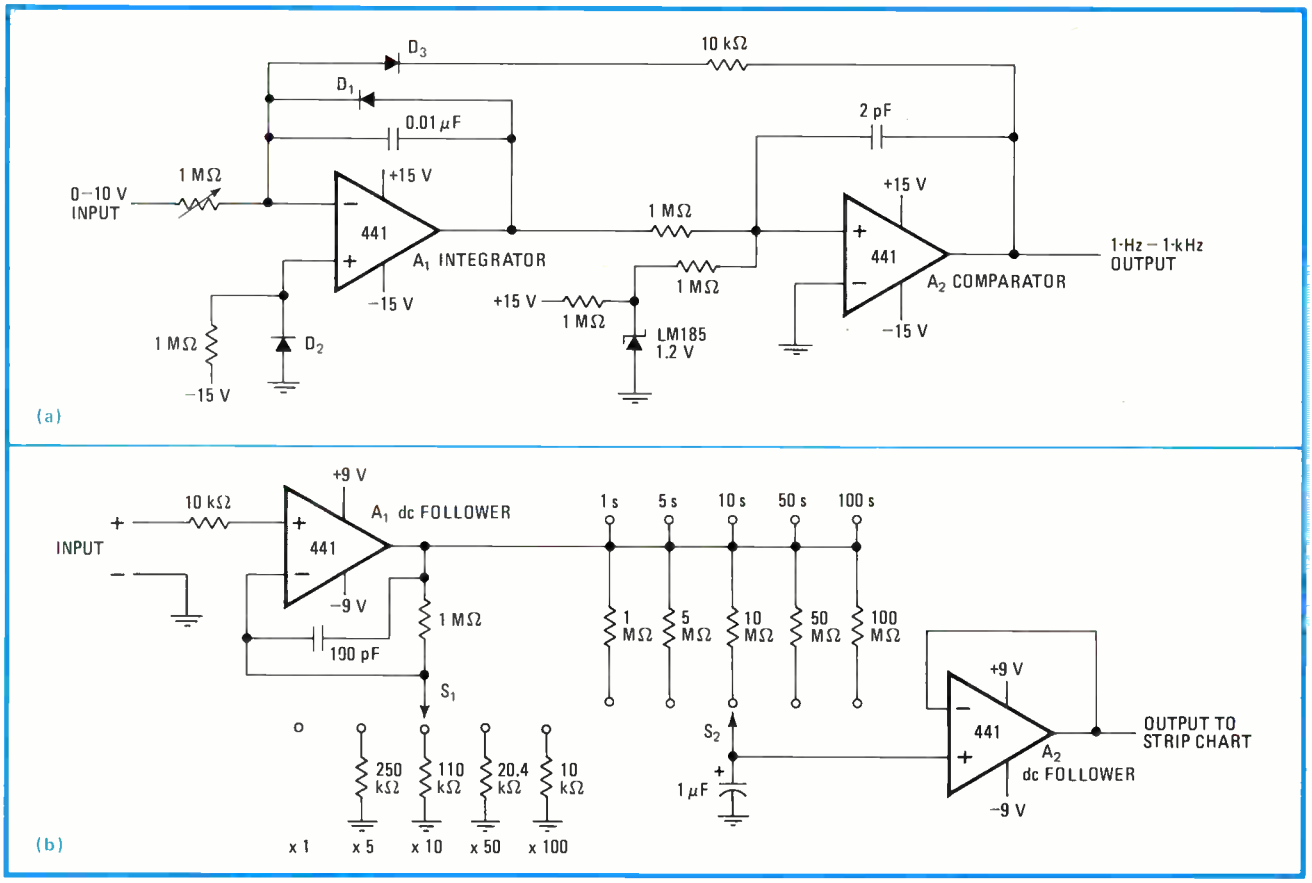
The voltage-to-frequency converter (Fig. 1a) provides linearity to within 1% over the range of 1 hertz to 1 kilohertz. What is more, it does not need an integrator-resetting network using an FET switch, and its current drain is only 1 milliampere.

Integrator A_1 generates a ramp whose slope is proportional to the current into the amplifier's summing junction. The ramp's amplitude is then compared with the 1.2-volt reference at A_2, which serves as a current-summing comparator.

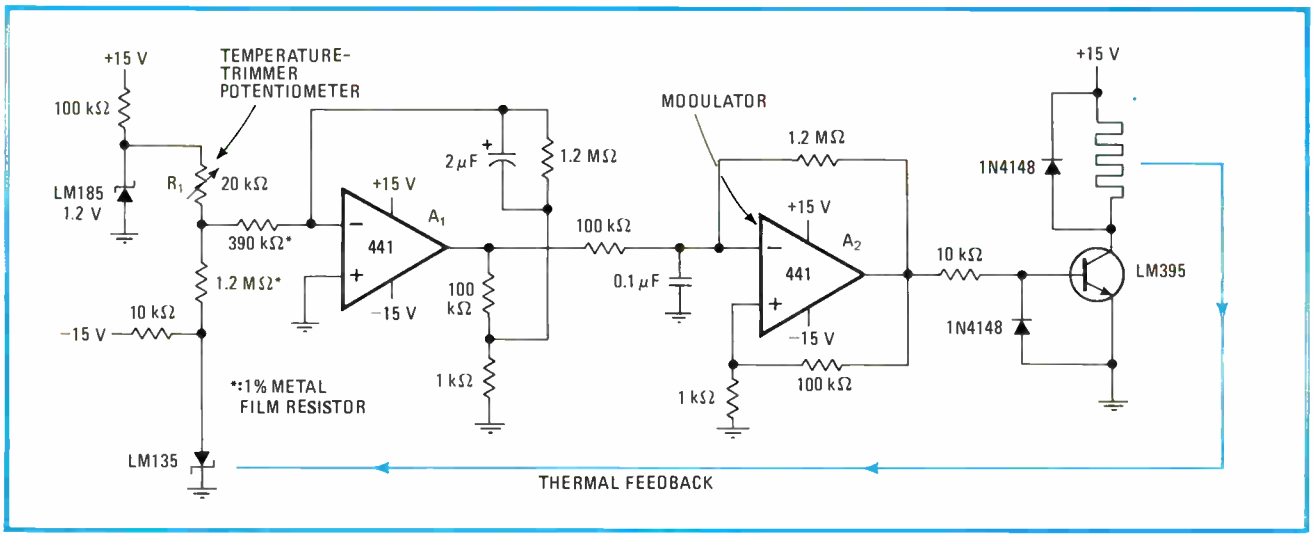
When the instantaneous amplitude of the ramp exceeds −1.2 V, A_2's output goes low, thereby pulling current from A_1's summing junction. This pulling, aided by diode D_1, causes A_1's output to drop quickly to zero. D_2 biases A_1's noninverting input, providing temperature compensation for the amplifier. These diodes and D_3 are 1N4148 parts.

The 2-picofarad capacitor at A_2 ensures that the output of the amplifier will remain high long enough to completely discharge the 0.01-microfarad capacitor at A_1, thus doing the job of the integrator-reset mechanism. As for calibration, the output is easily adjusted with the 1-megohm potentiometer for a 1-kHz output that is given an input voltage of 10 V.

The 441's low-bias current and its low-power consumption can also yield a simple and flexible preamplifier for strip-chart recorders (Fig. 1b). The circuit is powered by two standard 9-V batteries and may be plugged directly into the recorder's input. As a result, common-mode and ground-loop difficulties are minimized. The gain is variable from 1 to 100, and the time



1. Low current, low cost. A voltage-to-frequency converter and preamplifier for strip-chart recorders may be built with the 441 bi-FET op amp. Converter (a), which is easily reset by a capacitor at A_2, provides linearity within 1% over a 0-to-1-kilohertz range and draws only 1 milliampere. A battery-powered preamplifier (b) has an adjustable gain and time constant. The circuit draws less than 500 microamperes.



2. Heat switch. This feedback-type controller, using a switching modulator to conserve power, maintains the crystal temperature at about 75°C. Temperature, which may be trimmed over a 4° C range with potentiometer R_1, can be held to within ±0.1°C for a long time.

constant is adjustable from 1 to 100 seconds.

Input amplifier A_1 operates as a dc follower with gain. The gain has five ranges and is selected by S_1. The operational amplifier's input impedance is extremely high (10^{12} ohms) and consequently bias-current loading at the input is around 50 picoamperes. The 10-kilohm resistor in the input line provides current limiting under fault (overloaded input) conditions.

A_2, a second dc follower, buffers the RC filter composed of five resistors and a capacitor. The time constant is selected by switch S_2. This circuit draws less than 500 microamperes, ensuring long battery life.

The efficiency of the crystal-oven controller circuit (Fig. 2) is improved by having power switched across the heater element, instead of using a conventional linear-control arrangement. Oven temperature is sensed by the LM135 temperature sensor, whose output varies 10 millivolts/°C; thus its output will be 2.98 V at 25°C. This signal, converted into current as it flows through the 1.2-MΩ resistor, is then summed with a current derived from the LM185 voltage reference.

A_1 amplifies the difference between these two currents and drives A_2, a free-running duty-cycle modulator, over several kilohertz of frequency to power the output transistor and the heater.

Generally, when power is applied to the circuit, A_1 attains a negative saturation, forcing A_2's output to a positive one. The LM395 then turns on and the oven warms. When the oven is within 1°C of the desired setting, A_2 becomes unsaturated and runs at a duty cycle dependent upon A_1's output voltage. The duty cycle is determined by the temperature difference between the oven and the setpoint. For the given values, the circuit will maintain an oven temperature at 75°C, ±0.1°C. □

Swapable fiber-optic parts ease isolation problems

by Jim Herman
Motorola Semiconductor Sector, Phoenix, Ariz.

Assembling opto-isolators from their component parts to meet various high-voltage, high-frequency applications is now simplified with the introduction of interchangeable fiber-optic emitters and detectors. These devices can be built at a lower cost than conventional hybrids.

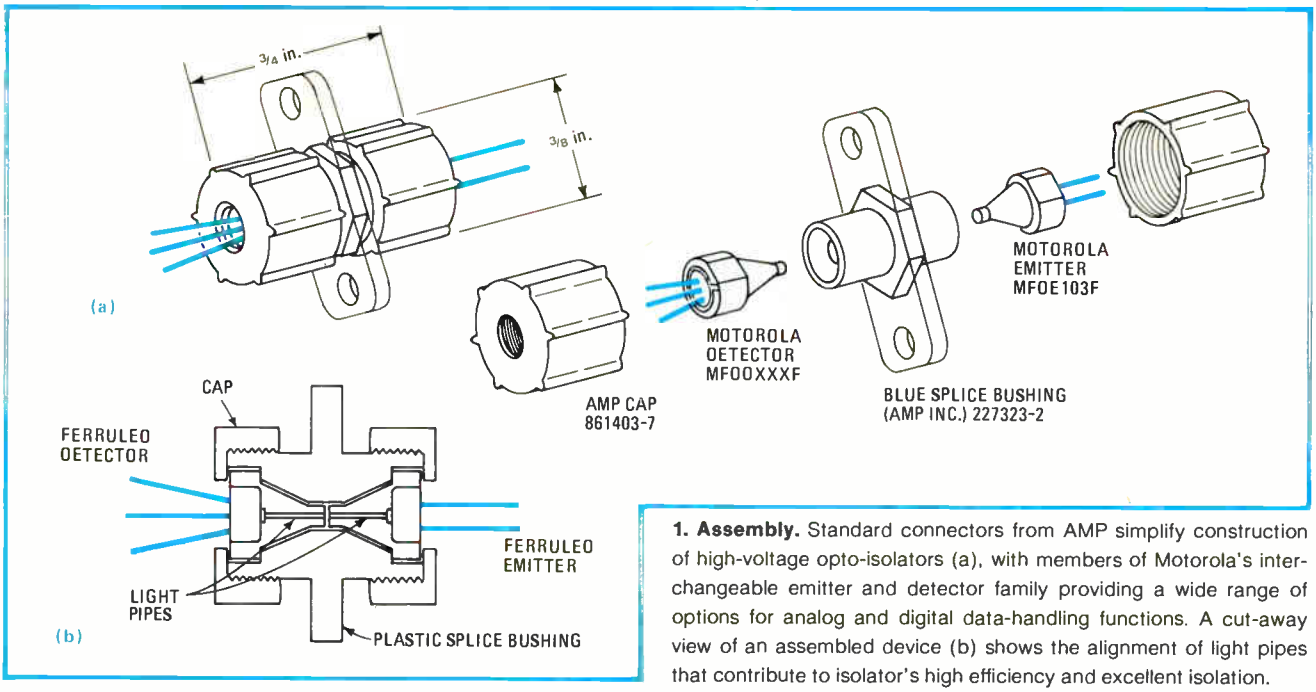
Therefore, systems such as a simple and effective 25-megahertz analog transmission channel and a 20-megabit-a-second emitter-coupled-logic data-handling system, which provide ac and dc isolation up to 50,000 volts, may be easily constructed.

A light-emitting diode and an optically-coupled photosensitive detector make up the basic optical isolator (Fig. 1a, p. 124). The plastic cable-splice bushing and plastic retainer caps housing the ferruled emitters and detectors are manufactured by AMP Inc., Harrisburg, Pa. When assembled, the components form an isolator that measures 0.75 inch long and 0.5 in. wide.

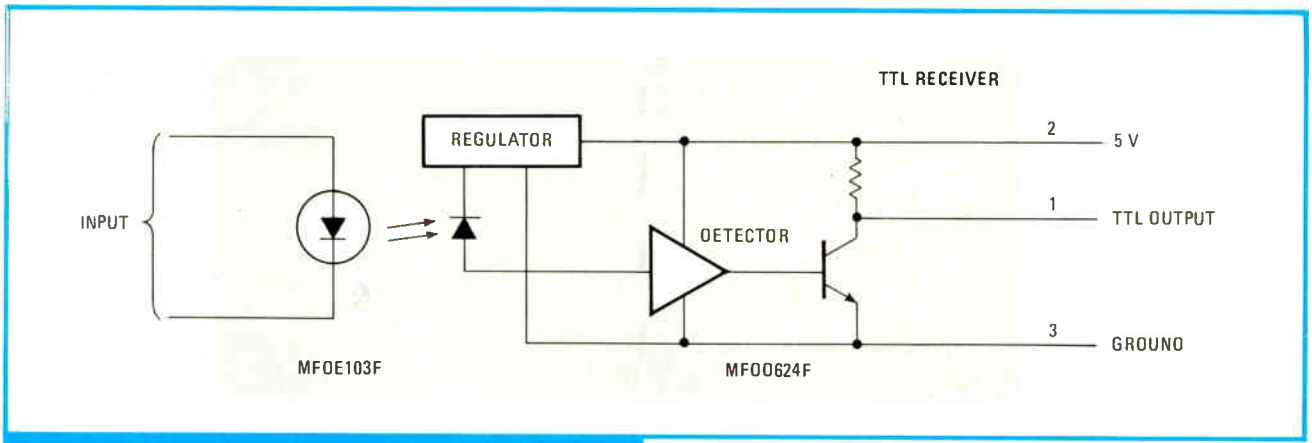
Characteristics of the isolator are determined by the selected emitter and detector. In particular, the interchangeable detectors provide the designer with several options that include interfacing with TTL or ECL loads, wide bandwidths, and analog or digital formats. The isolation voltage of the device is directly related to the separation between the LED and the detector, the package material, its size and shape, and the value of the parasitic capacity (C_C). This capacity determines the amount of ac protection.

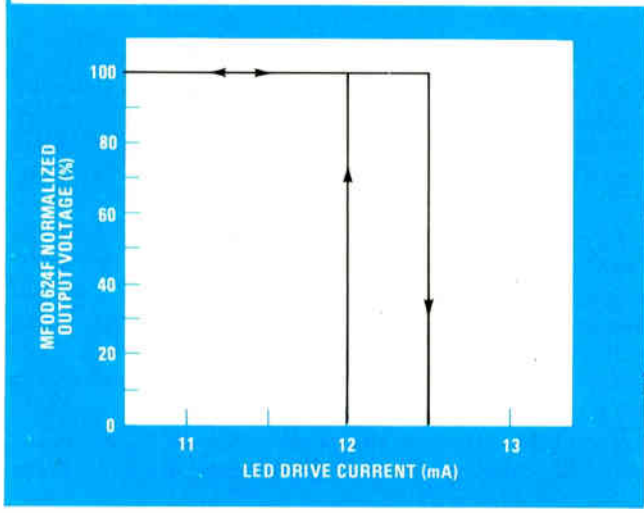
The actual isolation (breakdown) voltage may easily be determined by measuring the voltage potential across the isolator from input to output at a prespecified leakage current such as 80 microamperes.

The coupler (1b) contains light pipes that provide efficient coupling while maintaining a large separation



1. Assembly. Standard connectors from AMP simplify construction of high-voltage opto-isolators (a), with members of Motorola's interchangeable emitter and detector family providing a wide range of options for analog and digital data-handling functions. A cut-away view of an assembled device (b) shows the alignment of light pipes that contribute to isolator's high efficiency and excellent isolation.





2. Applications. An isolator that can handle 500-kb/s data rates for TTL loads is configured with the MFOE103F emitter and MFOD 624F detector. The device's transfer function is also very sharp. Replacing the receiver with a 404F detector converts the unit to one that delivers a 10-Mb/s data rate. When the MFOC600 receiver is added, an isolator will provide 20-Mb/s data rates to ECL loads.

between the emitter and detector. As a result, the input and output have excellent ac and dc isolation. A wide selection of emitters and detectors are available.

Among the devices that may be readily assembled is a 25-MHz analog isolator built with the MFOE103F emitter and the MFOD104F pin detector. The transfer function of this device will be linear, providing a 0-to-20-μA pin-diode output for a 0-to-75-milliampere LED driving current.

Similarly, a 500-kilobit TTL isolator, Fig. 2, is easily built with the MFOE103F emitter and the MFOD624F integrated receiver. For wider bandwidths, the MFOD 404F integrated detector preamplifier and the MFOC 600 receiver circuit may be used. This combination will provide 10-Mb/s data rates for driving TTL loads or 20-Mb/s rates for driving ECL loads. In addition to high-voltage optical isolation, this isolator will also provide automatic gain control to stabilize output signals and an analog output port for status monitoring. □

Designer's casebook is a regular feature in *Electronics*. We invite readers to submit original and unpublished circuit ideas and solutions to design problems. Explain briefly but thoroughly the circuit's operating principle and purpose. We'll pay $75 for each item published.

Low-cost 12-GHz receiver heralds satellite-to-home TV

Gallium arsenide MES FETs are basic to a low-noise unit that requires an antenna only 1 meter in diameter

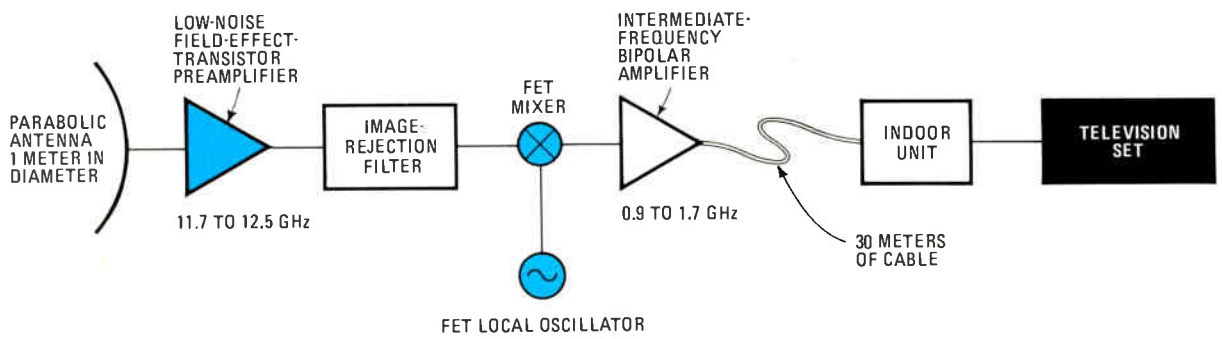
by Peter Harrop, Paul Lesartre, and Christos Tsironis, *Laboratoires d'Electronique et de Physique Appliquée, Limeil-Brévannes, France*

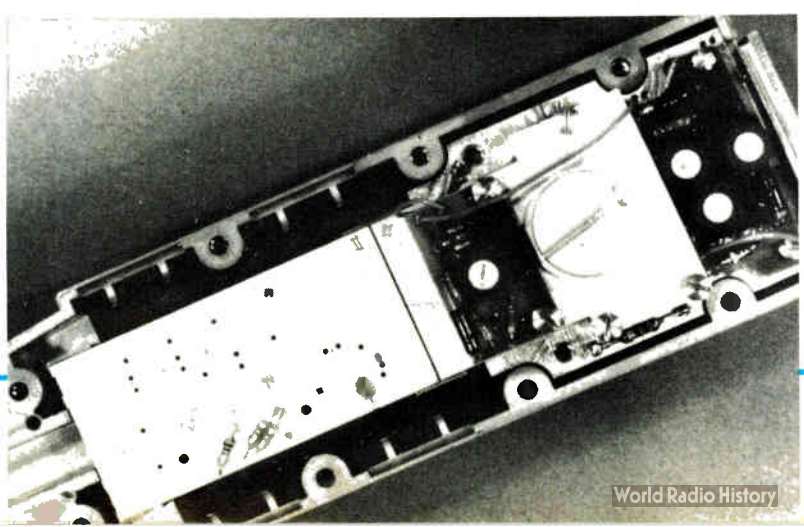
☐ Home television sets could soon be picking up broadcasts directly from satellites. Scientists in France have designed a low-cost microwave receiver that will need only a low-cost 1-meter antenna to be commercially feasible. The research effort was stimulated by experiments with the European Orbiting Test Station and the Japanese satellite Yuri, which confirmed that high-power geostationary craft transmitting at 12 gigahertz could provide sufficient signal-to-noise ratio for a quality picture. To gather further data on the concept, France and Germany plan a joint 1984 launch of two preoperational 12-GHz satellites.

The envisioned system will comprise outdoor and indoor units, according to the design from the Laboratoires d'Electronique et de Physique Appliquée in Limeil-Brévannes, near Paris. The heart of the outdoor unit is an amplifier—actually a gallium arsenide metal-semiconductor field-effect transistor—that is not only state-of-the-art but by now is also practical for the consumer market. The design and operation of this amplifier is best understood in the context of the requirements of the outdoor system.

Outdoor requirements

The outdoor unit is typically fixed at the focal point of the antenna and converts the 12-GHz input signal into a 1-GHz intermediate-frequency signal that is then transmitted to the viewer's indoor unit. GaAs MES FET technology is particularly suitable for the outdoor unit because it can simultaneously operate with low noise, high frequency, and high amplification. To bring the satellite signals to the viewer, the indoor unit receives the fm-modulated signal from the downconverter, selects a channel, and demodulates it. At that point, the signal may either be converted into a-m in the band for the antenna socket of the TV set or be directly injected into



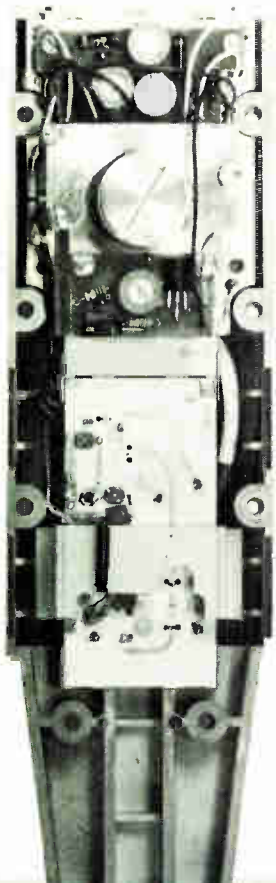


1. Multipurpose. In the Philips satellite-to-home receiver-downconverter, the MES FET plays a major role. Here it performs the functions of low-noise 12-gigahertz preamplification, downconversion from 12 to 1 GHz, and 11-GHz oscillation.

the receiver's standard video and audio circuitry.

The implementation of the outdoor unit is suited to the map of Europe, crowded with countries that look small at the range of a geostationary satellite. The frequency allocations created by this particular geography will no doubt markedly affect the next decade of innovation in satellite-to-home TV systems.

In 1977, the World Administrative Radio Conference allocated five 27-megahertz channels to each European country in one of the two subbands of 11.7 to 12.1 GHz and 12.1 to 12.5 GHz. It specified that the TV signals in these bands will be fm-modulated but may include more than one sound channel for different languages. (These channels may also be digitally coded.) The overlapping frequencies due to Europe's geography will cause spillover of satellite radiation patterns onto neighboring countries. Thus, viewers in closely adjoining areas will be able to receive not only their own five national programs, but also programs from neighboring countries.



2. Transitions. The receiver-downconverter is housed in a metalized plastic case and requires no temperature control. A waveguide-to-microstrip transition passes the 12-gigahertz input signal to the MES FET amplifier mounted on an alumina substrate measuring 2 inches by 1 in. The MES FET oscillator can either be electrically tuned or mechanically adjusted using the screw shown.

Regardless of the country or frequency band, it is likely that three reception systems will exist simultaneously to meet the European requirements. The first system is planned for community reception, whereby one ground station feeds a large number of houses. The second will operate with a collective reception scheme whereby one ground station supplies a block of houses or a small residential area. And finally, individual reception will be set up, each house equipped with its own antenna.

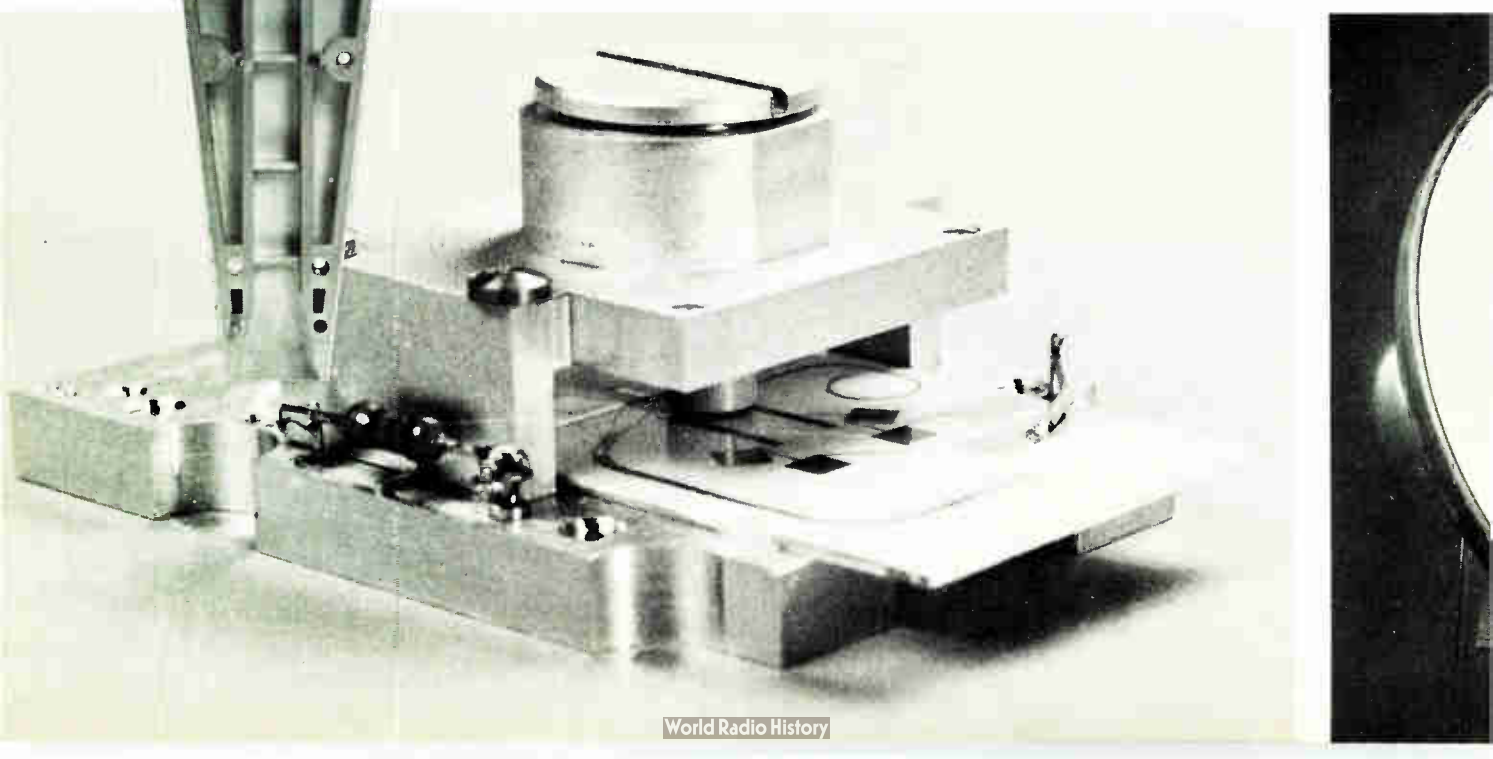
The specification the WARC recommends for the first two systems is an overall figure of merit of 14 decibels per Kelvin, derived by dividing the antenna's gain by the total system noise temperature (G/T). Individual systems will be required to have a G/T of 6 dB/K. All of these specifications can be met by a system based on a GaAs MES FET.

Interference reduced

In all these systems, since some channels overlap in frequency, circular-polarization microwave receivers must be employed to minimize potential interference problems. The second major source of interference comes about because proposed satellites, situated in one of four orbital positions, will transmit at a relatively high power. In fact, the effective radiated power per channel is about 60 dBW. Thus, the high-cost, high-technology requirements have been designed into the satellite side of the link, so that the specifications on the receiver end are relaxed—cutting the consumer's cost considerably.

Although cost counts, the absolute measure of any receiver is its capacity to present high-quality TV pictures on a standard TV set. Subjective as this criterion may be, it can in fact be defined in terms of a measurable signal-to-noise ratio at the TV receiver's input, which, by transposition up the receiver chain, may be specified in terms of the overall receiver's figure of merit—16 dB. Consequently, the minimization of the noise figure of any 12-GHz downconverter is fundamental to the receiver's performance.

There are four basic functions performed in the receiver's front end. These are 12-GHz filtering and low-noise



amplification (which is optional), 11-GHz stable oscillation, conversion from 12 GHz to 1 GHz, and 1-GHz i-f amplification. One system-design option involves the use of the same active component to perform all three radio-frequency functions. This is the solution LEP has proposed for the Philips industrial groups (Fig. 1).

In the Philips systems, MES FETs are used in the low-noise amplifier, the mixer, and the local oscillator. In each function, the single-gate MES FET presents particular advantages. It offers low noise in the amplifier stage, conversion gain in the mixer, and excellent temperature stability in the local oscillator.

The local oscillator is particularly steady when it is stabilized with a barium titanate dielectric resonator with the added compensating technique of voltage-controlled output power. The unit (Fig. 2) is housed in a molded, metalized plastic shell. The molding approach was adopted to minimize the hardware's price and remains relatively simple since no temperature control is necessary inside the front end. A bandpass filter is included to prevent all unwanted, out-of-band signals from impinging on the input stage.

Image rejection

A waveguide-to-microstrip transition passes the 12-GHz signal to the input of the two-stage MES FET amplifier mounted on one of two alumina substrates measuring 2 inches by 1 in. Image rejection between the amplifier and the mixer is achieved by means of a printed-circuit-board bandstop filter of the spurline type. Both the 12-GHz signal and the 11-GHz local-oscillator signal are coupled into the gate of the MES FET mixer by a directional filter. The high conversion gain of the mixer (5 dB) enables the use of an inexpensive 1-GHz bipolar amplifier, which is included on the same alumina circuit as the mixer. The local oscillator is mounted on a second substrate and its power fed through similar microstrip-waveguide-microstrip transitions, the waveguide section forming an integral part of the metalized plastic housing.

The oscillator itself uses another MES FET as the active component and its own barium titanate dielectric resonator as the frequency stabilizer. It can deliver 20 mW of output power, which along with frequency is easily adjusted by varying the MES FET drain voltage. Frequency stability is better than 3×10^{-6}/°C (from $-25°$ to $+55°$C) and the pushing factor is less than 1 MHz for a 10-dB variation in output power. Frequency can also be mechanically tuned over a 50-MHz range simply by adjusting a screw over the resonator. The characteristics of the oscillator remain unchanged.

The spectral quality of the oscillator is equivalent to that of a free-running Gunn oscillator. This means that the fm noise is 1 hertz root mean square per hertz at 50 kHz from the carrier in a double-sideband measurement. This is sufficient for this application because of the relatively high i-f. The efficiency is 18% at $+25°$C for an output power of 22 mW.

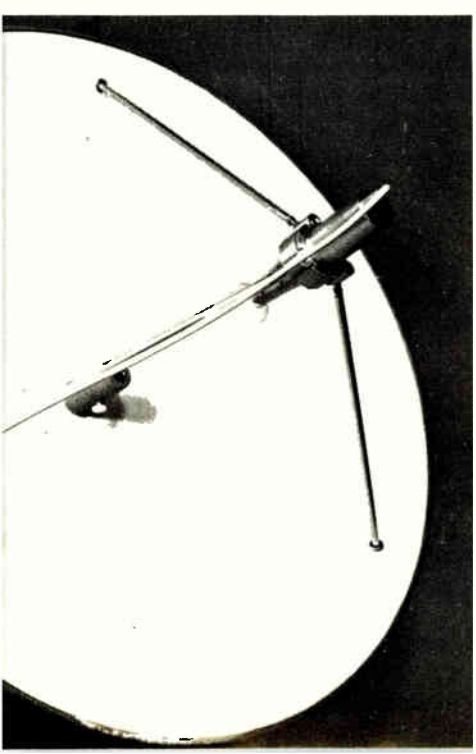
The complete outdoor unit is mounted at the focal point of a 1-m parabola (Fig. 3). Its overall gain is 30 dB and its noise figure is 3.8 dB from 11.7 to 12.5 GHz. Over the temperature range $-20°$ to $+55°$C, the noise figure increases monotonically at 0.12 dB/10°C. One such front end has now successfully completed field trials with Yuri and the OTS and has confirmed its capacity to furnish high-quality TV pictures in extreme weather conditions. The link budget for the future French system (using the data of an all-FET front end) indicates a minimum signal-to-noise ratio of 21.5 dB, a figure high enough to ensure a clear picture.

Alternative solutions

Recent progress in MES FETs has led to the introduction of a family of devices with two Schottky-barrier gates. Indeed, these dual-gate devices are capable of simplifying many of the functions that are currently performed with single-gate MES FETs. For example, LEP has demonstrated the use of a device with two Schottky-barrier gates as a dielectric-resonator–stabilized oscillator at 11 GHz and even as a self-oscillating mixer. As an oscillator, the most recent device has loaded quality factors (Qs) in excess of 2,000 when it is stabilized by a barium titanate dielectric resonator.

When used in the self-oscillating mixer mode, the dual-gate FET replaces both the oscillator and the mixer devices in Fig. 1, an exchange that considerably simplifies the microwave circuits in the receiver front end. In this operating mode, the device's second gate can be coupled to a dielectric resonator, while the first gate serves as the 12-GHz input.

Current front-end receiver research, at LEP and elsewhere, is directed toward a monolithic version of the FET front end where all the active components and some rf circuitry will be integrated on the same GaAs chip. This greatly reduces mounting and adjustment time and eliminates other time-consuming assembly operations. This approach is conceivable today because of progress in Czochralski GaAs growth techniques and localized ion-implantation procedures that can create large and reproducible GaAs wafers. However, the cost and material limitations of high-Q circuits, temperature-stable material, GaAs real estate costs, and production yield are considerations that ultimately will determine the degree of monolithic integration. □



3. Not obtrusive. The outdoor receiver-downconverter is mounted at the focal point of a 1-meter diameter parabolic antenna that will be acceptable to consumers. A 30-decibel gain and 3.8-dB noise figure is achieved from 11.7 to 12.5 gigahertz.

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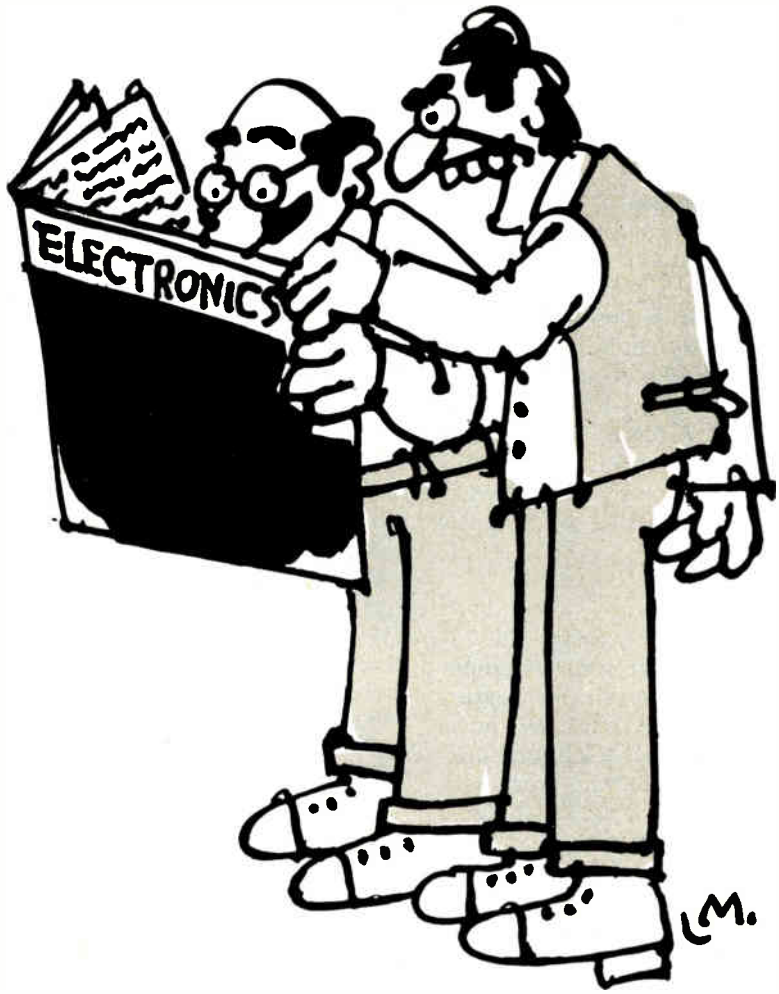

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Data-base manager fits microsystems, avoids application dependency

Set of software tools organizes information flow, facilitates representation of data relationships, works with many operating systems, high-level languages

by Mike Gagle and Gary Koehler, *Micro Data Base Systems, Lafayette, Ind.*, and Andrew Whinston, *Purdue University, Lafayette, Ind.*

☐ Data-base management systems have been reserved for mainframe computers and minicomputers, but microprocessor-based systems are ready to crash the club. Hardware advances and associated cost reductions, notably in high-capacity disk systems, can combine with the computing power offered by the new 16-bit microprocessors or with the currently popular 8-bit machines to provide microcomputer systems that can manage data as effectively as can minicomputers.

However, the missing ingredient has been the software to organize data-base management on microcomputer systems. Such programs are now available, in the form of the MDBS III data-base manager.

Unified collection

The purpose of data-base management is to provide a unified collection of software tools to store and retrieve information in a systematic manner, often in an on-line environment. A good data-base manager represents multiple, complex relationships among data items with little or no redundancy. It should also be independent of any particular application program and the specific physical representation of the data items. Of course, it should also provide a convenient and efficient means for the user to add, delete, or retrieve data and data relationships.

File management was the forerunner of data-base management. A common form of file management is the index sequential-access method (ISAM), which combines sequential-access file methods with direct-access file methods.

A sequentially organized file consists of a collection of records in which each one is stored in a sequential order based upon a criterion, such as alphabetical order. Sequential access means that a file's records can be quickly processed in the order in which they occur within the file.

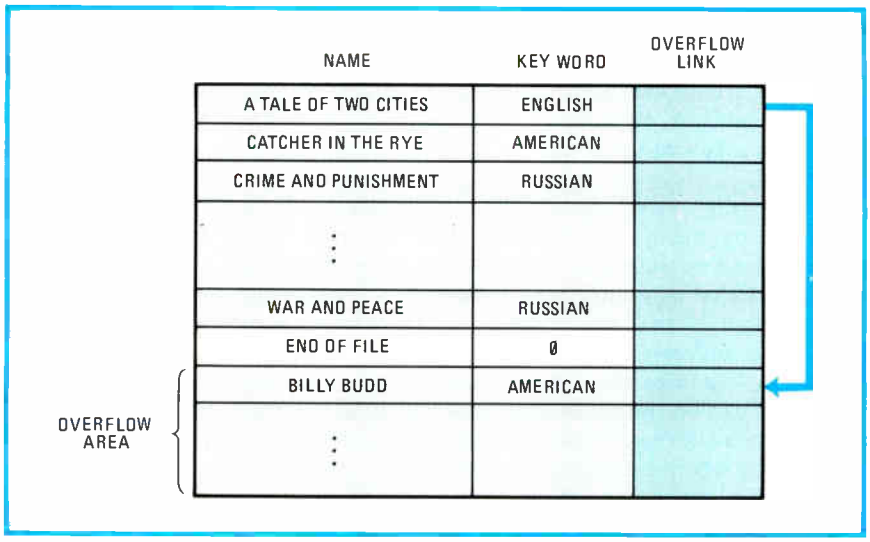
A direct-access file, on the other hand, is a collection of records from which each one can be retrieved by specifying the data value of one of its fields. The time that is required to locate a particular record is largely independent of that record's position in such a file.

An ISAM file manager uses a sequential file organization in which records can be processed in both a sequential and a random order; it also permits a certain amount of record insertion without reorganization. The file is initially created by loading the records in a sequential manner. These records must be in order, sorted by the key criterion to be used for later access (Fig. 1).

While the records are being loaded, an index is generated to permit direct access to the file. The system permits the addition of new records to the file by maintaining overflow areas. When the number of records in the overflow area becomes large, the file must be reorganized, which involves the same process used when the file was created.

A more elaborate approach

In contrast, the network data model developed by a task group of the Conference on Data Systems and Language (Codasyl) is a data-base management system. Unlike ISAM, it allows named relationships to be specified between different types of records. Each relationship has owner and member record types. Owners specify the



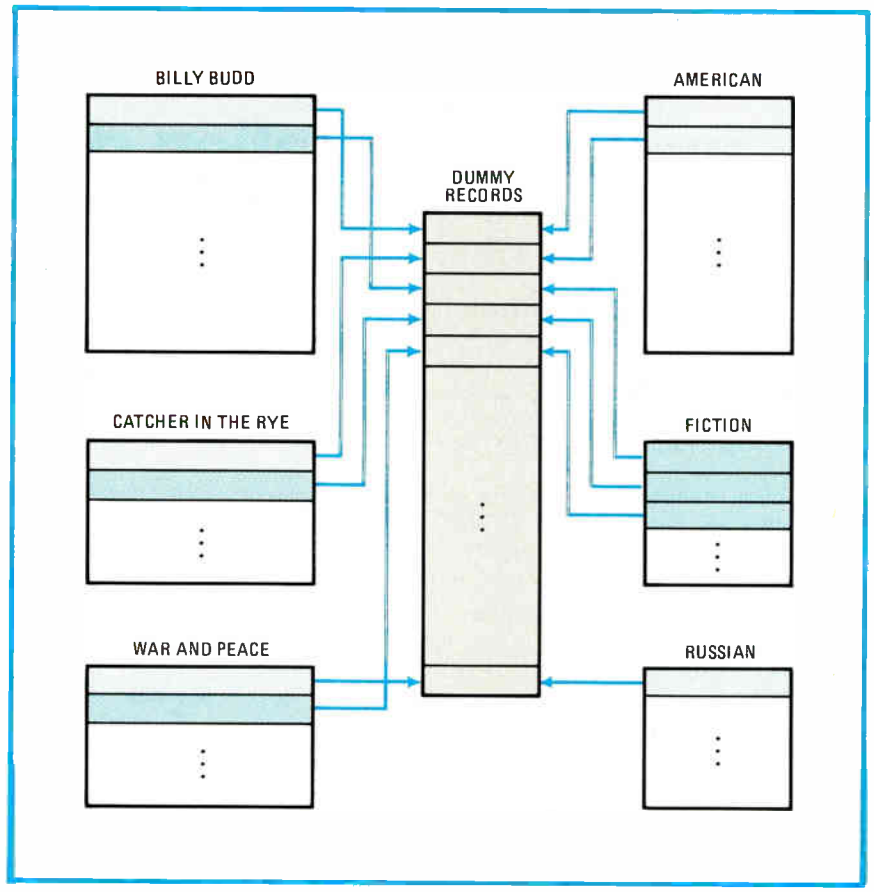
1. Sequential setup. The ISAM data-management model puts records in a single sequential order, in this case alphabetical. However, in order to find the books having a particular key word, a time-wasting exhaustive search of the entire file is required.

categories into which members may be classified.

A member can be accessed by specifying its owner, as well as a data value of one of its fields. In this way, records of one type that are related to records of another type can be easily processed. Moreover, a data base can grow and shrink with out the need for the reorganization required for ISAM.

In Codasyl specifications, the relationship between owner and member record types is said to be "one-to-many." This means that a given member can be associated with only one owner, so that a many-to-many relationship has to be implemented by two one-to-many sets involving the usage of a dummy intermediate record. (Fig. 2).

The MDBS system developed by Micro Data Base Systems goes beyond Codasyl by representing the many-to-many relationships directly, and therefore eliminating the need for a dummy record to represent the many-to-many relationship (Fig. 3). Other features that greatly increase the efficiency and flexibility of this offering include the area declaration and location modes.



2. Pointing to data. The Codasyl data manager associates a group of pointers with each data item, allowing many different orderings to be simultaneously available. However, to access these multiple orderings, a memory-wasting dummy file must be set up.

An area is a logical partition of the data base with a name that specifies which record types are included in it. Therefore, it allows the user to have control over the placement of the records. Security can be obtained by isolating highly sensitive data in a separate area and then imposing special control over that area. Cost can be reduced by maintaining frequently used data on high-speed devices and other data on lower speed, less costly devices.

A location mode is also definable for each record type to designate any special strategy for initial record placement in an area. One location mode, called calc, implements an address calculation scheme called hashing, which uses a key value called the calc key to store each new record.

Hashing is a way of choosing a storage address for a data item by means of a randomizing function. For instance, the first four characters in the data identifier could be treated as numbers and divided by a constant, and the result of that operation would then be used as the storage address. In this way, new data items are inserted in locations that are unlikely to be occupied. The record can be retrieved easily through specifying its calc key as its address. The use of the scheme yields high performance when specific records are desired quickly.

A second location mode is clustering. This allows efficiency to be further increased by physically clustering those records that are often accessed jointly. The MDBS location mode allows the user to choose the most appropriate storage method.

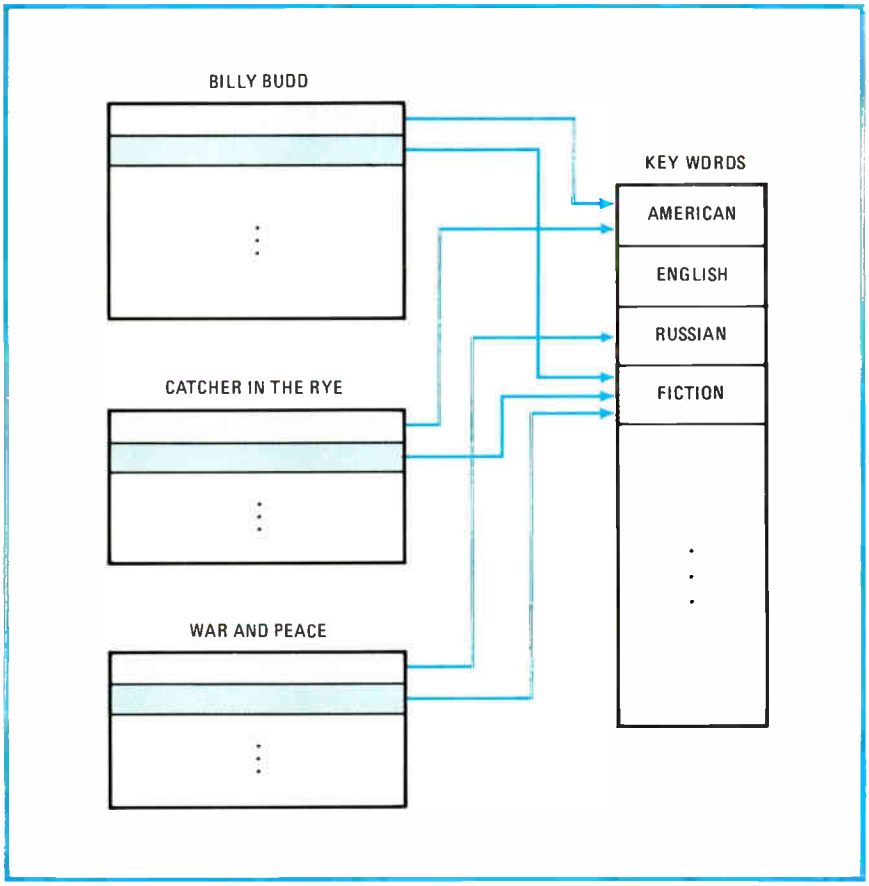
Because of the variety of languages and language processors available for microcomputers and the number of operating systems in use, MDBS is divided into three logically distinct components: the operating-system interface, the host-language interface, and the data-base control (which is the bulk of the system). This design philosophy has greatly simplified the task of modifying the system software for various combinations of operating system and host language.

Op-sys link

The operating-system interface consists of a series of routines that emulate an ideal random-file input/output handler. Each operating system has its own conventions for file naming, parameter passing, and error detection, so this interface can be quite different in makeup for each operating system.

The data-base control system issues requests to the interface to open and close the data base, as well as to perform random I/O operations on it. Since it expects a full data-base page to be read or written on each I/O call, the interface must map from the operating system's disk-sector size (for example, 128 bytes on a CP/M system, and 256 or 512 bytes on a Northstar DOS system) to the user-specified page size for the data base (some multiple of 256) and then issue the appropriate I/O calls.

The host-language interface is more complex, since



3. Handling multiplicity. The MDBS data-base manager can represent many-to-many relationships directly, thereby saving memory while still allowing quick retrieval of records. The arrows do not depict actual pointers; they indicate the logical relationships.

each host language has its own conventions for internally representing data. For example, integer and real values are not differentiated in Northstar Basic; Cobol has internal decimal and external decimal formats for numeric quantities; and Microsoft's Cobol has five possible representations of external decimal quantities.

For speed, MDBS is written in the assembly language of the target processor; for example, it fits into 18-K of main memory in Z80-based computers. In the microcomputer environment it is often quite critical to be able to organize the usage of main memory in a highly efficient manner. Accordingly MDBS can be placed anywhere in memory and can dynamically allocate buffers and tables of variable lengths.

Fine tuning

The system also can take advantage of any unused memory to increase buffer areas and hence to minimize disk paging. The page size is selected by the user to accommodate the requirements of the data base, realizing the tradeoff between page size and number of page buffers that may be resident in available memory. This choice is usually made to minimize the access time for a given data-base request.

An effective data-base management system should also minimize the amount of overhead (pointers, tables, etc.) stored in a data base, while still providing the user with fast retrieval and flexible data structures. Space-management routines are smart enough to recover holes left by deleted records, to minimize the occurence of spaces too small to contain a data record, and to provide for the judicious placement of records to facilitate fast access by the user.

As well as having these attributes, MDBS can work effectively with a variety of disks, including mini- and full-sized floppy disks and hard disks. Given the storage limitations of many forms of floppy disks it is usually imperative that a data base be able to spread across several drives. The operating systems for microcomputers usually do not automatically support such logical files, and so the MDBS handles a segmented data base.

The system can support a data base spread over eight drives and theoretically will manage over 4 billion bytes of information. The approximate amount of system overhead can be computed by some simple linear equations. Also, space management routines recover and coalesce space dynamically and allocate new memory in an intelligent manner. What is more, the judicious use of operating-system facilities make the MDBS independent of the type of disk units used, whether they be mini- or full-sized floppy disks or hard disks.

The speed of access to a required record is, of course, one of the most important aspects of a data-base management system. If many data-base pages are kept in a primary memory buffer, the chance that a required page is already in the computer is greater.

For a reasonably defined data structure, the MDBS data manager can randomly retrieve a record from a sorted set of 10,000 records with a worst-case performance of less then 15 disk accesses. On a single-density mini-floppy disk, this performance would translate into a worst case of 8 seconds delay.

Of course, high-density media as well as full-sized floppy disks are commonly employed. A typical Winchester hard disk would result in a worst-case access of 0.75 s. Because of caching and several hueristics in the search procedure and the physical location of records and pointer arrays, average access is usually much better than the worst-case performance.

A data-base management system is typically invoked from a user-oriented language. This may be from a high-level language such as Cobol by using a data-manipulation or a English-like query language. MDBS is currently callable from Basic, Fortran, Cobol, Pascal, C, PL/1, and machine language. It currently runs on the 8080, 8085, 8086, Z80, Z8000, LSI-11, and 6502 microprocessors and on the Northstar, CP/M, Oasis, Newdos, Trsdos, and Apple DOS operating systems. □

Rf level meter quashes errors from internal noise

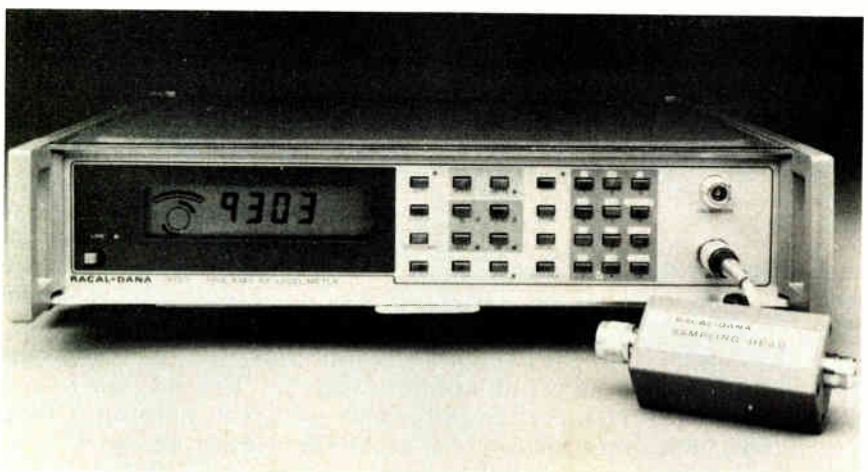
IEEE-488–compatible instrument also provides interchangeable sampling heads; liquid-crystal display includes analog readout for nulling

by Malcolm Sizmur and David Brewerton, *Racal-Dana Instruments Ltd., Maidenhead, Berkshire, England*

☐ Loaded with measurement capabilities, a new radio-frequency level meter is ready to take on the production testing of rf equipment with greater precision and less operator input than earlier models. As well as speeding up equipment checks for any operator, the model 9303 meter is a boon to users unfamiliar with rf measurement techniques, and it can fit into a computer-controlled measurement system.

The microprocessor-based instrument uses the basic measurement principles first seen in the 9301A, but goes beyond its predecessor in being able to communicate and be controlled over the IEEE-488 bus. Also, it can achieve higher overall accuracy through special sampling, noise-cancellation, and automatic-calibration circuitry. Among the computing functions it performs are power-ratio, gain or attenuation, and percentage-difference measurements, as well as a null function.

Functionally, the 9303 [*Electronics*, May 19, 1981, p. 204] can be divided into the blocks shown in Fig. 1. The input selector can accept signals from one of two input sources or from the internal-calibration generator, which emulates an input Tee head with a known, accurate, and stable signal applied to it. The instrument can call on this generator periodically to verify the accuracy of internal-measurement circuits automatically.



Cleaner. The 9303 rf level meter measures more accurately than its predecessors by noting internally generated noise before each measurement and subtracting it from the reading. Its specially designed liquid-crystal display (on the left of the front panel) is both analog and digital, giving users the choice of qualitative or quantitative information.

This calibration technique cannot, of course, take into account inaccuracies in the Tee head itself, since this would require a known signal to be applied to the head. So an additional external-calibration source in the 9303 provides a standard signal at an output socket. The user may connect the Tee head to be used to this socket and can initiate a full self-calibration simply by pressing a front-panel button.

Head sampler

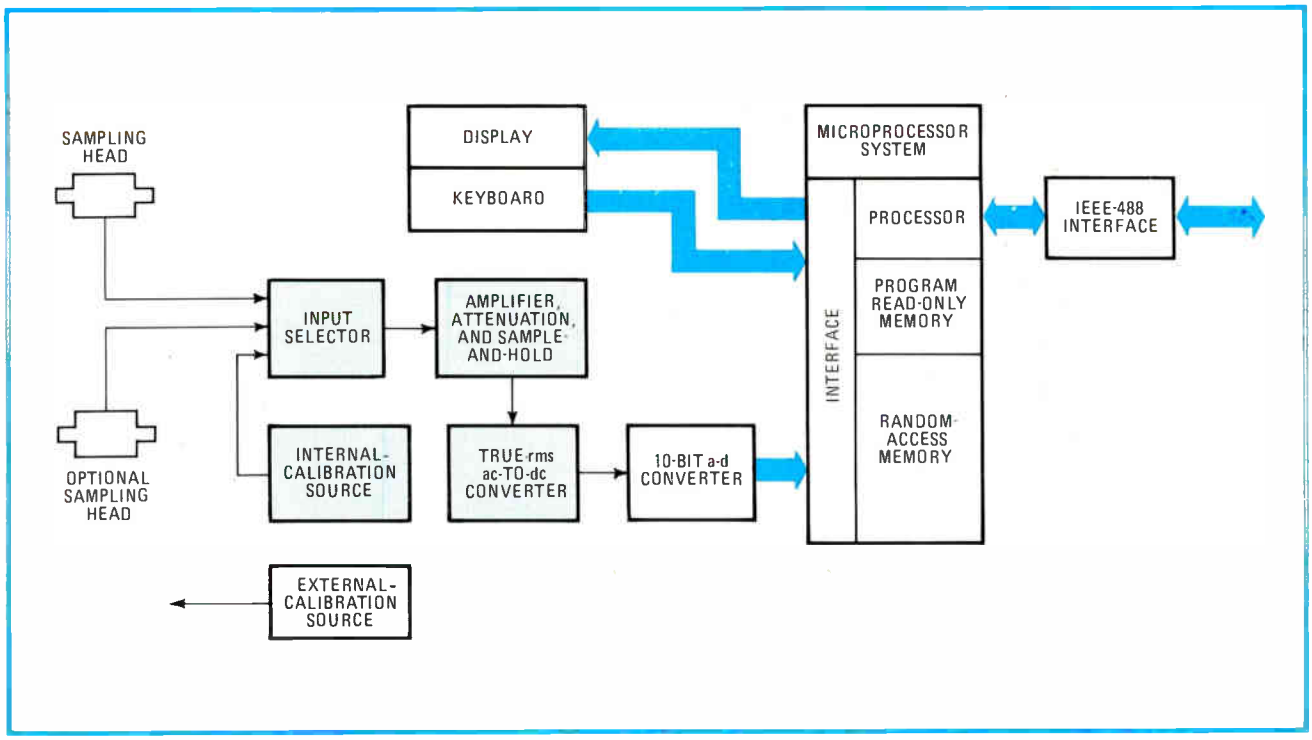
The sampling circuit for downconversion of high-frequency signals is contained within the Tee head. The input signal is sampled as it passes along a 50-ohm stripline in the head so that in-line measurements may be made at any point within a 50-Ω system.

The low-frequency output from the sampler, together with its drive signal and power inputs, are transmitted along a 1-meter multiconductor cable that joins the head to the main instrument. An extender cable is available so that the Tee head can be used up to 2 m from the 9303.

Using sample-and-hold circuits to convert signals from a high frequency to a lower one is a well-known technique. Provided the sampling frequency is not a subharmonic of the input frequency, a replica of the input waveform is built up at the output of the sample-and-hold circuit. Since the shape of the output is the same as that of the input, its root-mean-square value, assuming unity gain, will be the same as that of the input, neglecting quantitization errors.

Because the rms value of the whole is equal to the square root of the sum of the squares of the individual sample values, the final value will be unaffected if the order of the samples is jumbled. In other words, the samples can be taken in a random manner, provided that all sampling intervals are evenly distributed. What's more, the same results can be achieved by linearly sweeping the sampling frequency.

In the 9303, the sampler circuitry comprises a 50-Ω stripline assembly, a hot-carrier diode bridge, a step-



1. Analog emphasis. More digital than its predecessors, the 9303 relies on microprocessor control and communicates via the IEEE-488 bus, seen at right in the functional diagram above. But the art of its design is in its analog sections and sampling in-line heads seen at left.

recovery-diode pulse generator, and a field-effect-transistor buffer amplifier (Fig. 2). The diode bridge is usually reverse-biased by resistors R_1 and R_2. A fast pulse from the step-recovery-diode pulse generator turns the diodes on for about 100 picoseconds, and the signal level at the stripline is transferred onto capacitor C.

This pulse is amplified by the subsequent amplifiers, resampled, and held for rms detection. The resistor R_3 discharges C, ensuring that each pulse starts from zero. Immediately prior to the second sampling action, the noise output from the system is checked by the second sample-and-hold circuit and held for analysis.

The 9303 has input sockets on both front and rear panels with internal electronic switching between these two controlled by a front-panel button or IEEE-488 bus command. Thus two Tee heads may be connected and measurements taken from either as required. Tee heads can be interchanged without recalibrating the system, and each carries its own calibration curve for frequency-response corrections.

Signals from the input selector are amplified to the required level by the amplifier and attenuator section. Four microprocessor-controlled attenuator pads give an 80-decibel attenuation range in 10-dB steps, a corresponding full-scale input range of 300 microvolts to 3 volts rms.

Signals from the amplifier are fed to the true-rms ac-to-dc converter. A noise-canceling feature in the converter does not require front-panel adjustment, since it measures the input noise directly during an auto-zero period and performs a true-power subtraction with all subsequent input signals.

The noise at the input to the converter is predominantly that of the buffer amplifier and sampler output resistor and is monitored by a separate channel. If this value is represented by N, then the channel output is S+N, where S is the signal value. In the rms converter, these two signals are squared and subtracted, and the difference is averaged and its square root taken. Hence, the noise component is removed and the output is proportional to the input signal only.

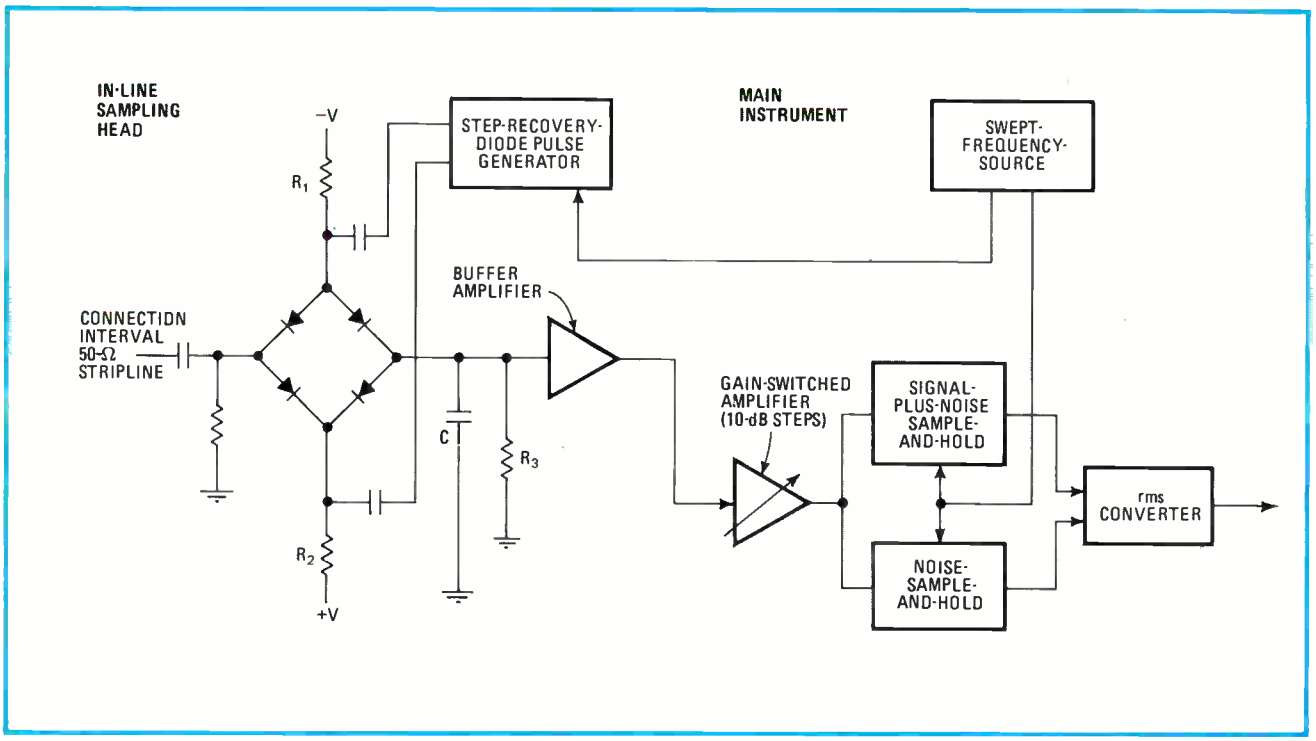
The use of this technique requires that the rms converter be of the type that separates the squaring, averaging, and square-root functions, which means that thermal converters are unsuitable. In the 9301A, a diode log-antilog system was used, but its frequency response is inadequate for the higher sampling frequencies in the 9303. Instead, a circuit based on a transconductance multiplier block provides both the squaring and square-root functions, its dc output being proportional to the rms value of the signal input.

The dc output from the rms converter is digitized by an analog-to-digital converter interfaced with the microprocessor system. The data fed to the microprocessor is corrected for gain and offset variations occuring in the analog measuring circuits before undergoing any necessary mathematical manipulation.

Calibration ins and outs

An instrument with so much analog signal processing inevitably suffers from gain drift with time and temperature. To overcome this, the automatic-calibration and external-calibration circuits were included.

The automatic-calibration source, an internal function, provides a reference square wave for calibrating the amplifier and attenuator chain and is internally connected to the amplifier input when required. The level of this reference is arranged to be identical between one 9303



2. Sampling at the source. In the 9303's sampling in-line Tee head, signals are picked off a 50-Ω stripline. Samples are taken when the diode bridge is set by a pulse from the generator, stored on capacitor C, and transmitted via the buffer amplifier to the main instrument.

unit and any other to ensure that sampling heads are completely interchangeable. This source uses a swept-frequency-pulse train at 50 to 100 kilohertz to generate the sampling drive, which is divided by two to provide a mark-space ratio of exactly unity at half the frequency for the output.

The external-calibration source generates a square wave at approximately 500 KHz, which runs asynchronously with the sampling drive for head calibration. A 1-megahertz TTL oscillator is followed by a divide-by-two stage to ensure unity mark-space at 500 KHz. The output level is 0 dBm into 50 Ω.

The operation of both calibration sources is essentially the same. Both derive their reference from a precision bandgap-reference integrated circuit having a time stability of ± 10 parts per million per 1,000 hours and drift of less than 0.1% over the instrument's operating temperature range. As seen in Fig. 3, a fraction of the reference voltage is summed with the output square wave using an integrator within a dc feedback loop. This approach locks the mean value of the output square wave to the reference current. The use of exact square waves in the 9303 ensures that the rms values of the calibration outputs are accurately controlled.

Within the feedback loop, the integrator sets the output of a current source, which is fed to the load or shunted to ground by a parallel pair of transistors driven from the appropriate frequency source to produce the square-wave output. The calibration outputs are accurately set during manufacture; in the case of the external-calibration output, the setup is a precision 50-Ω load and a thermal transfer standard.

The external output has a 50-Ω source impedance, and so any subsequent load error will be halved in effect. The only other sources of error after initial setting are the initial-setting error itself and the stability of the source components. Inaccuracy due to drift over a 1-year period and temperature variations is less than 0.5%.

Internal-calibration sequences are initiated by the instrument itself and require no response from the user. The sequence takes approximately 5 seconds, during which time measurements cannot be made. This sequence verifies the accuracy of the main instrument only, not of the Tee head. The first internal-calibration sequence occurs at turn-on and thereafter at intervals of 2.4 minutes and then every 8 min. Special functions are provided that let the user inhibit internal calibration altogether or initiate one immediately.

External-calibration sequences may be initiated by the user and require the Tee head to be connected to a stable 0-dBm signal (223.6 millivolts or 1 milliwatt). A suitable signal is available from the calibrator output connectors on the front and rear panels. Users may choose a different calibration source with the same frequency as the signal to be measured, thereby eliminating frequency-response errors from the measurement.

The sequence takes approximately 20 s to complete, the first 5 s being devoted to an internal-calibration cycle. Then the instrument measures the input to the head in use and computes a correction factor that it applies to future readings from that head.

A fixed attenuator in front of the head during high-level measurement may be left in place during the external-calibration sequence, and the instrument then adjusts all future readings to allow for the precise value of the attenuator. Full measurement accuracy is achieved when the Tee head is either terminated with a 50-Ω load (one is supplied) or used within an accurate

50-Ω system. A poor voltage-standing-wave ratio of the load used will adversely affect the accuracy, particularly when making in-line measurements.

A conventional 10× passive-divider oscilloscope probe may be connected to the head with a suitable adaptor since, with the 50-Ω load removed, the input impedance of the head is approximately 100 kilohm + 20 picofarads, as compared with 1 megohm + 20 pf for a typical scope. The different input resistance will cause errors in the extreme low-frequency response (10 to 100 KHz) only, as the input capacitance is the dominant factor at the frequencies of interest here. The capacitance trimmer provided on the scope probe is set to midrange, and the microprocessor system, making use of the external calibration facility, automatically compensates for the 20-dB attenuation in the probe.

The calibrator outputs provided on the front and rear panels give a nominal 1 mW into a 50-Ω load, but only one output may be used at a time. The waveform is a 500-KHz square wave and is switched on only during an external-calibration sequence (automatically), although a special-function routine is available to switch this on and off under user direction.

Accurate to a Tee

Each Tee head carries a calibration label on its side showing frequency-response corrections over the 0-to-2-gigahertz range. The corrections are shown as a scaling factor and may be entered into the instrument to eliminate frequency-response error at any frequency. The instrument powers up with a value of 1.000 in the calibration factor store, which may be displayed and changed with IEEE-488 commands or keyboard sequences. If the value set is anything other than 1.000, then the legend CF will appear on the display to remind the user that he has disturbed the calibration.

The factor entered applies to the measured voltage. If computed power is being displayed, then the correction is squared by the instrument. The instrument computes power by squaring the voltage reading and dividing by the value in the ohms reference store. The value in this reference store may be displayed and changed with a keyboard sequence.

The 9303 computes the power factor before performing such calculations as power ratio, gain or attenuation in decibels, percentage difference, or null, so that these functions can be applied also to power values. An example is determining the ratio function, which displays the input reading divided by the stored ratio value. If the watts mode is selected before the ratio mode, both numbers are converted to equivalent power before the division is performed.

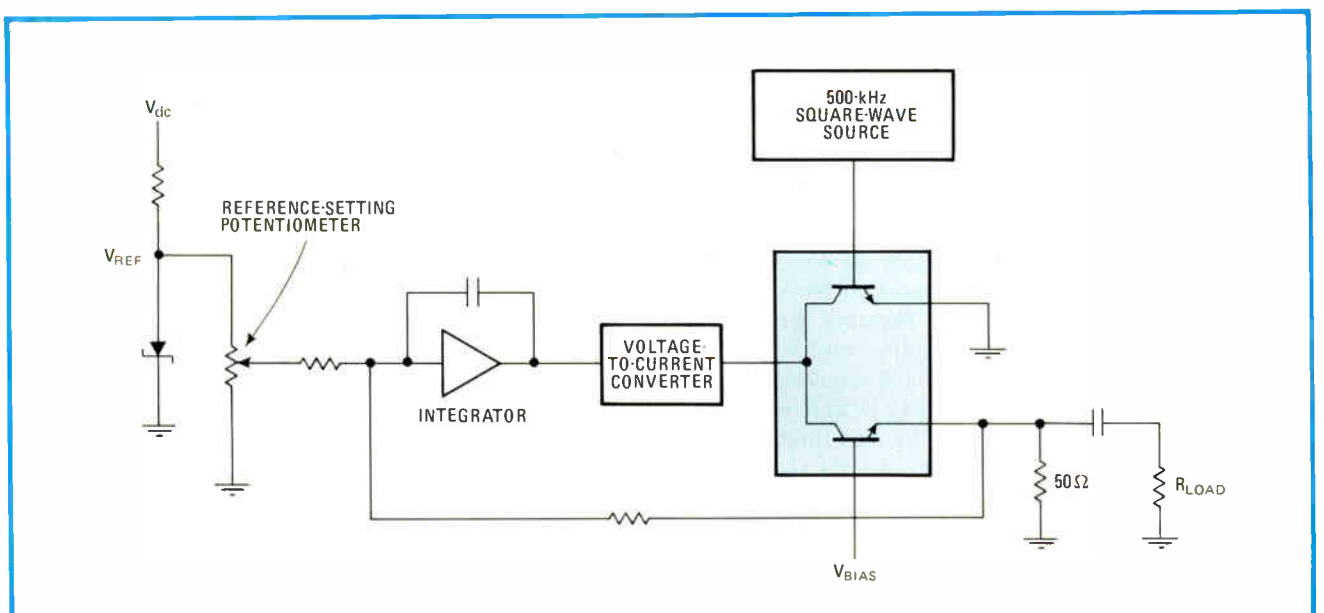
The ratio store contains a reference value held in volts. If the instrument is in the power mode, then this value is converted to power using the current ohms reference-storage value before being used in a calculation or displayed. The ratio store may be loaded either from an input reading or directly from the keyboard. The power-up value for the ratio store is 1 volt.

Decibels, percentage difference, and null are computed functions that operate in the same way as the ratio function. All four of these functions are mutually exclusive; only one can be called at a time.

Each computed function maintains its own independent reference store. Each store can be set up either in volts or watts, although in the latter case the instrument will convert the entered value to volts before it is stored. If the instrument is in the power mode when a store value is recalled, then a volts-to-watts conversion will be done before it is displayed.

After computation, the results of these functions are displayed. In all cases except the decibel function, both readings and stored values are converted to watts, if appropriate, before the computation.

One operational difference between the null function and any of the others is that whenever this function is



3. Calibration source. For a stable external calibration source the 9303 uses a bandgap reference diode (left). The integrator within the dc feedback loop sums a portion of this reference voltage with the output of the square-wave generator to lock the mean output to the reference.

A different display

A common application for radio-frequency level meters is in finding peaks and null points in a system's bandwidth. A tuned circuit, filter, or trap circuit all require adjustment at some stage, with a coil or trimmer being tweaked to maximize or minimize the output. With a purely digital display, spotting the point at which the maximum or minimum actually occurs is much more difficult than with an analog display, and hence most rf instruments still rely on the less accurate and more costly d'Arsonval movement for measurement presentation.

For the 9303, a simple bar-graph liquid-crystal display for analog readings was first considered, but to achieve resolution comparable to an analog meter would require 100 bars, which meant 100 connections to the display (multiplexing in an LCD causes very narrow viewing angles and contrast problems). So the decision was to build a novel LCD with both digital and analog segments. The analog portion consists of an arc and a circle.

The arc is ten segments long with each segment representing 10% of full scale. The circle also has 10 segments, with each segment representing 1% of full scale. As the input to the instrument increases, the segments in the circle are addressed in a clockwise manner. For each complete trip around the circle, an additonal segment of the arc is addressed.

When the input peaks, the circle's segments begin to be addressed in a decreasing manner and the circle rotates in a counterclockwise direction as the input falls. Thus the LCD provides analog relational information which is much easier for the user to interpret.

called, the null store will be automatically updated to the current reading. Thus the initial result will be zero.

The decibel function is probably the most frequently used of the four. The instrument powers up with 223.6 mV (1 mW into 50 Ω) in the decibel reference store and so will indicate dBm directly when called. This display will indicate dBm (as opposed to decibels) if the reference is equivalent to 1 mW.

The value of internal computing

Other standard reference values such as 1 V or 1 μV may be entered with a few keystrokes. For measuring frequency response or gain or attenuation, the reference store would be set up from an input reading taken at the reference frequency or input to a device. After this, the instrument would show variations relative to this standard level directly. This feature is most useful when checking test specifications that set relative limits, because there is no need to set the signal level to any particular value before starting the test.

The percentage-difference function is also of value when testing between limits. Where a specification calls for 1 V ±5%, for example, 1 V can be entered into the percentage store directly, and the instrument will show deviations directly. Frequency-response checks may also be done in the percentage-difference mode.

The null function is particularly useful in the power mode, since it can mask the effect of noncoherent noise or interfering signals. It is possible to measure, for example, the background noise produced by a receiver front end (with no signal present). Pressing the null key would automatically store this reading and subtract it from all future readings—thus the immediate display would be zero. Applying a signal to the unit under test would now produce a reading for the true intermediate-frequency output power at the signal level (conversion efficiency) corrected for spurious signals such as noise and local-oscillator breakthrough. The same technique can be used to measure modulation sidebands in the presence of a carrier frequency and other fixed outputs from a transmitter.

The ratio function is virtually a linear version of the decibel feature and is mainly useful where high resolution is required. The setting procedure for the attenuators of the 9303 itself illustrates this: storing a signal level of about 1 V, then entering the ratio mode, increasing input power 10 dB, and stepping up to the next range will set the attenuator trimmer for a reading of 10.00 (10 dB in the power mode).

The 9303 is prone to jitter in the readings, and some form of selectable smoothing is desirable to achieve compromises between fast response and steady readings. Averaging is performed on the digitized signal over a set period and the display updated with the result at the end of that period. The range of averaging period allowable is 0.1 to 99.0 s in 0.1-s steps. The effective reading rate is the reciprocal of this time (not to be confused with the digitizing rate of the microprocessor system, which is a fixed 100 conversions per second).

Storing front-panel settings

When stepping through a test sequence repeatedly, it is obviously helpful to be able to recall complete front-panel settings and store values from a previous test. The 9303 facilitates entry, storage, and recall by accommodating as many as 10 complete front-panel settings. Recalling will set the instrument to its power-up state.

The current panel settings are held in the nonvolatile memory when power is removed. The unit powers up to a predetermined state—volts measured, automatic range, 50-Ω, 1-s averaging. The previous settings are obtained by keying in 99.

The analog meter, together with digital display of results in engineering units is only feasible with a liquid-crystal display (See "A different display," above). These features, when combined with the single-function-entry keyboard, result in an instrument that is very easily operated manually, yet one that has adequate computer power for systems use. The incorporation of the microprocessor has enabled improvements in accuracy to be achieved and maintained between longer calibration periods than previously. The sampling head is very rugged and immune to shock and can withstand indefinite overloads up to 1 watt on any range. All of these factors combine to give a reduced cost of ownership to the customer. □

Stepper checks state of E-PROM's memory

by Steven Bennett
Harris Semiconductor, Melbourne, Fla.

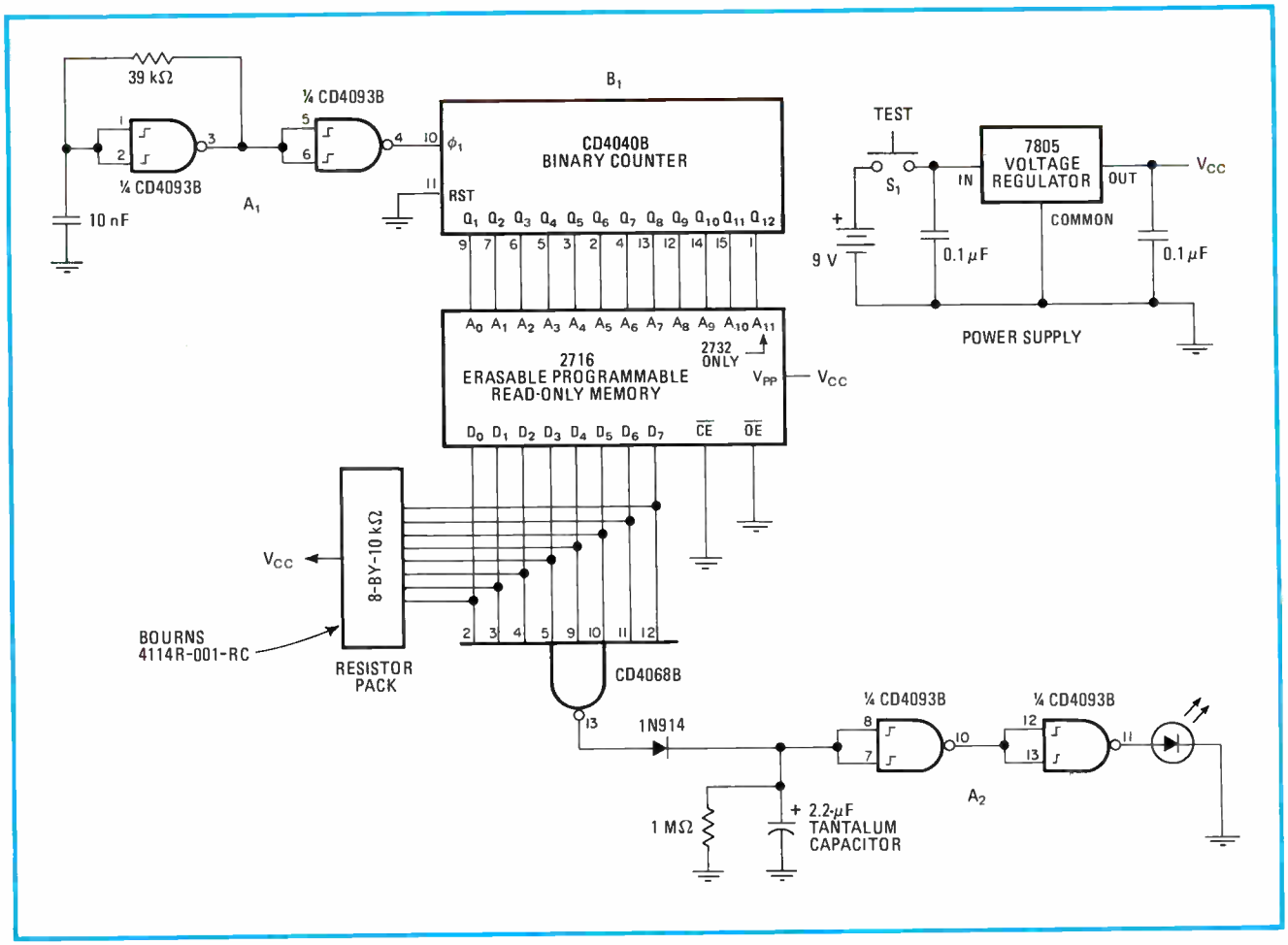
Too often, ultraviolet-light–erasable programmable read-only memories have their contents blindly destroyed by users who cannot determine whether the memory contains valuable information or is totally blank. However, this circuit can scan each E-PROM location with a binary counter and so will distinguish memories that contain data from those that do not—all at a cost of around $8.

In use, the memory device is placed into the test socket and the momentary contact switch, S_1, is pressed. If as little as 1 bit of memory is stored in any of the E-PROM's locations (logic 0 for an E-PROM), the light-emitting diode will light.

A 2-kilohertz clock signal for the 12-bit binary counter, B_1, is generated by oscillator and buffer A_1 so that the addresses will cycle through the 2716 2-K-by-8-bit E-PROM in about 1 second. (Although this circuit was dsigned for the 2716, it may also be adapted for any type of memory, bipolar or MOS.)

If any bits in a given location are low, then a pulse will be generated at the E-PROM's output and will drive the 4068 NAND gate high. This pulse, which is generated at the NAND output, is stretched to 2 s by one-shot and buffer A_2 to drive the LED. □

Engineer's notebook is a regular feature in *Electronics*. We invite readers to submit original design shortcuts, calculation aids, measurement and test techniques, and other ideas for saving engineering time or cost. We'll pay $75 for each item published.



Seeing is believing Using a 12-bit binary counter, a tester of ultraviolet-light–erasable PROMs inspects each location of the device to determine if it contains data or is blank, thereby saving contents from accidental erasure. For a 2-K-by-8-bit E-PROM, the test takes about 1 second, with a light-emitting diode turning on if any memory location contains a data bit.

Two-chip ammeter measures currents down to picoamperes

by Douglas Modlin
Electrical Engineering Department, Stanford University, Stanford, Calif.

An ammeter circuit that can measure currents ranging from picoamperes to amperes may be built with two operational amplifiers, one having a low input bias current and offset voltage and the second having a high output-current capability. The accuracy of the meter is within 1%.

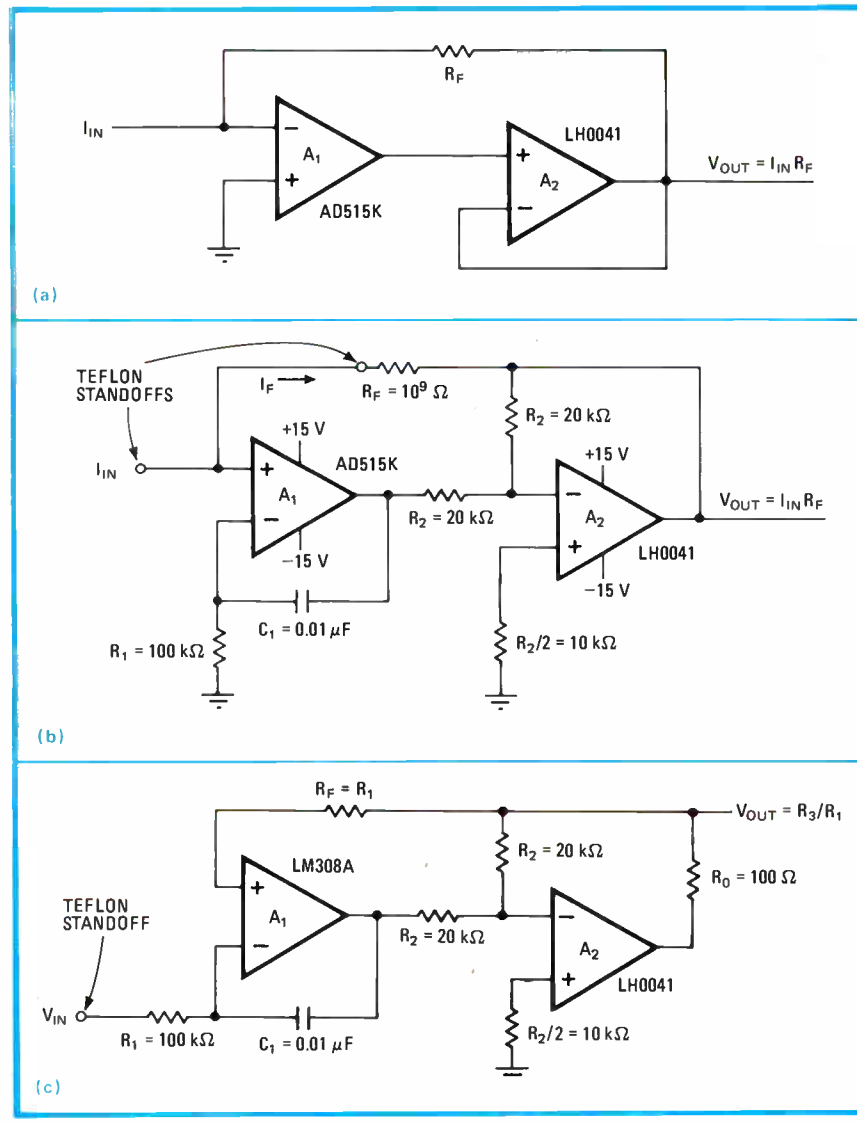
The basic configuration of the circuit (a) establishes A_1 as a field-effect–transistor input device that is internally compensated and A_2 as the power stage. The feedback arrangement of the circuit is technically possible but not practical because A_2's gain-bandwidth product is much less than that of A_1. This factor is due to A_2's high-output capacity. As a consequence, the circuit is unstable and oscillates near the unity-gain crossover point of A_2, because of a phase-shift around the feedback loop exceeding 360°.

Converting A_1 into an integrating comparator (b) stabilizes the circuit, thereby increasing the op amp's response time without introducing an additional phase shift to the feedback loop. Input current I_{in} flowing to the noninverting terminal of A_1 produces a positive voltage at its output and across integrating capacitor C_1. A_2, serving as an inverting, unity-gain amplifier, then raises its output to a voltage that causes I_f to equal I_{in}.

As a result, the output voltage corresponding to this input current is $V_o = I_{in}R_f$. The circuit accuracy is determined strictly by the tolerance of R_f. The input offset voltage of A_1 (1 millivolt maximum) and its correspondingly low offset current (0.15 picoampere maximum) have virtually no adverse effect on circuit accuracy. As for A_2's output offset voltage, which is a maximum of 6 mV, it is canceled in the feedback loop. In order to maintain a virtual short at its input, A_1 develops a voltage across C_1. When this voltage is applied to A_2 through R_2, A_2's offset voltage is canceled. This cancellation effect is independent of the second stage gain given by $A = -R_3/R_2$.

Feedback resistor R_f sets the current range. To measure currents in the region of 1 pA for display on a 3½-digit digital voltmeter (resolution is 1 mV), R_f should be 10^9 ohms and be proportionally lower for higher currents. The circuit's input port A_1, should be protected against leakage currents by Teflon standoffs or otherwise be guarded. This measure also holds true for mounting the selectable resistor R_f.

The picovoltmeter in (c) is much the same as in (b), but is configured as a low-input bias current, low-offset buffer amplifier whose gain is established by $A = R_3/R_2$. This circuit takes advantage of the best features of both op amps but suppresses their limitations. Including resistor R_o in the circuit will stabilize the amplifier for capacitive loads. Incidentally, the LH0041 allows a user to select current limiting. The circuits discussed are not limited to the op amps listed in the figures. Any device with similar characteristics may be used. □



Infinitesimal. This ammeter, using one op amp having a low offset and another with a high-output driver, measures current from 1 pA to 1 A. Feedback resistor R_f determines the range of measurement. Based on the rudimentary circuit of (a), ammeter (b) is self-compensating and stable, providing accuracy to within 1%. Test currents are converted to corresponding voltage for display by 3½-digit digital voltmeter. A version for measuring low potentials (c) is similar. The LH0041 op amp allows users to select current limiting.

Meter measures processor's dynamic utilization capacity

by Henryk Napiatek
Lacznosci Institute, Gdansk, Poland

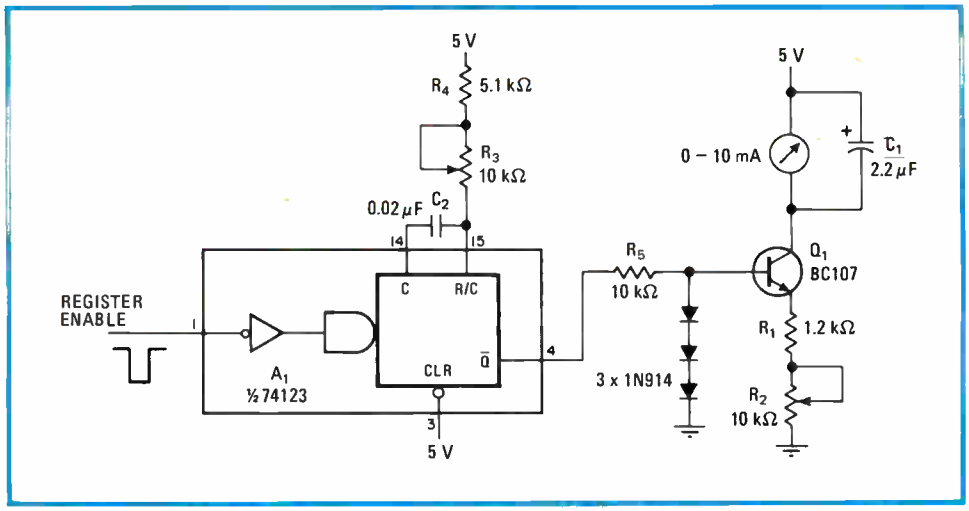
An ordinary milliammeter, calibrated in percentages, plays a key role in this simple one-chip, one-transistor indicator of the fractional utilization of a microcomputer's central processing unit in a real-time environment. As a result, the circuit (see figure) will be useful in optimizing system performance and debugging random process routines that typically occur in telephone- and vehicular-traffic applications.

The degree of utilization in processing data and handling interrupts versus the time the machine executes the scheduler's idle loop is simply measured by firing a monostable multivibrator with an output signal derived from the operating system's idle loop. The one-shot's pulse width is set equal to the execution time of the scheduler's idle loop, which generates one pulse for each loop's pass. The scheduler's idle loop is executed only if the processor does not process any data or handle any interrupts. The scheduler's idle-loop execution time is about 50 microseconds. Interrupts cause the processor to execute program routines concerning traffic changes.

The integrated ouput signal of the one-shot thus represents a fraction of the total time the CPU is not being used. This fraction will be indicated by a drop in the reading of the milliammeter that is connected to the inverting output circuit of an npn transistor.

A register-enable pulse or similar signal leaving the output bus of the appropriate system peripheral is applied to the 74123's input. This signal is essentially an idle CPU mark that is derived from the sample idle-loop routine of the scheduler and is written in macro-11 assembly language for the PDP-11/34 minicomputer (see program).

The pulses from the one-shot's output are amplified by transistor Q_1 and integrated by capacitor C_1 and the milliammeter's resistance and distributed inductance. The meter's reading thus reflects the difference between the circuit's 5-volt output limit, which represents 100% CPU utilization, and the total interrupt time, to yield an index of the CPU's actual use.



Indexing interrupts. This simple circuit determines the percentage of time the microcomputer's central processing unit is working on processing data and handling interrupts, thus serving as a low-cost optimization and debugging tool. A meter, calibrated directly from 0% to 100%, has typically a 2-μs integration time for rapidly following dynamic changes in machine capacity. The one-shot timer's pulse width is equal to the execution time of the scheduler's idle loop.

The circuit is calibrated by adjusting potentiometers R_2 and R_3. To calibrate the meter at full scale, the CPU's idle loop is halted (no input pulses) and R_2 is adjusted for a 100% meter reading. All external interrupts in the idle loop are then disabled (for example, the instruction CLR@#IDLESR should be replaced by the instruction CLR@#LIGHTS) and the routine run. The milliammeter is zeroed by adjusting R_3 for 0% processor utilization. In this case, the processor executes only the scheduler's idle loop. This design can be modified in hardware and software to accommodate indicators other than the milliammeter that can measure other parameters related to real-time operating systems. □

IDLE LOOP OF PDP-11's SCHEDULER USED FOR CIRCUIT CALIBRATION

```
                    ;ETEXOS W.01/E/.04 OPERATING SYSTEM

        LIGHTS =    177570      ;LIGHTS REGISTER
        IDLESR =    160224      ;REGISTER IN SPECIAL INPUT/OUTPUT DEVICE
        PSW =       177776      ;CENTRAL PROCESSING UNIT STATUS WORD
        PR7 =          340      ;PRIORITY 7
        R3 =           %3       ;CPU'S REGISTER 3
                    :
1S:     MOV #PR7+1,@#PSW        ;EXTERNAL INTERRUPTS DISABLED, BIT C = 1
        MOV #IDLCNT,R3          ;ADDRESS OF IDLCNT 3-WORD VECTOR
        ADC (R3)+               ;BIT C+IDLCNT
        ADC (R3)+               ;
        ADC (R3)+               ;COUNTING OF IDLE LOOPS IN IDLCNT VECTOR
        CLR @#IDLESR            ;ONE-SHOT TIMER STIMULI
        CLR @#PSW               ;EXTERNAL INTERRUPTS ENABLED
        BR 1S                   ;TO NEXT IDLE LOOP
IDLCNT: .WORD 0,0,0             ;IDLE LOOP VECTOR COUNTER
```

Engineer's newsletter

New standard updates specs for signal quality

Data communications specification RS-334 has been updated by the Electronic Industries Association. Now known as RS-334-A, "Signal Quality At Interface Between Data Terminal Equipment and Synchronous Data Circuit-Terminating Equipment for Serial Data Transmission," the revised standard provides **a basis of agreement on the signal quality when timing signals are exchanged across the interface between the data terminal and the data-communications equipment in synchronous serial systems.** There is also a section on the significance of distortion in frequency measurements, and terminology has been revised to be consistent with that used in documents of the International Consultative Committee for Telegraphy and Telephony. Copies of RS-334-A may be obtained for $6 each from the Standards Sales Office, Electronic Industries Association, 2001 Eye Street, N. W., Washington, D. C. 20006.

Another way to guard against voltage spikes

Henry Simon, general manager of the Polyswitch products group of Raychem Corporation in Menlo Park, Calif., says that Alex Kisin [*Electronics*, Sept. 8, p. 153] and Peter Schwartz [*Electronics*, Oct. 6, p. 150] have overlooked a cost-effective method of improving the performance of the series-resistor- and shunting-diode techniques for the protection of analog measurement devices at the input stage. According to Simon, by replacing the series resistor in the simple resistor-diode circuit with a low-ohm PolySwitch protector device [*Electronics*, Jan. 13, p. 159], **a much lower value of resistance can be used to limit surge currents.** As illustrated in Fig. 4 of the Jan. 13 article, a PolySwitch protector as low as 25 Ω in resistance—such as Raychem part number C24T002H—can effectively protect diodes from damage due to voltage spikes as high as 240 V root mean square. This amount of series resistance adds very little to the propagation delay of the analog data.

Reflectance sensor scans to digitize continuous-line graphs

What with the near-ubiquity of digital technology, it sometimes is necessary to digitize continuous-line graphs. For James A. Blackburn of the physics department of Wilfrid Laurier University in Waterloo, Ont., and his colleague H. J. T. Smith of the physics department of the University of Waterloo, Hewlett-Packard Corp.'s new high-resolution reflectance sensor (HEDS-1000) is the key to such digitizing. They use a Tektronix 4052 desktop computer programmed to control an HP 7225A digital plotter so that **the pen executes a scan of the plotter surface on which the graph of interest has been placed.** The line sensor is mounted within a special housing machined to the same dimensions as a standard plotter pen. As the scan proceeds, any line crossings result in a signal being sent from the HEDS-1000 to the controlling computer, which then stores the corresponding coordinates.

Satellite box score ranks birds, tracks launches

Engineers and managers in the aerospace industry, the military, or other Government agencies who want **to keep track of world-wide satellite launches** should obtain the just-published Space Log, vol. 18, from TRW Defense and Space Systems Group at 1 Space Park, Redondo Beach, Calif. 90278. The 100-page paperbound book has details on the latest birds as well as on past satellites. There is also a handy box score listing the leaders in the different satellite categories. Write to the company on a letterhead for your copy.

-Harvey J. Hindin

Look no further than the Mitel MH88305 when you're looking for a DTMF Receiver that combines exceptional dynamic range, good talk-off immunity and excellent signal-to-noise performance in one compact module.

The MH88305 is excellent for such demanding applications as central office, end to end signalling, mobile radio and PABX.

This hybrid device is a direct replacement for the first generation MH88205, but offers enhanced performance and lower cost.

A PITCH FOR EXCEPTIONAL SENSITIVITY: THE MH88305 DTMF RECEIVER.

The key features of the MH88305 are:

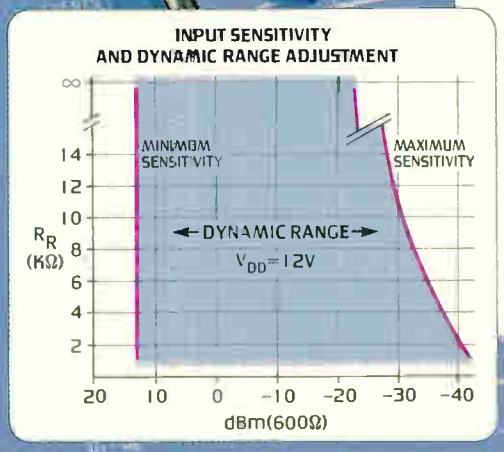
- Up to 55dB dynamic range.
- 14dB acceptable signal to noise ratio.
- 60dB Dial Tone Rejection.
- Acquisition time adjustment down to 10 ms.
- One external component adjusts: input sensitivity, guard time, twist accept/reject limit.
- 5V or 12V operation.
- Error rate better than 1 in 100,000 tones.

The swept in-band 3rd tone tolerance is measured as A-16 dBm and, in this case, total receiver performance conforms to the CEPT recommendations.

The Mitel MH88305 DTMF Receiver.

It gives you exceptional sensitivity right down the line.

Find out more about this and other related Mitel products. Contact your local Mitel sales office.



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Circle 141 on reader service card

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The 2272 can take on bigger missions than any other system (up to 3584 pins, to be exact). But unless you've been locked below deck for a decade or so, you're bound to recognize that the easy way to give you that kind of fire power is to make some tradeoffs in the quality of your tests.

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LAUNCH THE 2272.

features no one else has, such as automatic bus disable to "zero in" on the device under test; automatic feedback squelch, to defend against glitches and other intruders; and automatic component wiring compensation to protect you from devious wiring constraints. And you have our exclusive Scratchprobing™ method and Bus Busting™ beyond-the-node diagnostics at your command, as well.

In fact, we can safely say our new 2272 Circuit Board Test System gives you the fastest program development, the easiest debug and the most comprehensive, thorough testing of any in-circuit system you can buy.

The 2272. It'll destroy a lot of the illusions you have about what an in-circuit test system can do.

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Circle 145 on reader service card

The next generation:

TI's Advanced Schottky magnitude comparator.

One single device—TI's new SN54/74AS885—is now all you need to compare two parallel 8-bit binary words. You would need four standard Schottky parts to equal the functional capability of the AS885. The saving is obvious. The performance outstanding. With TI's Advanced Schottky technology, the next generation of TTL logic is here today.

Speedy and small

The AS885 is more than twice as fast as the standard Schottky arrrangement. Typical propagation delay is only 12 ns vs 28 ns(see table).

Contained in a 24-pin, 300-mil package, the AS885 occupies just 0.4 sq. in. of board space instead of 1.0 sq. in. This compact design includes an octal on-chip latch to store one 8-bit input data word.

Savings with the new Advanced Schottky

	SN54AS885 SN74AS885	Standard STTL Configuration	Your Savings
Packages	1	4	3 packages
Package Area	0.4 sq. in.	1.0 sq. in.	0.6 sq. in.
Pins	24	66	42 pins
Performance (t_{pd})	12 ns	28 ns	16 ns
Power	650 mW	1500 mW	850 mW

As for power, consumption is substantially reduced—650 mW compared to 1500 mW.

The AS885 performs a binary 2's complement magnitude comparison of two 8-bit numbers. With a choice of logical or arithmetic routines built right into your system. And, they can be cascaded to any length.

Advanced technology

The new AS885 is the newest member of the growing Advanced Schottky (AS) Series from Texas Instruments.

As the historical leader in Schottky technology, TI has constantly refined the process until, across the line, the AS Series sets new performance standards. Featuring a typical 1.5-ns SSI gate delay and higher-density MSI, the Series is—typically—twice as fast as the original Schottky family.

In addition, there's an Advanced Low-Power Schottky (ALS) Series that's more than two times faster than today's popular 74LS family—at half the power.

And both the AS and ALS devices can be designed-in as simply as you do with TI's popular Low-Power Schottky (54/74LS) and Schottky (74/54S) TTL series.

Figure the savings

Ideal for high-speed processors and microprocessor/microcomputer-based systems, the AS885 produces real bottom-line results. Fewer components, reduced power consumption, greater performance—they add up to savings in design time, board space, production and operating costs.

Initial quantities of the AS885 are available now. Check with your local authorized TI distributor or TI field sales office.

For more information on TI's Advanced Schottky magnitude comparator, simply fill out and return the coupon today.

Check one: EL5

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Circle 146 on reader service card

Attention, Multibus™ users...

Only the CD100M now supports CP/M and CP/M86 in the perfect desktop package.

Hear this, LSI-11 users...

Only the CD100L emulates a VT103, an RL02 and an RX02 in a single desktop package.

And both now include a 10 megabyte Winchester!

CD100M — THE TOTAL OEM SOLUTION

To give your Multibus microcomputer system increased file storage, the Callan™ CD100M Integrated Work Station now includes a high performance 10 Mbyte 5¼-inch micro Winchester disk drive complete with full DMA and fully automatic and transparent burst error correction. A one Mbyte unformatted floppy provides file entry and back-up. With its integral 6 slot Multibus compatible card cage, intelligent video terminal, and Winchester/Floppy disk system, the CD100M is the *only* single desktop package available to OEM and volume end-users who wish to configure a modular microcomputer system using any Multibus compatible card set. It's the perfect solution, significantly reducing product costs and development time.

CP/M AND CP/M86 CONFIGURATIONS

If you prefer the popular CP/M operating system, Callan can provide the CD100M with either 8-bit or 16-bit micros. A Z80 with 64K RAM and CP/M, or an 8086 with 128K RAM with error correction and CP/M86 are both available as the complete solution for CP/M compatible software. And both systems include 10 Mbyte Winchester performance.

If you're using Multibus cards in your system you must see the Callan™ CD100M Integrated Work Station.

CP/M and CP/M86 are trademarks of Digital Research. Multibus and 8086 are trademarks of Intel Corp. Z80 is trademark of Zilog.

Built-in card cage holds 6 Multibus or 7 quad/14 dual height LSI-11 cards.

CD100L — COMPLETE DEC COMPATIBILITY

For the OEM or end-user configuring an LSI-11 system, only the Callan™ CD100L Integrated Work Station can emulate a 10 Mbyte RL02 Winchester disk, a 0.5 Mbyte RX02 floppy, and a VT103 Terminal in a *single* desktop unit. Software presently running on RT-11, RSX-11 or other LSI-11 operating systems can now run on the CD100L, reducing hardware costs by as much as 30%. For users who prefer a more complete solution, the CD100L can also be ordered complete with LSI-11/2 or LSI-11/23 and RT-11.

MORE FOR LESS

No other solution compares for performance, features and price. The VT100/VT52 compatible terminal offers 6 video attributes, true split screen with separate scrolling regions standard. The LSI-11 Q-bus compatible card cage provides 7 quad or 14 dual height slots to house even the largest configurations. A Winchester controller is available to directly emulate the 10 Mbyte RL02. RX02 emulation is available either in a 1 Mbyte dual floppy configuration or as 0.5 Mbyte back-up for the Winchester.

If you're tired of multiple package or multiple vendor solutions, you must see the CD100L.

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Circle 148 on reader service card

Controller board uses PDP-11 chip

DEC unwraps a version of Pascal for the PDP-11 and LSI-11 along with firmware-oriented dual-width processor board

by James B. Brinton, Boston bureau manager

Digital Equipment Corp.'s "Falcon" SBC-11/21 is claimed to be the smallest 16-bit single-board computer yet, and DEC calls the Micropower/Pascal software system announced with it "the first universal programming tool for the LSI-11 microcomputer family." The SBC-11/21 marks the end of the firm's nearly decade-long effort to reduce the PDP-11 architecture to a single chip on a single board, a process that began with the LSI-11 four-chip set. The hardware is thus a technical milestone, but the announcement of Micropower/Pascal will probably affect more users.

Micropower/Pascal extends DEC's operating-system and language capabilities downward toward the smallest board-level computers DEC makes, the LSI-11/2 and the new SBC-11/21. Heretofore, LSI-11 users had to make do with general-purpose software designed for larger systems, such as DEC's RT-11 and RSX-11 operating systems and its Fortran or Macro languages.

Quick work. Now, all but the smallest dedicated applications—those needing no operating system as such—can use Micropower and in almost all LSI-family applications, programs can be written and debugged in Pascal. The offering is said to make much quicker work of applications programming. According to a DEC spokesman, a designer "might require only 20% to 30% of the programming time formerly required. Even the debugger, PASDBG, is written and responds in Pascal. That adds speed too."

Micropower also gives DEC a software growth path for its customers to follow right up into PDP-11–class computers if they wish. The SBC-11/21 gives a hardware growth path beginning at a lower entry price than DEC has offered before.

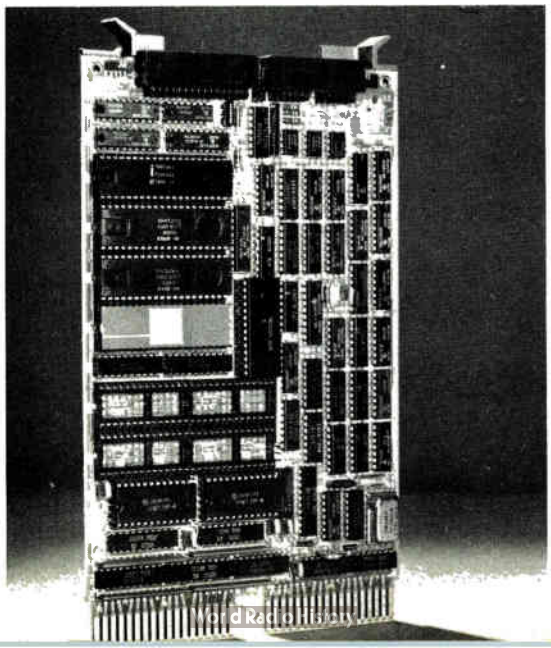
The SBC-11/21 is Q-bus–compatible, fits a 5.19-by-8.9-in. dual-width board, and executes the base-level PDP-11 instruction set via its T-11 microprocessor, a one-chip n-channel MOS version of DEC's PDP-11 architecture [*Electronics*, Nov. 3, p. 129] running at 5 MHz.

The SBC-11/21 is targeted at original-equipment manufacturers' applications where space is at a premium, especially firmware-intensive ones. Though the computer comes with 4-K bytes of random-access memory as standard equipment, it can hold as much as 32-K bytes of read-only memory.

Targeted. DEC is frankly pointing the new computer at the 8-bit competition. "It's faster, easier to program, and offers 16-bit precision," says Microcomputer Products group product-planning manager Ted Semple. At a price of $521 in 100-unit lots, and only $790 in single units, the SBC-11/21 is aimed at the share of market now held by 8-bit boards, notably Intel's. DEC has high hopes for the Falcon unit in applications such as laboratory and medical instrumentation, manufacturing monitoring and control, process control, and robotics.

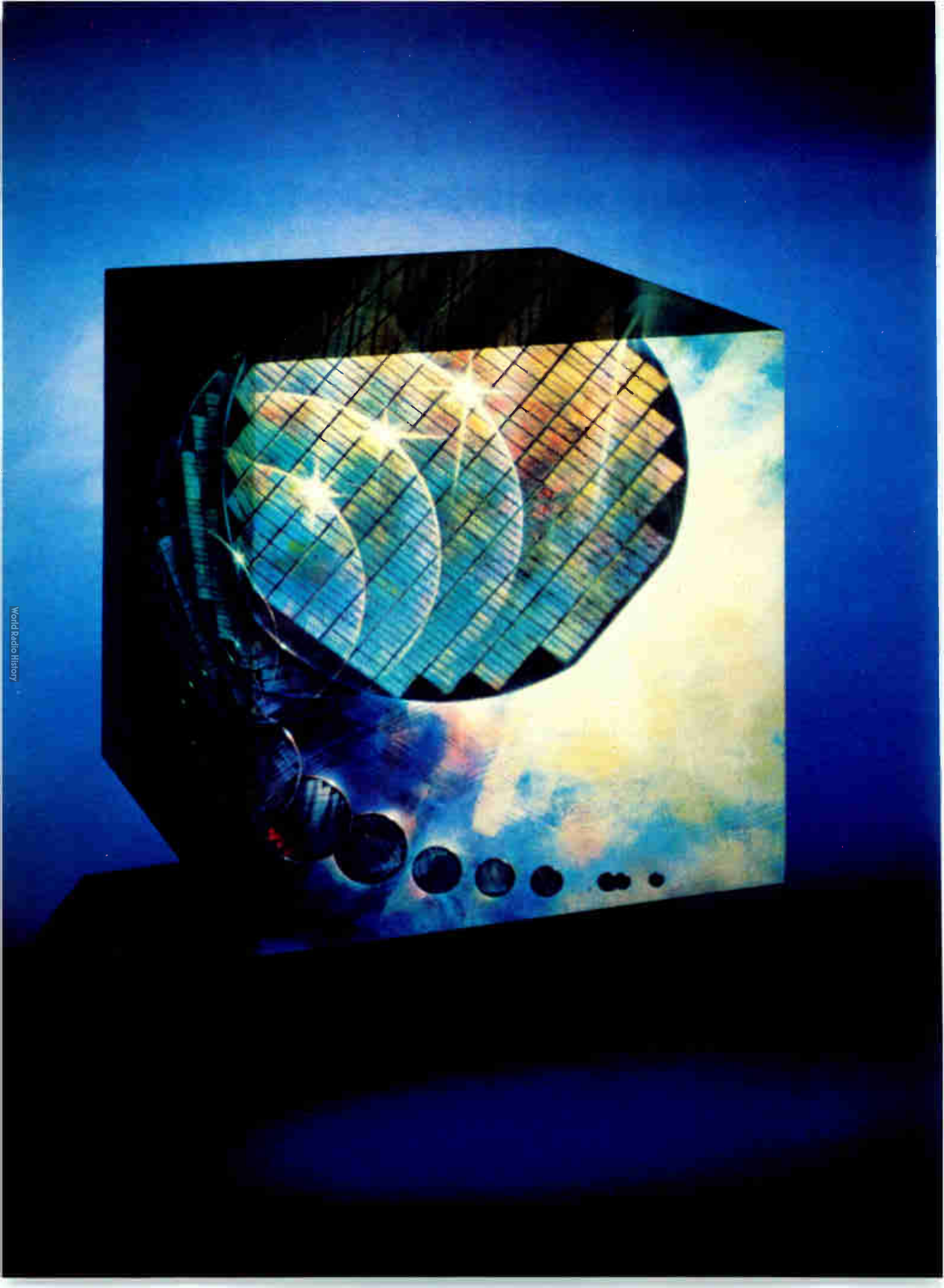
The small unit is equipped with two asynchronous serial ports compatible with RS-232-C and RS-423 standards. According to Semple, the board can communicate in full duplex at 38.4 kilobaud, for a combined rate of 76.8 kilobaud, one that enables customers to use peripherals like DEC's TU-58 cartridge system. The board comes with a real-time clock offering output at 50, 60, or 800 Hz.

A development system for the new board and LSI-11–based systems backs up Micropower Pascal and lets users create software on any PDP-11 running version 4.0 of DEC's RT-11 operating system. A RAM module fits beside the computer, allowing users to load software into RAM and experiment to create the correct set of machine instructions. It is then easy to burn the necessary programmable ROMs.



Deliveries of the SBC-11/21 will begin in December. Micropower/Pascal will be licensed for $8,500 in quantity, with run-time copies $30 each; deliveries are set for March 1982.

The Digital Equipment Corp., 146 Main St., Maynard, Mass. 01754 [338]



Another new standard from INMOS.

4K x 4/16K Static RAM

The IMS1420: High Speed. Low Power. Available Now.

The VLSI technology leader in 16K static RAMs introduces another industry first. Organized 4K x 4, the IMS1420 offers a chip enable access time as fast as 45ns.

Lowers System Cost

The low entry level price of $45.00 (100's) for the IMS1420-55 makes this new 4K x 4 a viable alternative to 4K x 1 and 1K x 4 fast static RAMs. It matches their speed, saves board space and reduces power consumption by at least a factor of four. Trade off your 4K designs today and lower your system costs.

Need Higher Speed?

The companion IMS1421 delivers even more performance where higher speed is a must. With a chip select access time as fast as 30ns, the IMS1421 sets a new speed record for 16K memories.

Naturally, both new RAMs operate from a single +5V (± 10%) supply and are fully TTL compatible. They're packaged in industry standard 20-pin, 300-mil dips and also industry standard 20-pin chip carriers.

Application Note Tells You How

Check your current 4K static RAM designs today. Chances are good that one of the new INMOS 4K x 4 RAMS offers a better system solution. Call or write for our new application note that tells you how to make the switch - and save.

INMOS 16K STATIC RAMS					
Static RAM Family	Organization	Max. Access Time		Max. Power Dissipation	
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IMS1420-55	4K x 4	55ns	50ns	600mW	165mW
IMS1421-40*	4K x 4	30ns	40ns	600mW	NA
IMS1421-50	4K x 4	40ns	50ns	600mW	NA
IMS1400-45	16K x 1	45ns	40ns	660mW	110mW
IMS1400-55	16K x 1	55ns	50ns	660mW	110mW

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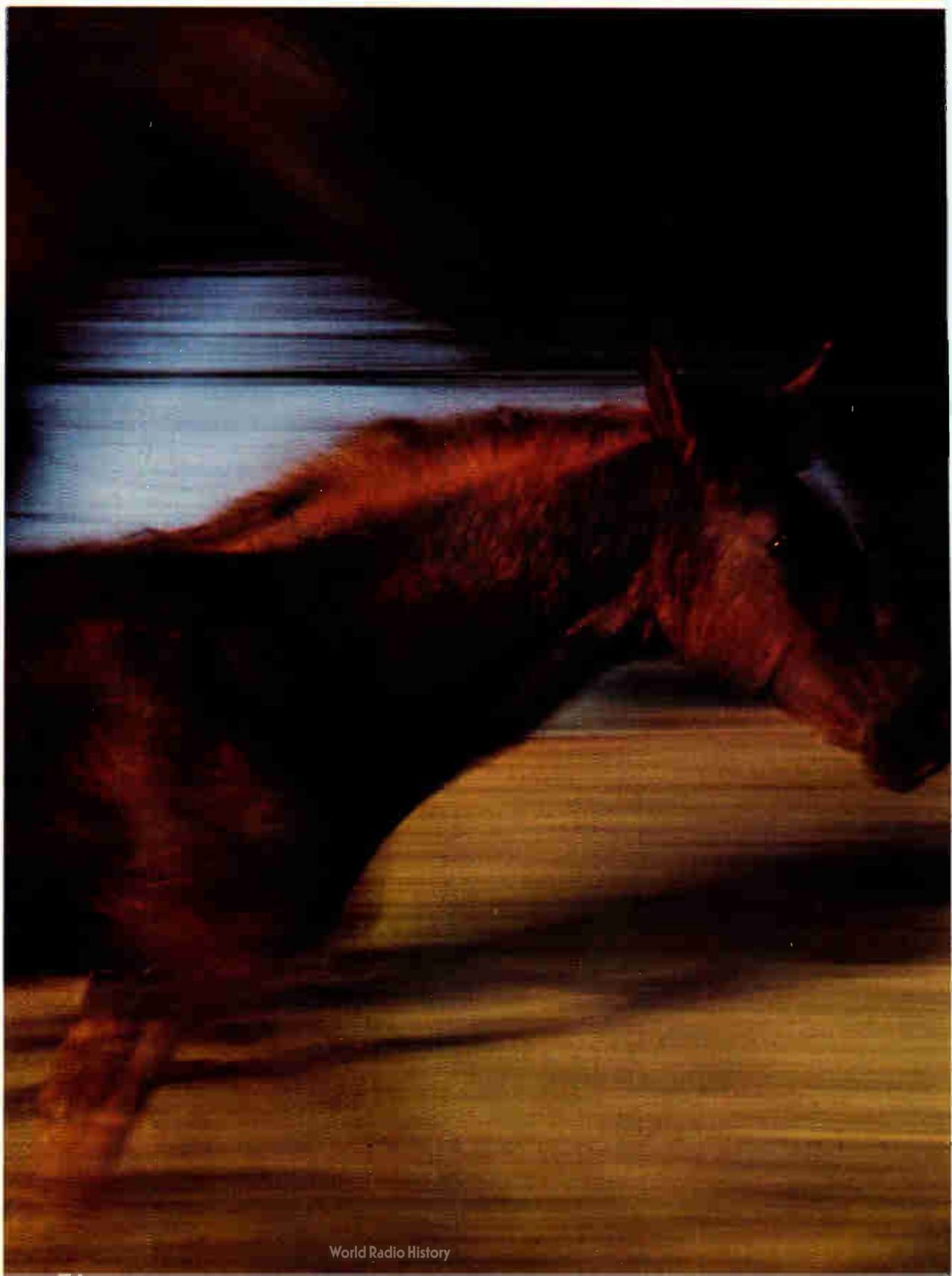
Circle 150 on reader service card

New AMI single-chip Codecs.



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Introducing the thoroughbred of Codecs. It took years of experience to develop the traits seen in AMI's new single-chip Codecs. Low power consumption. High quality. Cost-effectiveness. All in the single compact package you've been waiting for. And all because of AMI's extensive experience in designing and manufacturing standard and custom Codecs.

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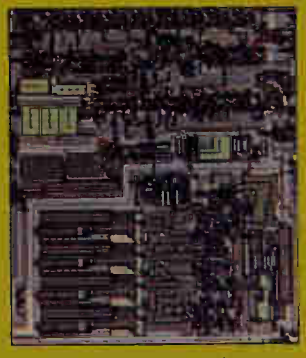
We invite you to compare AMI Codecs against any other alternative—feature for feature, spec for spec. Add them up and you'll agree, the smart money's on AMI single-chip Codecs.

No need to wait any longer. AMI's exciting single-chip Codecs are ready to go. To find out more about them, or to get our comprehensive 16-page data sheet, visit or call the AMI sales office nearest you. They could make you a winner.



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Net gets color graphics, laser printer

Turn-key business-graphics system and high-speed printer hook to Datapoint's ARC net; facsimile interface also introduced

by J. Robert Lineback, Dallas bureau

Datapoint Corp. is bringing three key technologies to its local-area computing network: color graphics, high-speed laser printing, and facsimile communications. The three offerings increase the capabilities of Datapoint's Attached Resource Computer (ARC) network in areas deemed essential for the office of the future.

The firm is taking its first step into the world of color with the introduction of its turn-key business-graphics system. The business-graphics market is expected to grow annually by 80% to 90%, crossing the $1 billion mark in about four years [*Electronics*, Aug. 25, p. 48].

To meet this growth, Datapoint will be offering a high-resolution (512-by-482-element) raster display, a graphics-input tablet with stylus, and a system-controller package—its 9680 color business system. The basic configuration will cost $30,000 with deliveries starting immediately.

Present options for the color system include a dot-matrix printer that combines the four colors from four single-ribbon printheads and two models of film recorders that can expose film for transparencies or prints (35-mm film or Polaroid 8-by-10-in. transparencies and prints). The color printer costs $15,000, and the color film recorder for 35-mm film only runs $10,000. A recorder capable of handling both 35-mm and 8-by-10-in. film goes for $20,000.

Designed for the nontechnical operator, the 9680 system needs no user programming. The system components and peripherals are interfaced with a controller containing a processor and 160-K bytes of random-access memory.

To create shapes, lines, curves, colors, and type fonts, commands are entered either by keyboard or by "light keys," boxes that appear on the display screen when the stylus is placed on the tablet. The cursor is controlled by moving the pen on the tablet. Once the cursor is sitting on the proper light key, the operator presses the pen onto the tablet. If the user wants to clear the screen of light keys, he merely lifts the pen from the tablet's surface; he can then see the images being created. The cursor can also be controlled by the keyboard.

Responding to a growing demand for laser-based printers—which may represent more than half of the total nonimpact-printer business by the middle of the decade [*Electronics*, Jan. 27, p. 100]—Datapoint is also unveiling its 9660 laser printer. Using an electro-photographic printing process, the 9660 produces images using a matrix of 480 and 240 dots/in. horizontally and vertically, respectively.

It can print on both sides of the paper and up to 20 surfaces each minute (1,300 lines). The 9660, which has a standard buffer memory of 128-K bytes, goes for $65,000. Deliveries are expected to begin in mid 1982.

Versatile. The printer can hold five different types of paper, and operators can make copies using five different typefaces from any workstation in the ARC network. Documents also may be directed to locked mail-boxes in the printer cabinet. The standard printer has 10 output bins.

The 9660 is so versatile that Datapoint is a bit reluctant to call it a mere printer, says Daniel A. Hosage, executive vice president of interna-

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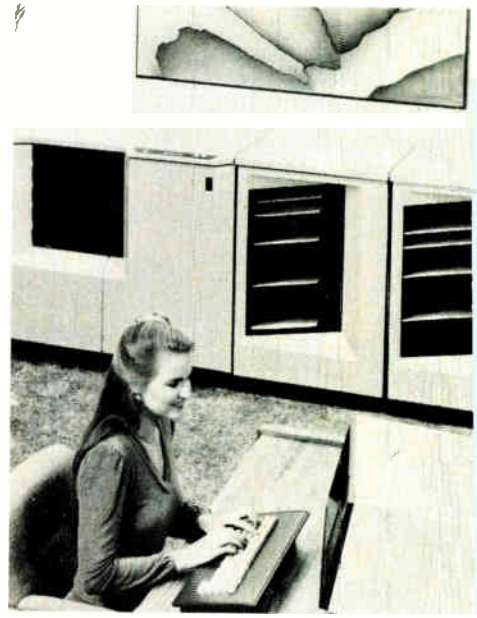

tional operations (he was an executive of Datapoint's Office Systems group during the development of these products). "Considering its variety of type fonts and printing styles, it is almost a new brand of office typesetting machine," he says.

The company's facsimile communications interface permits Datapoint processors to transmit and receive images from most commercially-available facsimile machines adhering to the standards of the International Consultative Committee on Telephony and Telegraphy (CCITT). Stand-alone processors or members of the ARC network may use the interface.

A microprocessor-controlled device, the interface provides facsimile protocols and format conversions necessary for communications with both analog and digital facsimile machines conforming to U. S. and CCITT groups I (analog), and II (analog), and III (digital). The unit communicates with processors over its RS-232-C interface at asynchronous data rates of 9.6 Kb/s.

The interface costs $4,950. A unit with the CCITT group III option costs $7,450, with deliveries of the interface scheduled to begin in May 1982, the company says.

Datapoint Corp., 9725 Datapoint Dr., MST-41, San Antonio, Texas 78284. Phone (512) 699-7552 [339]

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These connectors are designated: Amphenol 118 Series (MIL-C-26482/Series 2); Amphenol 418 Series (MIL-C-38999/Series I and II); and Amphenol 518 Series (MIL-C-83723/Series III).

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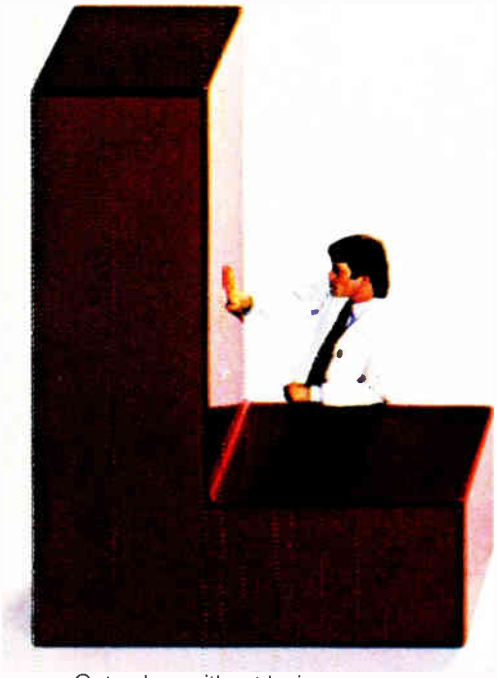
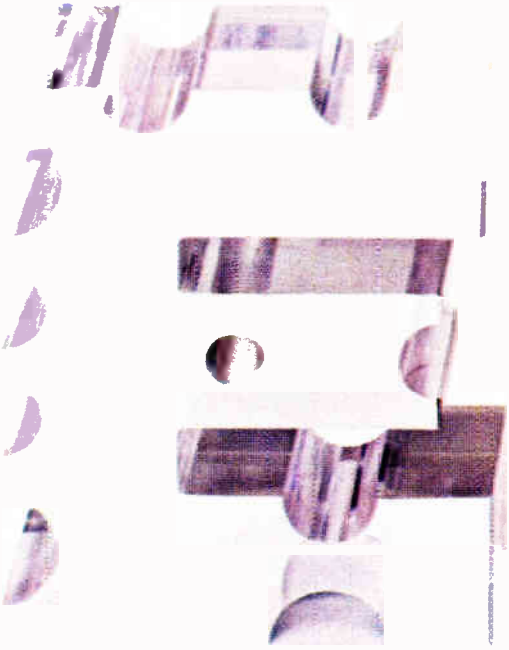
Circle 209 on reader service card



Get colors without losing properties by specifying LEXAN resin in standard or custom-matched opaque and translucent colors; or by using compatible paints. (Available clear too.)



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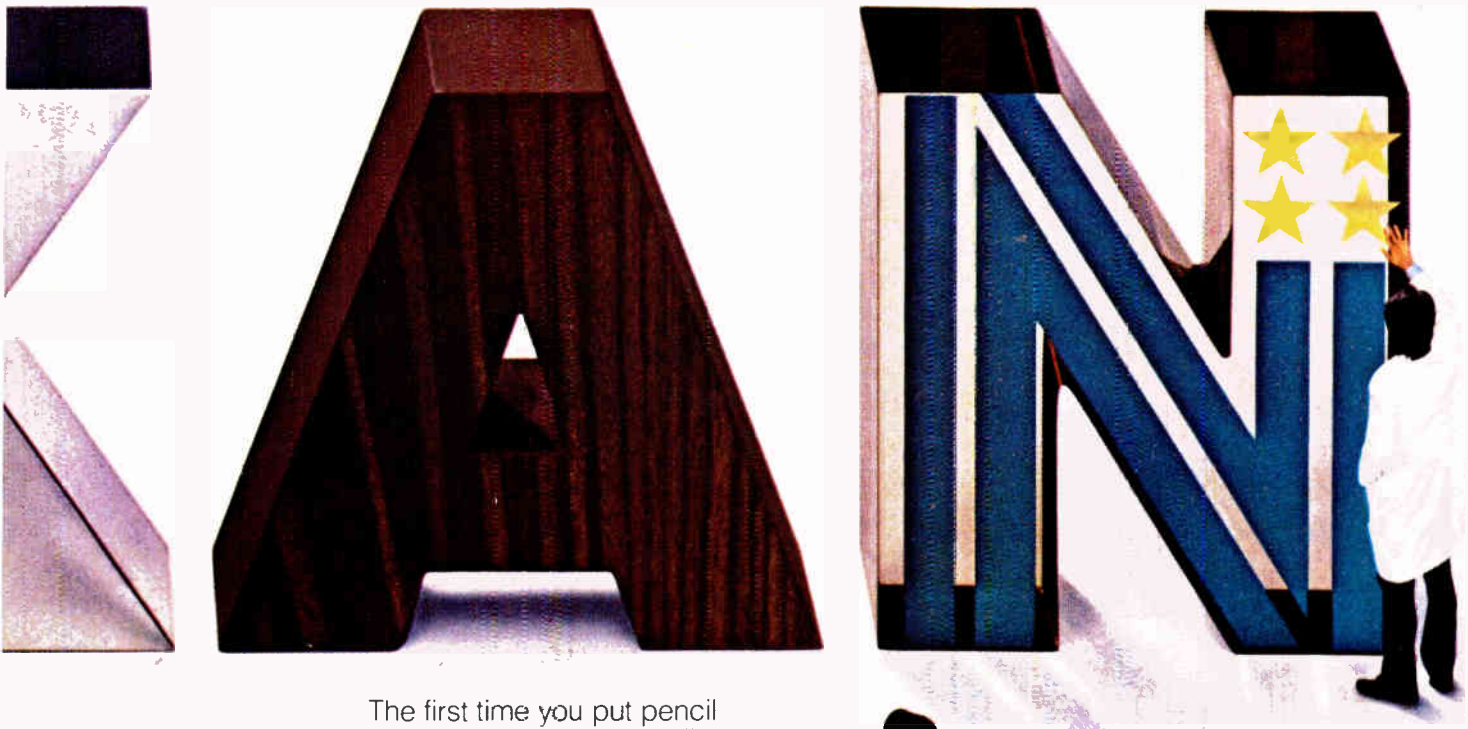

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Semiconductors

Fast C-MOS RAM idles on 100 μA

4-K-by-1-bit static part accesses in 55 ns maximum, works with C-MOS or TTL

Motorola's MCM65147 4-K-by-1-bit high-speed static random-access memory, made with its high-performance complementary-MOS process, has been developed following a technology exchange with Hitachi, producer of the comparable HM6147 C-MOS static RAM. The exchange was made in connection with Hitachi's second-source agreement to produce Motorola's 6800 and 68000 microprocessors. Both the Motorola and the Hitachi RAMs are similar to the n-channel Intel 2147.

The 65147 is offered with a 55-, 70-, or 85-ns maximum access time and is directly compatible with TTL levels and Motorola's recently announced high-speed C-MOS logic family [*Electronics*, July 14, p. 46]. With C-MOS inputs, it draws 35 mA maximum from the power supply and only 100 μA maximum when on standby. The latter is an improvement on the Hitachi maximum standby current figure of 800 μA. When TTL inputs are used, the 65147 uses 12 mA maximum on standby and 35 mA maximum when active, figures identical to the corresponding ones for the HM6147.

Motorola's MOS operation made some minor design changes to the RAM, including modification of its input-protection circuitry. In a ceramic dual in-line package, the 55-ns version is priced at $7.15 each in orders of 100; in like quantities, the 70- and 85-ns parts are $6.45 and $5.80 each, respectively. They are also packaged in plastic.

The firm sees two principal uses for the 65147. It will replace n-MOS 2147 RAMs in existing designs to save active power use; the 2147 dissipates 500 mW in a typical active mode, compared to the 65147's 75 mW. Also, Motorola expects its RAM to be used in new fully C-MOS designs that allow the device to run with rail-to-rail logic excursions.

Motorola Inc., 3501 Ed Bluestein Blvd., Austin, Texas 72721 [411]

Chip's diodes are isolated to 1 kV

Four closely matched diodes for hybrid-circuit use come in version wired as bridge

Over 1 kV of silicon dioxide isolation separates the four precisely matched diodes on the Dionics DI 914, a small 25-mil-on-a-side chip for use in hybrid circuits. The two standard versions have metalization patterns for either separate diodes or, in the B version, a connected four-diode full-wave bridge circuit.

Replacing four standard 12-mil Dionics 914 chips with a single diode quad saves more space than an area comparison would indicate, because the four individually mounted chips would require considerable separation to afford comparable isolation. The four diodes, intended for signal-level, not high-power, applications, have close thermal tracking.

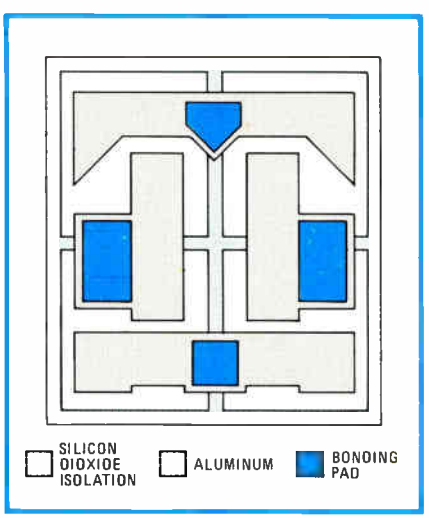
The diodes are isolated not only from each other, but from the bottom of the chip. This allows pure epoxy or adhesive films to be used for bonding to the hybrid substrate, thus reducing die-bonding time at potentially harmful high temperatures. For applications requiring conventional eutectic die bonding, chips can be supplied with gold backing. The manufacturer says that the chip's 4-mil aluminum bonding pads are the industry's largest.

Both versions of the chip are available with breakdown voltage ratings of 75, 60, or 45 V. Parts with a B or QM suffix conduct 20 mA minimum at a forward voltage of 1.0 V and 10 nA maximum at a reverse voltage 10 V below their breakdown ratings. Each diode presents a total capacitance of 3.0 pF. The forward voltage drops of the DI 914's four diodes are matched over a range of 100 μA to 100 mA. At a forward current of 1 mA, the drop is 1.0 mV (QM suffix) or 30.0 mV maximum (Q suffix).

The four diodes of the DI 914 can be used individually or wired in series or parallel. The DI 914B bridge version is suitable for use in comparative circuits such as timer circuits or differential amplifiers. Both the diode quad and the quad bridge can be supplied to meet most military standards; both are shipped in either K packs or Circle packs.

The diode quad is priced at 32¢ each and the bridge version at 35¢ in lots of 10,000. Delivery is from stock to six weeks.

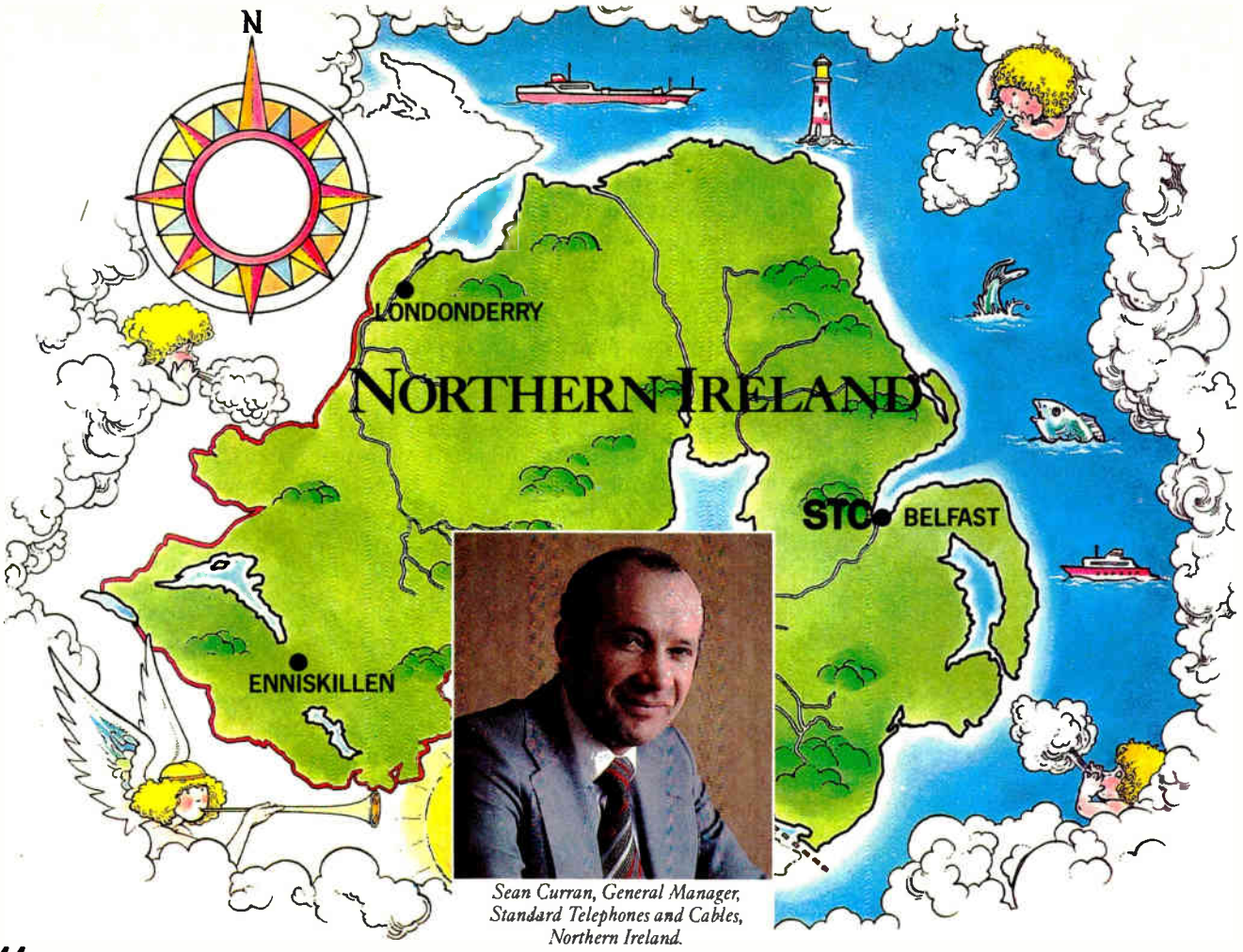
Dionics Inc., 65 Rushmore St., Westbury, N. Y. 11590. Phone (516) 997-7474 [412]



Four square. The four matched diodes of Dionics Inc.'s DI 914B chip are separated by over 1 kV of silicon dioxide isolation and wired in a full-wave bridge configuration.

Programmable shift register has a 64-point memory

A solid-state device for short- or long-term storage, the PM-5002 programmable 64-bit shift register re-



Sean Curran, General Manager, Standard Telephones and Cables, Northern Ireland.

"New technology? Our Northern Ireland workforce take it in their stride."

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Position

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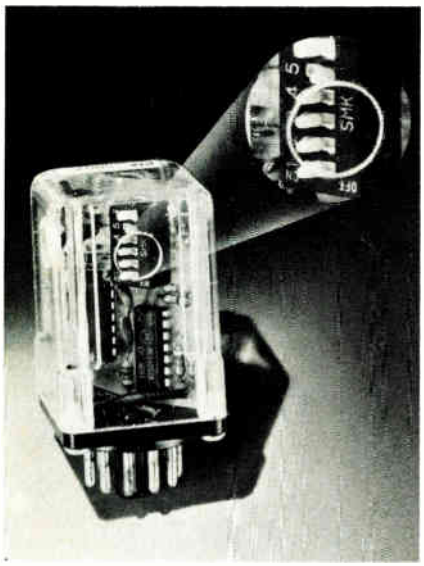
ceives information from either open-collector or logic-level inputs. The plug-in device has a 64-point memory capability, but this can be expanded by cascading multiple PM-5002 modules within an individual control unit. The versatility of the device can be enhanced by using it with an 8-bit shift register that can generate multiple outputs.



The PM-5002 measures 1⅜ in. square with a height of 2½ in. and is built on an 11-pin base that uses a PMS-11 socket assembly. This assembly has two five-terminal barrier strips and is intended for use in a 3-in.-wide polyvinyl chloride track.

Through an opening in the unit, the operator can program the control's six switches, which operate on a binary number system. The 5002 sells for $95, with a 28% discount on 100-piece orders. Delivery of small quantities is from stock.

Tri-Tronics Co., 619 Enterprise Dr., Oak Brook, Ill. 60521. Phone (312) 654-3255 [413]

Chip spots, fixes double-bit RAM errors

Able to correct double-bit errors, the basic DP8400 expandable error checker and corrector can examine 16 bits at a time and correct up to two errors. It comes in a 48-pin dual in-line package. Adding units expands it to 32- or 48-bit word sizes; no external components are needed.

Double-bit correction for both hard and soft errors is accomplished with either of two techniques. The complement-correct method, requiring no extra hardware, corrects both types of errors. For systems requiring extreme data integrity—for example, when there are two soft errors—the second approach calls for twice the DP8400s, double the check-bit memory, and a 4-K-byte programmable read-only memory.

Using National's Schottky technology and having low propagation delays, the DP8400 detects an error in a 16-bit word in 21 ns and corrects it in an additional 14 ns. Detection time for 32-bit words is 34 ns. The unit will be available this month for $60 each in quantities of 100.

National Semiconductor, 2900 Semiconductor Dr., Santa Clara, Calif. 95051. Phone (408) 737-5000 [414]

Bipolar multiplier calculates 32-bit products in 80 ns

Using an unclocked logic array, the Am29516 and Am29517 parallel multipliers produce a 32-bit product in no more than 80 ns over the full military temperature range. The 64-pin devices are also available in a commercial grade.

Though the Am29516 is a plug-in replacement for TRW's MPY16HJ, its Imox bipolar fabrication makes it 2.5 times faster. The unit has separate clocks for each of its two input and two output registers.

The Am29517 is suitable for microprogrammed system applications, but differs from the Am29516 in that it has one system clock and three register clocks. The single-clock approach eliminates the problems of clock delay and skew that result from external clock gating.

Both devices feature internal emitter-coupled-logic circuitry for high speed and both have TTL-compatible input/output ports for maximum interfacing flexibility. They operate from a single 5-V power source. The price for either part is $157 per piece in 100-lot quantities. Delivery takes 6 weeks.

Advanced Micro Devices Inc., 901 Thompson Pl., Sunnyvale, Calif. 94086. Phone (408) 732-2400 [415]

MOS device provides digital approach to data separation

Converting a serial bit stream from a floppy-disk drive into separate clock and data signals for a floppy-disk controller is eased with the FDC 9216—the unit separates data at less cost and circuitry than with an analog approach and needs no adjustments either.

The most common separation method has been through a complex analog phase-locked-loop circuit that requires several critical control adjustments. But the large-scale integrated MOS 9216 works totally digitally, compensating for the drive's mechanical speed variations by separate long- and short-term timing correctors. The only peripheral circuitry needed is an external 8-MHz clock.

The new floppy-disk data separator is a monolithic device made with Standard Microsystems' Coplamos n-channel silicon-gate process. It is available in a plastic or ceramic eight-pin dual in-line package. Delivered from stock, each unit sells for $6.85 in 100-unit lots.

Standard Microsystems Corp., 35 Marcus Blvd., Hauppauge, N. Y. 11788. Phone (516) 273-3100 [418]

LSI controller chip directs traffic on dynamic RAMs

Operating on arrays of 64-K dynamic random-access memories in microcomputer systems and on memory-

New products

expansion boards, the 8203 large-scale integrated peripheral controller multiplexes row and column memory addresses, generates strobes, and controls memory-refresh cycles. It also arbitrates between simultaneous access and refresh requests.

The high-density device has on-chip array drivers and damping resistors in series with the address multiplexer outputs. It controls up to sixty-four 64-K RAMs totalling 256-K bytes of capacity. The 8203 can also be strapped to operate with 16-K dynamic RAMs. By changing only three jumpers, such systems can later be upgraded to accommodate 64-K RAMs. The 8203 works with Intel's 8080A, 8085, iAPX 86, and iAPX 88 families of microprocessors, as well as with other popular 8- and 16-bit central processing units.

Made with Intel's bipolar process technology, the 8203 comes in a 40-pin ceramic dual in-line package and dissipates at most 1.4 W, working from a single 5-V supply. Samples are available now; full production is expected in January. In 100-piece quantities, each unit sells for $27.15.

Intel Corp., 2625 Walsh Ave., Santa Clara, Calif. 95051. Phone (408) 987-7465 [416]

Bipolar chip performs math for 8-bit processors

An intelligent coprocessor for an 8-bit microprocessor, the new SN54/74S508 is claimed to multiply and divide 15 and 25 times faster than popular 8085 and 6800 microprocessors. Able to process digital signals, the 8-bit bus-organized device follows 28 multiplication instructions and 13 division instructions. It executes basic multiplication instructions in less than 0.8 μs and basic division in under 2.2 μs.

The bipolar device can also be used in digital modems, personal computers, small-business computers, and intelligent instruments and weapons. Multiplication instructions include positive and negative accumulation and both single- and double-length addition in conjunction with multiplication. Also possible are continued division of a remainder or quotient and repetitive multiplication followed by division.

In a 24-pin dual in-line package, the SN54/74S508 is available now in both commercial and military specifications. In quantities of 100, the former version is priced at $64, while the latter is $96.

Monolithic Memories Inc., 1165 East Arques Ave., Sunnyvale, Calif. 94086. Phone (408) 739-3535 [417]

Low-cost chip houses disk controller-formatter

Designed for 5¼-in. floppy-disk drives, the FD176X family of monolithic controller-formatters have all the features of the industry-standard FD179X family but at a lower cost.

The devices, which can also handle 8-in. drives, operate at 1 MHz and are compatible with existing floppy-disk–drive designs using the 179X version.

Four parts in the family, the FD1761, -63, -65, and -67, cover all combinations of single or double density, true or inverted data bus, and single- or double-sided drives. They may be used with the IBM 3740 single-density or System/34 double-density formats or, alternatively, with nonstandard formats to achieve greater density.

The chips are designed for soft-sectored systems having automatic track-seeking with verification and provide direct-memory access or programmed data-bus transfers. They support single- or multiple-sector read or write operations with automatic sector search in both modes or can read or write the entire track. To further simplify FD176X/9X design-in, data-separator and clock-generator support chips are available. The chip, housed in a 40-pin dual in-line package, sells for $25.30 in plastic versions and $36 in ceramic models in lots of 100. The FD176X controllers, which operate over the 0°-to-70°C temperature range, are available immediately.

Western Digital Corp., 2445 McCabe Way, Irvine, Calif. 92714 [419]

The seeds of success.

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Oldham, England, OL9 8NP
Tel: 061-624 0515
Telex: 668038

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Munich-22, West Germany
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Circle 210 on reader service card

FOR THE PRICE OF A NEW CAR, YOU CAN START YOUR OWN COMPUTER COMPANY.

Skim through almost any newspaper and you'll see that for around $7,000 you can buy a basic new car. Perfect for going back and forth to work.

But for those of you who harbor ambitions of working for yourself, and for those of you who dream of becoming a star where you're now working, there is a far more prudent investment.

The MPT/100 computer you see here.

To start with, the MPT/100 costs a good deal less than a new car.

Besides, the MPT/100 can take you a good deal further.

Inside the MPT/100 you'll find a 16 bit microNOVA® computer. 64K bytes of memory. 80 column by 24 line screen. Full keyboard with numeric pad. 716 KB of on-line storage on 358 KB mini-diskettes.

Out back you'll find an I/O bus that accepts the standard microNOVA peripherals, including Data General Winchester-type disks. As well as your own interfaces. Two synchronous/asynchronous communications ports, programmable to 19.2K baud.

And a host of features many desktop computers don't even have as options.

Which is a lot of computer to find in a desktop computer that doesn't take up the whole desk.

As impressive as the hardware may be, it's the systems software that runs on the MPT/100 computer that makes it the computer to further your ambitions.

A multi-tasking FORTRAN and a multi-tasking PASCAL

that executes at assembly language speeds. An ANSI-compatible BASIC that lets you quickly write large programs that take up a small amount of space. A full range of user-friendly aids like a Command Line Interpreter, a Menu Editor, and a Debugger. And MP/OS, one of the most advanced operating systems in the industry.

With software like that, you can be out making a name for yourself while everybody else is trying to figure out how you did it.

You can take your big ideas anywhere in the world. Because the MPT/100 comes with the same worldwide support we give every Data General computer.

And when you start to carry a lot of weight in your industry, you can migrate all your software, all your peripherals, and everything you've learned. Because we've gone out of our way to make Data General computers get along with each other.

The point we're driving at is that this computer can help you do what a lot of other companies have done with other Data General computers.

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Of course buying an MPT/100 may mean driving your present car a while longer. But look at it this way. A few years from now, maybe you'll be driving any car you jolly well please.

For more information about the MPT/100 computer, call your local Data General office, your Data General manufacturers representative, or one of the distributors listed below. Or write us at MS C-228, 4400 Computer Drive, Westboro, MA 01580.

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Circle 169 on reader service card

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Want to type and edit multi-level equations with typewriter simplicity? **NO PROBLEM**

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Most typewriters – even many of the latest electronic models – are limited to basic typing.

But the Lanier No Problem Electronic Typewriter is multi-use, with extraordinary powers for technical and scientific typing.

No Problem typing – a better way to type.

The No Problem concept

To begin with, the No Problem typewriter speeds up the typing of your proposals, manuals, and reports like no ordinary typewriter can.

It eliminates typing rough drafts on paper. Pages are prepared on a TV-like screen instead.

Changes and corrections are made right on the screen. So no whiteouts. No retyping. No false starts. Whole paragraphs can be moved with the touch of a few keys.

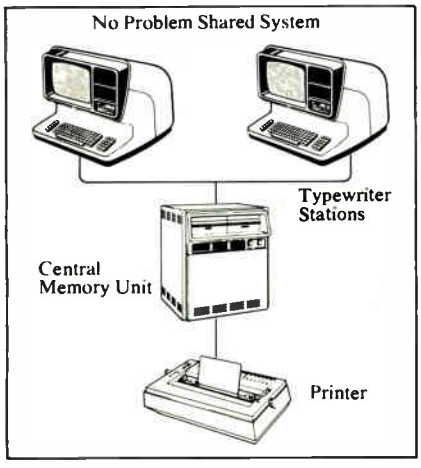
Letter quality printing is done at up to 540 words per minute.

With the No Problem typewriter, one typist can now do work as fast as 3 or 4 people using ordinary electric typewriters.

Plus, the basic intelligence for the No Problem typewriter is contained on No Problem Smart Discs.™ So future functions and improvements can be added with new Smart Discs as they are developed.

One typewriter or a shared system

The No Problem Shared System™ offers you even greater typing capabilities.



The No Problem Shared System™ adds new capabilities to the already versatile No Problem concept.

The heart of the system is the Central Memory Unit. It can store up to 30,000 pages, giving you lower storage costs per page, and eliminating the need for typists to handle numerous discs.

You can start with one or two typewriter stations connected to the Central Memory Unit, and add typewriter stations or printers as your needs increase.

There is also an attractive economic factor in sharing printers and other equipment.

Advanced features

Consider the old method of incorporating complex mathematical equations into your copy: leave the space blank, then hand letter them in after the page was typed. Or, you could run to the photocopier, then "cut and paste."

With the No Problem Shared System, you can incorporate *and edit* virtually any equation you may encounter—*right on the screen.* It will display *256 different characters,* including Greek and math symbols.

Line drawings can be constructed on the No Problem screen, too.

The No Problem Shared System automatically selects left, right or center page position for numbers, and chapter names on even and odd pages. Repagination automatically updates section numbers to accommodate your additions and deletions.

Advanced editing automatically positions footnotes on the proper page.

And the printing of the No Problem Shared System approaches typeset quality and flexibility. Proportional and bold printing, to fit any format or width, is easily done. Even in two typestyles and two colors on the same page at the same time.

Most of all, the No Problem Shared System can improve your cost/performance ratio dramatically with its increased workpower.

Modular design protects your investment

You can add Shared System typewriter stations, standalone No Problem typewriters, printers and Smart Discs to your office at will.

So your investment will *continue* to be a money-making problem solver as long as you own the equipment.

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Nov. 17, '81 Electronics 4 89 E K1

Circle 171 on reader service card

Components

BiFET op amp has multiplexed inputs

Eight-input hybrid contains ladder and switches for digitally programmable gain

Taking a low-cost route, Burr-Brown has combined a programmable-gain operational amplifier made with bipolar and field-effect transistors with an eight-channel multiplexer, giving data-acquisition systems a hybrid front end with maximum-gain nonlinearities of 50 ppm. The single-ended amplifier configuration was chosen to produce a less expensive part than programmable instrumentation amplifiers like the company's 3606.

As analog products marketing manager Dennis Haynes says, "Microcomputer control of data-acquisition components has become so widespread that there is a growing demand for the basic programmable functions at a minimum cost." A 3-bit channel address selects one of eight analog input channels to the PGA100. Another 3 bits determine the tap point on a resistor ladder in the op amp's feedback path to set the channel's gain in binary-weighted steps between 1 and 128 or other ranges as chosen by the user with an external trim.

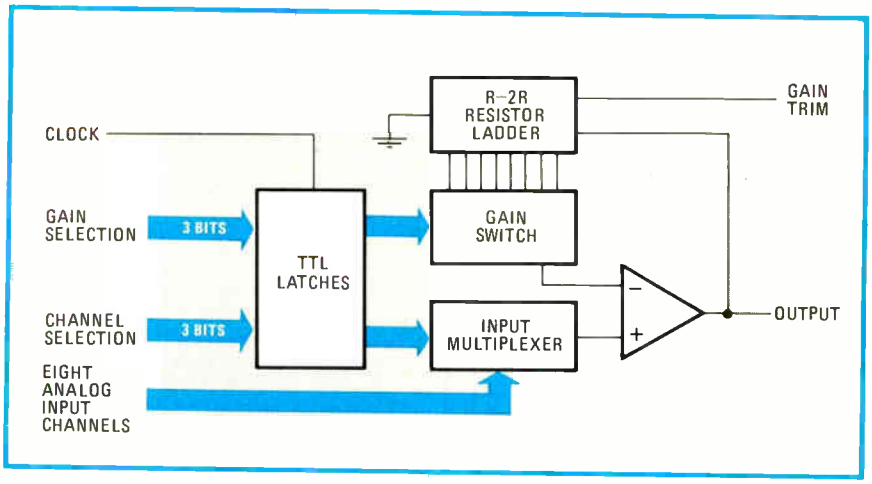
One easy way to get more resolution in a data-acquisition system without going to expensive, high-resolution analog-to-digital converters is by increasing the gain of the input channel. "Both process-control and test-equipment applications often require sampling many signals of widely varying levels, as well as signals with wide dynamic ranges," Haynes says.

Although the PGA100's gain inaccuracy is a modest ±0.05% and offset is specified at ±1 mV, these figures are relatively unimportant for computer-controlled data acquisition, where software is increasingly used for continuous correction of system errors. For example, one input can be tied to ground, so that the system's output when reading this channel gives a value for the accumulated offset errors in all the components, which can be subtracted from later measurements.

"Instead of tight error specs," says Haynes, "the user can get, for example, a multiplexer that won't be damaged by voltages 20 V beyond the supply voltages and that has very low crosstalk of ±0.003%." Other key specifications are a typical settling time to within 0.01% of 5 μs, and a slew rate of 14 V/μs.

The PGA100 is priced at $43 in 100-unit lots. Delivery is from stock to four weeks.

Burr-Brown Research Corp., International Airport Industrial Park, P. O. Box 11400, Tucson, Ariz. 85734 [341]



Channel at gain. A microcomputer can select one of eight analog input channels and a binary-weighted gain with Burr-Brown's PGA100 hybrid multiplexing amplifier.

Long capacitors distribute power

Custom-length multiple-tap decoupling capacitors reduce noise, parts count on board

The problem of noise on the power-distribution lines of printed-circuit boards—one that has traditionally been solved with decoupling capacitors at every socket—can be dealt with more effectively and less expensively by a distributed capacitor bus bar. The Cap-Bus, with a capacitance of as much as 0.05 μF per inch of its length, eliminates the need for power-supply traces on the printed circuit board: the bar serves both as a power-distribution element and as a decoupling capacitance.

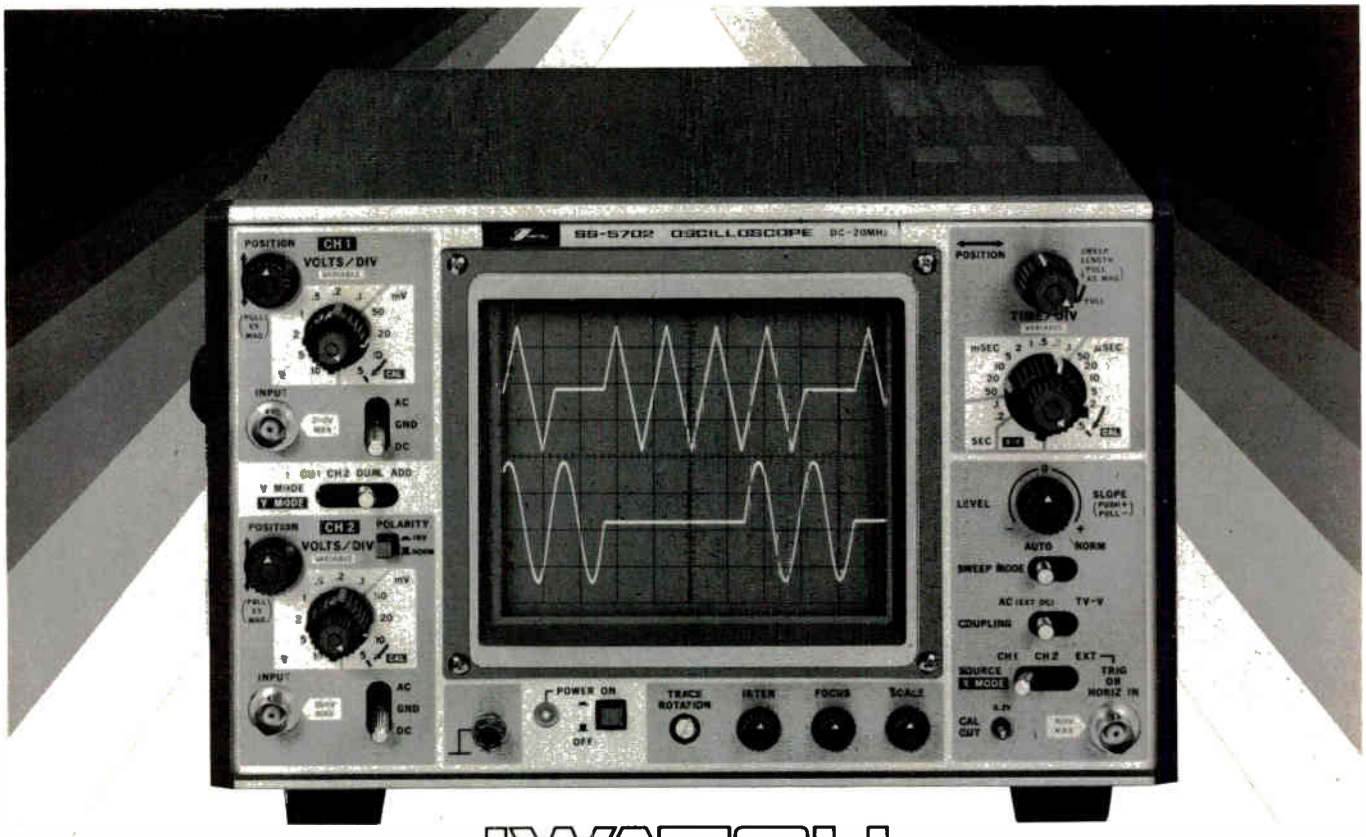
The thin distributed capacitor not only saves board space, but is more effective in noise reduction. Tests conducted on 2-MHz shift-register circuits show at least a 500% reduction in the peak noise on power lines compared to the same total capacitance when individual components are mounted at each socket.

The dielectric in the Cap-Bus has a strong temperature coefficient leading to a capacitance increase of 0.006 μF/°C. The capacitance also decreases slightly with frequency, changing a total of about 18% between 100 Hz and 100 kHz. Maximum operating voltage is 50 V.

Custom configurations. Cost of the Cap-Bus depends on the exact configuration specified; customers can select the total length of the bar, number and location of taps, and total capacitance required. For example, an eight-tap bar ranges from $1.30 for 0.08 μF to about $3.70 for 0.28 μF total capacitance, divided

AN INNOVATIVE 20 MHz OSCILLOSCOPE THAT EMPHASIZES OPERABILITY

The SS-5702 has flexibility and power which make it ideal for the maintenance and troubleshooting of TVs, VTRs, audio equipment and a wide range of other electronic systems by hobbyist as well as professionals. At the top of its class, the SS-5702 uses a 6-inch rectangular, parallax-free CRT.



IWATSU SS-5702 DC~20 MHz OSCILLOSCOPE

IWATSU makes more than 20 oscilloscopes as well as an impressive lineup of other instruments including logic analyzers and digital memory scopes. The fastest oscilloscope has a maximum frequency of 350 MHz. And the same technological expertise and product quality that make this super high-frequency oscilloscope possible are incorporated in the SS-5702.

- 6-inch rectangular, parallax-free CRT
- TV-V trigger
- Variable sweep length
- Double Lissajous figure
- 1 mV/div to 10 V/div sensitivity
- 100 ns/div to 0.2 s/div sweep
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Circle 173 on reader service card

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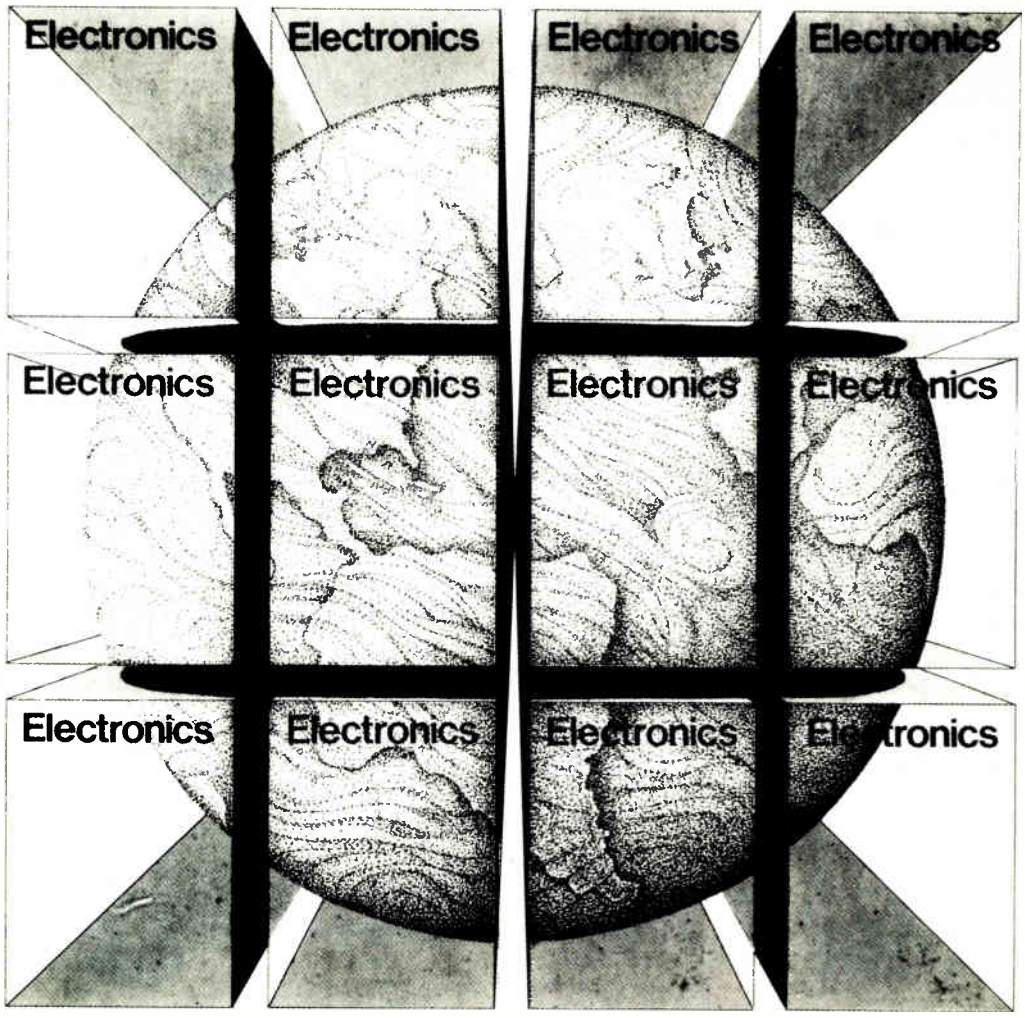

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evenly among the eight tap points. Delivery is in 6 to 8 weeks.

Eldre Components, Inc., 1500 Jefferson Rd., Rochester, N. Y. 14623. Phone (716) 244-2570 [342]

Pair of amplifiers attain high gain, high speed

A 4-bit binary word selects the gain of two instrumentation amplifiers housed in 24-pin ceramic dual in-line packages. The range of gains for the AM-542 extends from 1 to 1,024 in 11 binary steps, and for the AM-543 from 1 to 128 in 8 binary steps.

The AM-542's ±50-μV initial offset voltage and low 1-μV/°C offset voltage drift are useful in applications requiring low offset drift and high accuracy and gain. Its gain nonlinearity is within 0.005%, its common-mode rejection ratio is 90 dB, and its output-voltage range is ±10.5 V at 5 mA. Different models of this amplifier operate over the commercial, industrial, and military temperature ranges, as do models meeting Mil-Std-883B.

The AM-543, however, is suitable for applications requiring only moderate accuracy but high speed over the commercial temperature range. At unity gain, a 20-V step settles to within 0.01% in only 6 μs, and the unit's slew rate is 13 V/μs. The AM-543 has a 7-MHz small-signal bandwidth at unity gain, a common-mode rejection ratio of 80 dB, and a ±10-ppm/°C temperature coefficient—its gain nonlinearity is only 0.01%. Prices start at $129 each for the AM-542 and $139 for the AM-543, with delivery from stock.

Datel Intersil, 11 Cabot Blvd., Mansfield, Mass. 02048. Phone (617) 339-9341 [343]

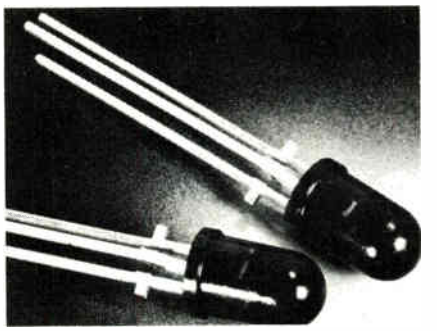
GaAs infrared LEDs put out 15 mW of radiant power

A family of high-power gallium arsenide infrared light-emitting diodes having a 950-nm peak-emission wavelength and a spectral half bandwidth of 50 nm is particularly suitable for use in infrared remote-control systems, commercial and industrial alarm systems, light barriers, and smoke detectors, as well as short-haul fiber-optic digital transmission systems.

The diodes have a radiant power of 15 mW at 100-mA forward current, and in switching mode, permit radiant intensity levels of 120 mW/steradian for the CQY99, 125 mW/sr for the V290P, and 180 mW/sr for the CQW14, at a forward current of 1.5 A and a pulse duration of 100 μs.

The CQY99, V290P, and CQW14 diodes come in standard T-1¾ plastic packages and sell for $0.30, $0.33, and $0.36 apiece, respectively, in 1,000-piece quantities. Delivery takes 6 to 8 weeks.

AEG-Telefunken Corp., Route 22, Somerville, N. J. 08876. Phone (201) 722-9800 [344]

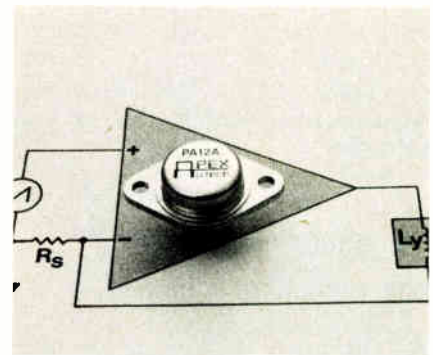


Little op amp packs big drive current

The PA12 power operational amplifier goes beyond the traditional 5-A output of TO-3–housed devices by providing ±15 A at ±50-V supply voltages. This combination represents an output of 440 W for dc circuits like programmable power supplies, heaters, and power light-emitting diodes and 220 W for loads.

Even at 15 A, the PA12 exhibits a low crossover distortion of 0.006%. This level of distortion was accomplished with a class A/B output stage that is biased on by a compensating semiconductor junction (base-emitter voltage multiplier), which is fine-tuned by two thermistors. Inductive kickback protection is pro-

New products



vided by two internal flyback-protection diodes across the output transistors. The positive and negative output current limits are separately programmable from ±10 mA to ±15 A.

Other specifications include a 4-V/μs slew rate, a ±2-mV input offset voltage, and a common-mode rejection ratio of 100 dB. Built on a high–thermal-conductance beryllia substrate, the hybrid integrated circuits sell for $53.85 each in lots of 100. Small quantities may be delivered from stock.

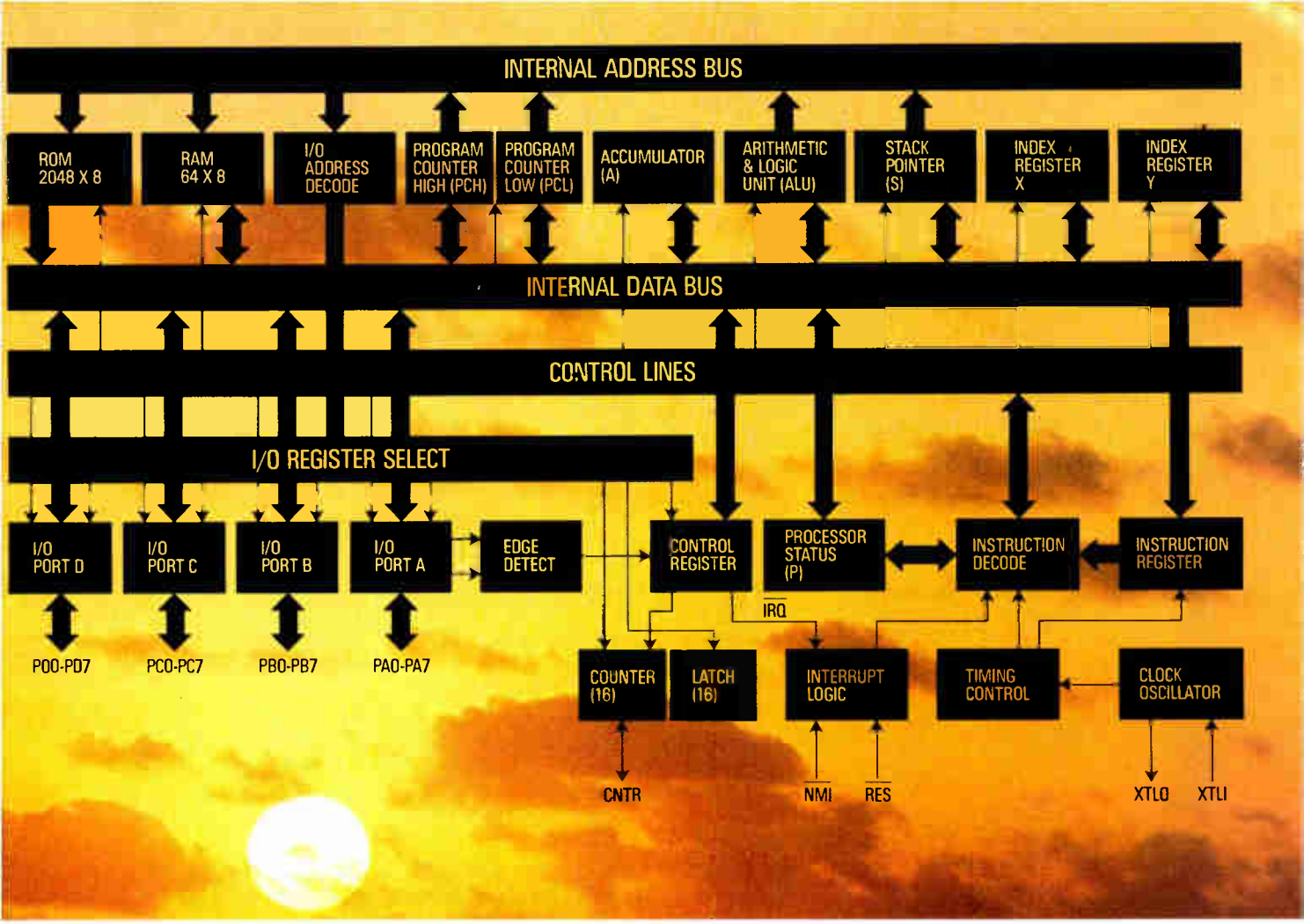
Apex Microtechnology Corp., 1130 E. Pennsylvania St., Tucson, Ariz. 85714. Phone (602) 624-0273 [345]

Potentiometers replace control-panel parts

The Ferenstat potentiometers capitalize on a new variable-speed solid-state sensing technology to perform control functions typically requiring potentiometers, shaft encoders, and thumbwheel switches. With a proprietary array of miniature detectors, the Ferenstat responds to the presence, motion, and direction of a human finger on its surface.

The Ferenstat is microprocessor-bus–compatible and provides parallel, serial, and pulsed outputs. The unit's speed-sensing feature allows the finger's velocity to govern input. For slow finger movements, the input can represent 0 to 10 bits for full distance traveled; fast movement can represent 0 to 256 bits.

As control devices, the Ferenstats have applications in audio equipment, process control, stage lighting, appliances, travelers'-check dispens-



The 6500/1 One-Chip Micro. First, look what it's got. Then, look what it costs.

$10.50 at 1,000. And there's more good news. No masking charge for the on-board 2K x 8 programmable ROM. And, the MOS 6500/1 is available in either 1MHz or 2MHz versions.

Here's what you get. A microcomputer on a chip. The 8-bit NMOS 6502 CPU, software compatible with your existing 6502 programs. Four I/O ports (32 bi-directional lines). One bi-directional counter line. On-board clock. 2048 x 8 ROM. 64 x 8 static RAM. Your choice of a 1MHz or a 2MHz internal clock. 16-bit programmable counter/latch with four modes. +5V supply. And more. All, on a 40-pin DIP. Plastic or ceramic.

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Circle 177 on reader service card

New products

ers, automatic tellers, and video games. Depending on the application, Ferenstats may be produced in lengths of 2 to 16 in. without affecting the resolution of controlling functions. As a component, the Ferenstats sell for under $100 each in original-equipment–manufacturer quantities, but as a replacement part in a control panel they cost considerably less. On small quantities, delivery is from stock.

Tasa Inc., 2346 Walsh Ave., Santa Clara, Calif. 95051. Phone (408) 727-8272 [346]

Ten-stage photomultiplier withstands harsh temperatures

A high-temperature sodium-potassium-antimony photocathode and a circular-cage copper-beryllium dynode structure form the heart of the C83027E 10-stage photomultiplier, which can operate at temperatures up to 175°C.

The 25-mm-diameter photomultiplier meets the shock, vibration, and acceleration specifications of MIL-

STD-810, ideally suiting it for gross and differential counting in deep-hole drilling where cooling requirements must be minimized. Certified test data for the $1,500 device is available. Delivery takes 30 days after receipt of order.

RCA Electro-Optics and Devices, New Holland Road, Caller Box 3140, Lancaster, Pa. 17604. Phone (717) 397-7661 [347]

"Old Reliable" introduces a powerful new microprocessor.

RCA's new 1805 gives you all the 1802 features plus a whole lot more.

The CDP1805 microprocessor uses the register-based architecture of the most popular CMOS microprocessor in history: the 1802.

It's a direct plug-in replacement for the 1802 and 1802A, but its design enhancements give you even better performance. You get a 64-byte RAM for program instructions or data, 22 additional instructions, an 8-bit presettable down-counter with a division by 32 prescaler, event counter mode and pulse width mode.

Our other new microprocessor, the CDP1806, has everything except the RAM. Both are capable of 4 MHz clock, while using less than 25 mW from a 5V supply.

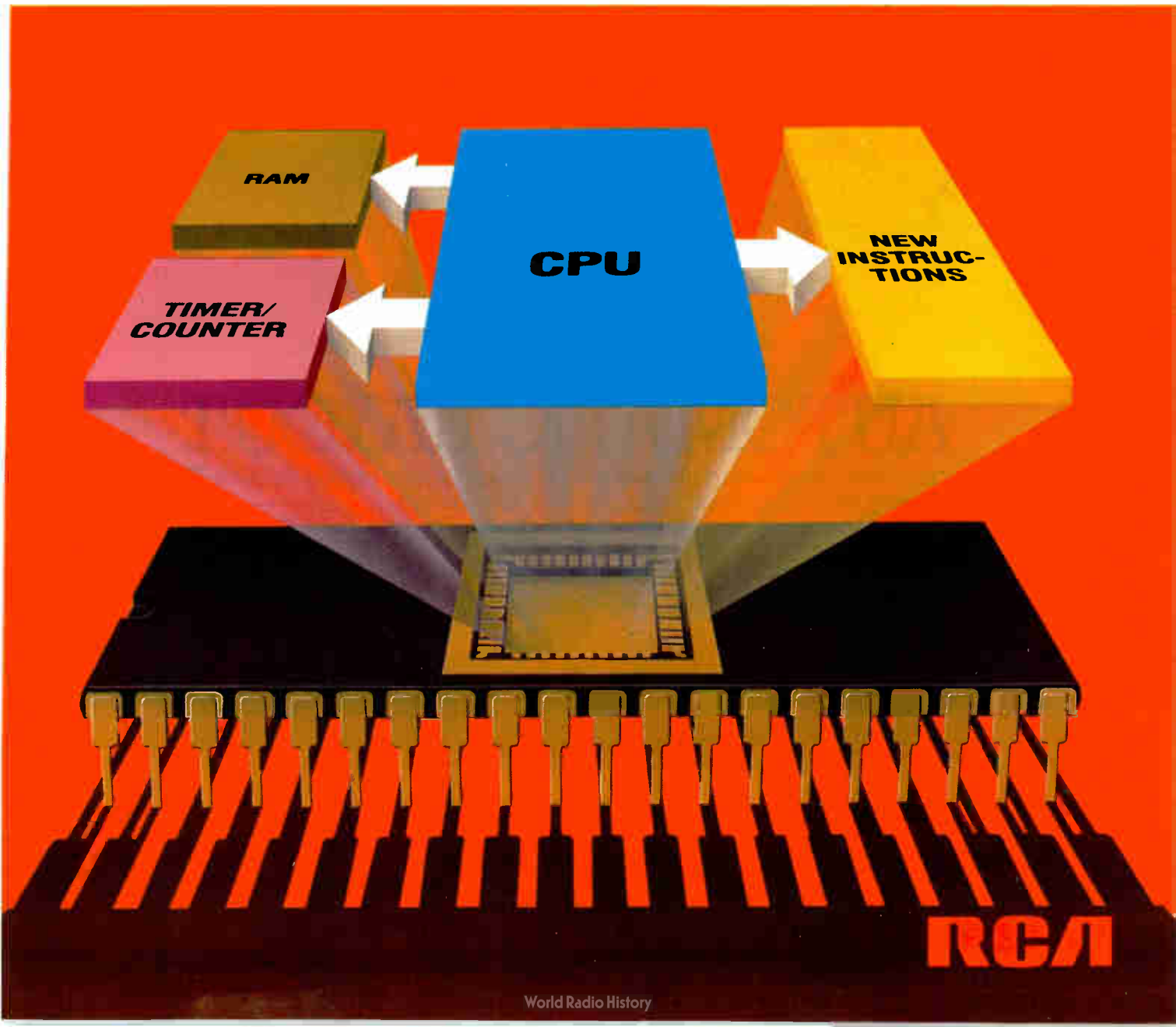
You'll achieve significant chip count reductions, and save execution time and memory space.

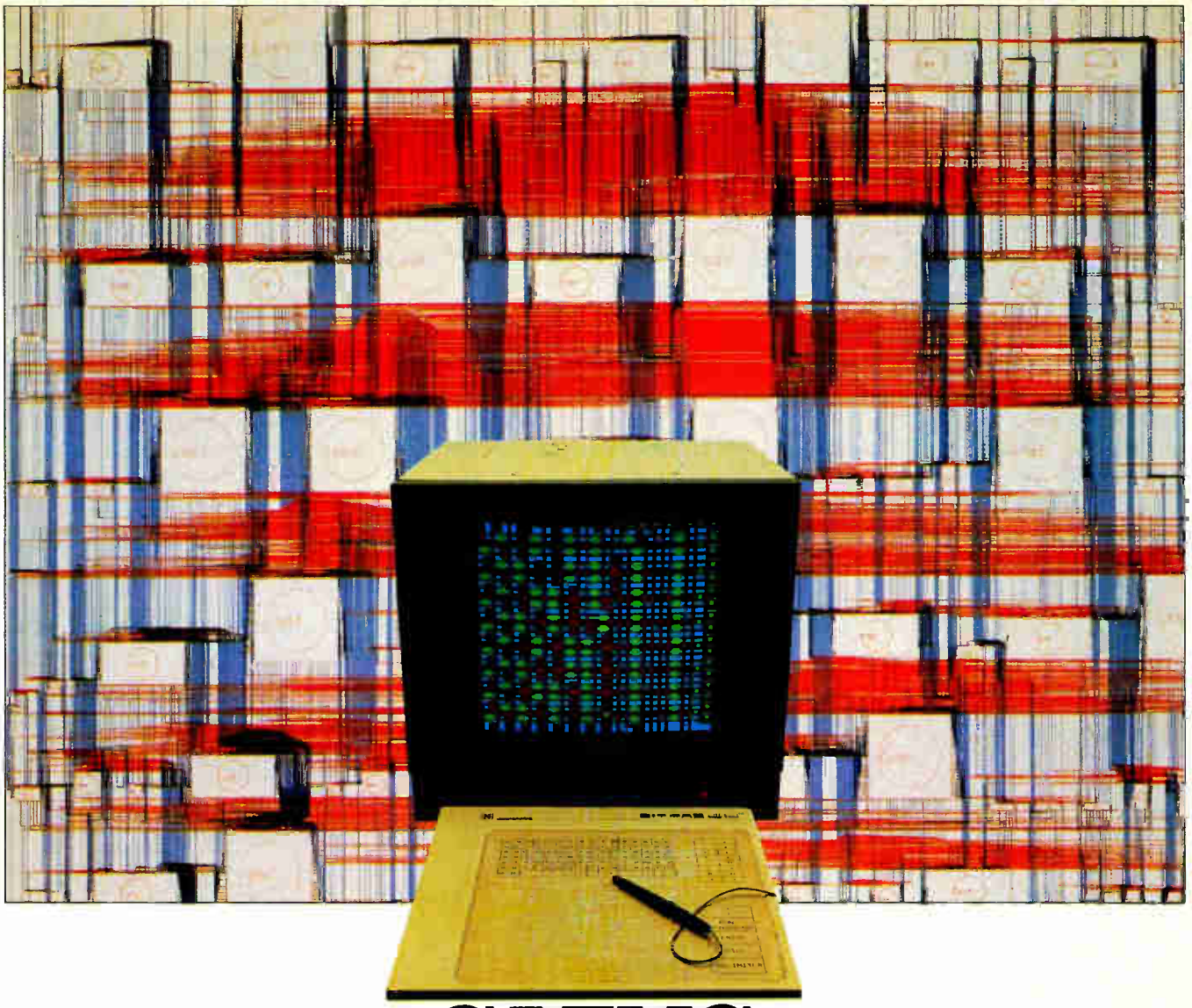
For example, the call and return instructions execute four times faster than the routines on the 1802A. And four new instructions provide direct 16-bit data transfer between internal registers and external memory.

These new microprocessors are supported by a large and growing family of I/O devices, RAMs, ROMs, high-level languages and development systems. Plus full technical support from the people at "Old Reliable." And remember, we're the people who invented CMOS.

For more information, contact any RCA Solid State sales office or appointed distributor.

RCA Solid State headquarters: Somerville, NJ. Brussels. Sao Paulo. Hong Kong. Circle 179 on reader service card





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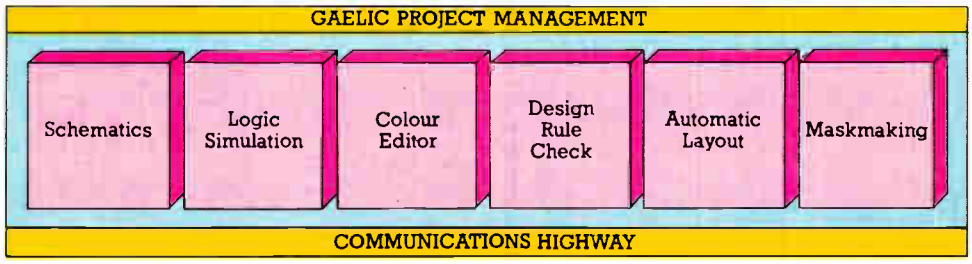
With this software module you can interconnect I.C. cells of mixed sizes to create a VLSI chip layout automatically, without errors and quicker than ever before.
When your product needs a special chip to get you ahead of competition, GAELIC ensures you get it – Right on time.



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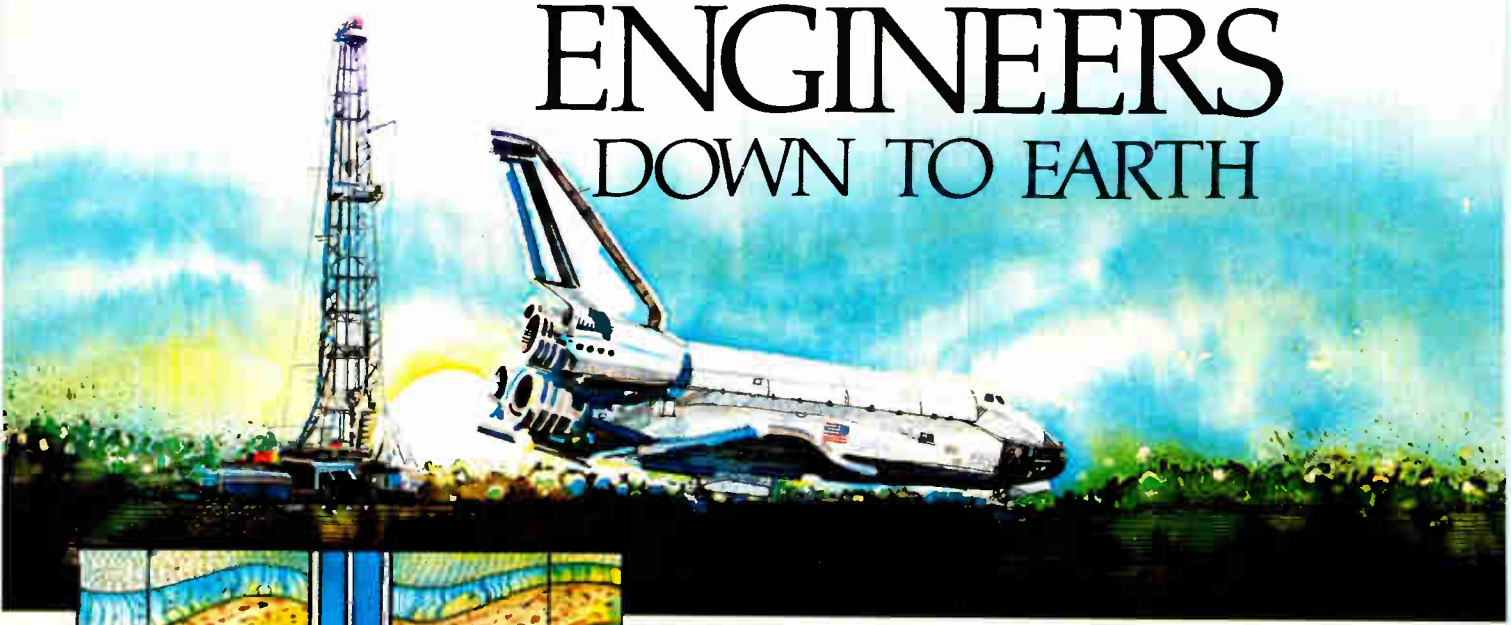

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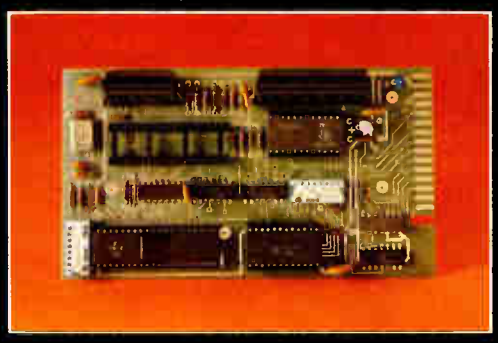
Oak puts E^3 up against the world's fastest typists.

In a keyboard market clogged with claims and confusion about "N-key-rollover," look to Oak's FTM® keyboard for the practical answer. It provides E^3-Entry Error Elimination. And that means precisely what it says. We challenge the fastest typists in the world to make it error. They can't.

Yet E^3 makes its real contribution to Oak's Full Travel Membrane (FTM) keyboard—and to you—in the cost column. You get the Entry Error Elimination and 100-million-cycle-plus performance you've got to have in a keyboard at prices far below those of keyboards with comparable performance. That's practical. Entry Error Elimination is a remarkably sensible microprocessor based N-key-rollover and phantom key lockout system developed by Oak engineers. Without the cost and complexity of Hall Effect and capacitive technologies.



And that's not all. Beneath the FTM keyboard is Oak's proven, industry-leading membrane switch technology. So you get all the good things of membrane switching—reliability, durability, RFI and EMI resistance, design flexibility, and—of course—low cost. All without sacrificing the qualities you demand in a keyboard, right down to human engineered industry standard feel and touch.

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Circle #187 to have a salesman call

Computers & peripherals

Streaming drive starts, stops fast

125-in./s tape streamer has capstan and tensioner for 45-in./s start-stop operation

Streaming tape drives generally do not perform well in start-stop operation and start-stop drives have a lower data-transfer rate than do streaming drives. However, Datum Inc.'s DMF-1000 ½-in. tape drive combines the advantages of both types: streaming at 125 in./s and operating at 45 in./s in a start-stop mode.

The drive, called Gemini for its dual capabilities, controls the tape with a capstan at all times, unlike most streamers, which eliminate the capstan motor to lower drive cost. This motor keeps the tape running at accurately controlled rates and speeds stopping and restarting, even during the streaming mode. Most streaming drives without the capstan will in fact perform start-stop duties, but at only 12.5 in./s and with relatively long ramp times.

The DMF-1000 also has a tension arm, common in start-stop drives but also omitted on streamers. The tensioner, which maintains 8 lb of pressure on the tape to prevent stretching or breaking, works with the capstan to shorten ramp times.

In standard start-stop operations, the drive accelerates the tape from 0 to 45 in./s in the 8.4 ms specified by ANSI standards. A nominal total of 10 ms is required to get the tape to speed and then begin reading or writing; at 125 in./s, this time increases to 80 ms. It takes 335 ms to stop the tape when it is streaming and back it up to start reading or writing where it left off.

Data can be dumped into Gemini at 200 kilobytes/s at 125 in./s, compared with 160 kilobytes/s for 100 in./s streamers, with no problems due to the higher speed, according to Avner Levy, director of development for the DMF-1000. Datum Inc. selected a speed of 45 in./s for the start-stop mode because most firms want relatively high tape speed even in start-stop processing, says Levy. A minor component change will convert the drive to 25 in./s.

When the drive is streaming, it will drop to 45 in./s if a lack of data being transferred forces it to stop and restart too many times at the higher tape speed. The user then has the option to continue at 45 or go back to 125 in./s.

Users can also select 800 or 1,600 b/in. data storage using inverted nonreturn-to-zero or phase-encoded formats. IBM/ANSI nine-track compatibility is also offered. The drive uses an industry-standard formatted tape interface and it accepts 7- to 10.5-in. reels.

To keep interference low, the firm placed noise-generating output transistors and heat-producing voltage regulators on a single board, isolating them from the devices on a second board that process the signal. Preamplifiers are located near the read heads to enhance the signal-to-noise ratio during streaming.

In single quantities, the price is $6,400. Delivery takes 60 days.

Datum Inc., 1363 South State College Blvd., Anaheim, Calif. 92806. [361]

Network link fully automates manufacturing facility

Lower costs, increased capabilities, and an improved network are the benefits of the real-time computer systems, desktop computers, terminals, and data-capture devices comprising the HP 1000 technical computer system for industrial-automation applications.

Under the HP 1000 umbrella, the top-of-the-line Value/65 system consists of a model 65 computer system, 1 or 2 megabytes of main memory, and five software packages. The software bundled into the system is a full American National Standards Institute Fortran 77 compiler, a Pascal compiler, Image/1000 data-base management software, and the Graphics/1000-II 2D and interactive three-dimensional graphics software packages. A Value/65 system with one megabyte costs $64,685; with two megabytes, $73,685.

The heart of the Value/65 is the model 65, an F-series computer with a hardware floating-point processor, scientific and vector instruction sets, and fast Fortran processor. It has 256-K bytes of parity memory and a 16-megabyte fixed disk and is priced at $49,610. Delivery of the Value/65 package is slated for late December.

An upgraded Data Link can accommodate HP 1000 computer systems, HP 9826/35/45 desktop computers, a wide range of terminals, data-capture terminals, and data couplers. It is typically used with a master HP 1000 computer and up to 128 slave devices, communicating at 9,600 b/s. The Multidrop DS/1000-IV option on the Data Link requires one, rather than two, interface boards for each node and lets subordinate computers commu-

"The dependable SM-2 relies on 27 flexible circuits of PYRALUX,"

says M. C. Keel, Vice President and Program Director, Standard Missile Programs, General Dynamics Pomona Division.

"SM-2 is a proven system with a high reliability record. That record was the result of painstaking effort, and part of the story was the selection of PYRALUX flexible composites to achieve reliable high density packaging," says Mr. Keel. "We can stack printed cable assemblies with PYRALUX 4 layers high in tight missile spaces, bend them 180° and we know they won't fail. We use PYRALUX for all 27 flexible circuits in the Navy's SM-2 missile," he concluded.

The missile's autopilot and battery circuits of PYRALUX consist of two 4-layer flat cable assemblies containing power, signal, and shielded digital circuits.

PYRALUX® flexible composites are a family of tough, adhesive-coated, laminated substrates offering high strength for flexible, rigid/flexible multilayer circuitry. The PYRALUX WA/A adhesive provides excellent and uniform adhesion to KAPTON® Polyimide Film, minimizing the worry of physical or chemical delamination. Conventional production solvents and chemicals can be used without affecting the bond. PYRALUX also has excellent resistance to the thermal exposure of solder dip, wave and reflow. Circuits can be removed, repaired and resoldered reliably.

Investigate the advantages of specifying PYRALUX flexible composites for your circuitry. For more information, write DuPont Company, Rm. X38894, Wilmington, DE 19898.

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Circle 189 on reader service card

nicate at a rate faster than 19,200 b/s. Data Link starts at $2,776 and Multidrop at $4,200. Delivery on these units takes eight weeks.

Hewlett-Packard, 8120 Embarcadero Rd., Palo Alto, Calif. 94303. Phone (415) 875-1501 [363]

Minicomputer additions are geared to commercial users

Streamlined compact cabinets house additions to the V77 line of 16-bit minicomputers that boost reliability and performance, lower power requirements, and add 50% to the writable control store's capacity. For example, an enhanced V77-800 system equipped with 0.75 megabyte of memory, a writable control store of 2-K 48-bit words, a cartridge-disk unit, a printer, and a tape drive requires 12 printed-circuit boards and 12 card slots, whereas earlier versions needed 17 boards and 23 slots. Also, a single 150-A power supply handles a fully loaded system where two 100-A power supplies were previously needed.

The additions include a 128-K-byte and 256-K-byte version of the V77-500 system, priced at $29,500 and $33,500 respectively, an enhanced V77-800 priced at $43,000, and a new compact model, the V77-700, selling for $36,100.

These processors, configured as commercial systems and designated the V77-550, -750, and -850, consist of a central processing unit, 256-K bytes of memory, a data-communications multiplexer, an operator's console, and either a peripheral disk or a disk-tape system. They are priced as the sum of the components minus 10%. All systems are available for immediate delivery and can easily be integrated into Sperry's Univac 1100 mainframe settings.

Sperry Univac, P. O. Box 500, Blue Bell, Pa. 19424. Phone (215) 542-4213 [364]

Graphics printer uses uncoated paper

The PrintGraphics print system produces hard copy from video graphics displays on inexpensive paper using most retrofitable graphics cards available with industry-standard alphanumeric displays. All previous graphics copy, other than plotters, required expensive coated electrosensitive or electrostatic papers. However, pin-addressable matrix printers capable of working in a graphics mode have made it possible to use uncoated paper.

Typical displays with which the PrintGraphics can interface include the Tektronix Plot 10–compatible RG512 and VT640 from Digital Engineering, which are fitted to the Lear Siegler ADM3 series, and the DEC VT100 terminals.

The PrintGraphics system contains a Z80-based controller placed between the graphics display and a pin-addressable printer. Depending on the source image and printer, copies may be made in seconds. The PrintGraphics system is available now and sells for approximately $962 to $6,415.

Riva Terminals Ltd., Glendale Park, Fernbank Road, Ascot, Berks., UK [365]

Smart terminal depends on software

Billed as a smart terminal, the Z80-based TS-1 is software-driven for versatile operation and easy enhancement. Besides its native mode, the 26-lb terminal emulates the DEC VT52 and the Lear Siegler ADM31. With an option it can emulate DEC's VT100.

The 60-key keyboard contains as standard a 14-key numeric pad and 12 easily programmed function keys. An additional row of 14 shiftable programmable function keys, yielding 28 functions, is optional and costs $195. Brightness is software-controlled from either the keyboard or the computer and can be adjusted to 127 levels of intensity. Software switches also select such communication characteristics as parity, bit rate, protocol, refresh rate, transmission mode, and word length.

All software-controlled selections are stored in a continuous complementary-MOS memory that is battery backed. Measuring 12 by 16 by 14 in., the terminal will sell for $1,295. Delivery takes four weeks.

Falco Data Products Inc., 1286 Lawrence Station Rd., Sunnyvale, Calif. 94086. Phone (408) 745-7123 [367]

Software-driven system eliminates add-ons

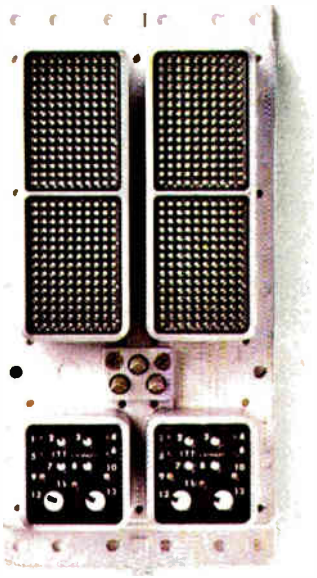
A software-based word-processing system that needs no additional components to suit a variety of applications is Toshiba's EW-100. It has a capacity of 295,682 characters using single-sided, single-density 8-in. floppy-disk drives and 1,025,024 characters using double-sided, double-density drives. It prints bidirectionally at a rate of 45 characters/s, using a daisy-wheel printer, and displays 24 lines of 80 characters on its 12-in.-diagonal screen.

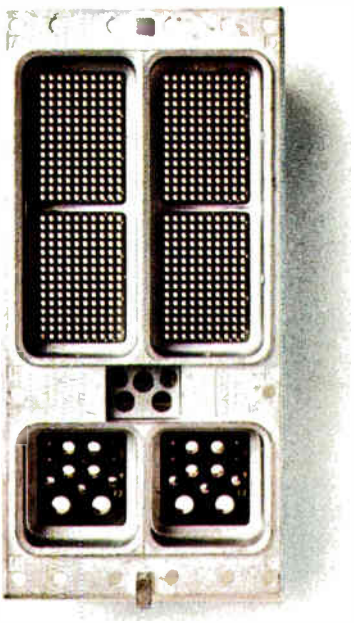
The EW-100 features backspace correction, automatic word wraparound, centering, decimal tabulation, underscore, headers and footers, horizontal and vertical scroll, recorded format, electronic tab set-clear, copy and super copy, move and super move, hyphenation, and simultaneous input/output.

Designed for table-top use, it guides the user through the various steps of operation by displaying messages on its cathode-ray tube. Its keyboard is separate from the CRT for operating comfort. Prices begin at $7,250 per system.

Toshiba America Inc., Information Processing Systems Division, 2441 Michelle Dr., Tustin, Calif. 92680 [366]

ARINC 600. FIRST TO FLY WITH AVIONIC SPECS.





Since rack and panel connectors were first devised, the ITT Cannon Electric name has been synonymous with technological leadership. And when the avionics industry called for a new design to meet the demands of modern technology, ITT Cannon again held center stage with the ARINC 600 connector series. We were the first manufacturer qualified to commercial avionics specifications. That means we've already gone through the learning curve, and can offer you a most dependable line of Arinc connectors.

Cannon's low insertion force BKAD/E series connectors are available in environmental and non-environmental designs. Their contacts are fully interchangeable with our DPX series. And termination tooling is the same for easy retrofitting. You get greater reliability, easier maintenance and lower cost per mated line in a totally-installed system.

At ITT Cannon, we have product when you need it. And you can choose from a wide assortment of contact configurations. For immediate information, refer to our pages in EEM. For literature, the name of your local ITT Cannon distributor or other information, contact Rectangular Division Marketing Manager, ITT Cannon Electric, a division of International Telephone and Telegraph Corporation, 10550 Talbert Avenue, Fountain Valley, CA 92708. (714) 964-7400. In Europe, contact ITT Cannon Electric, Avenue Louise 250, B-1050 Brussels, Belgium. Phone: 02/640.36.00.

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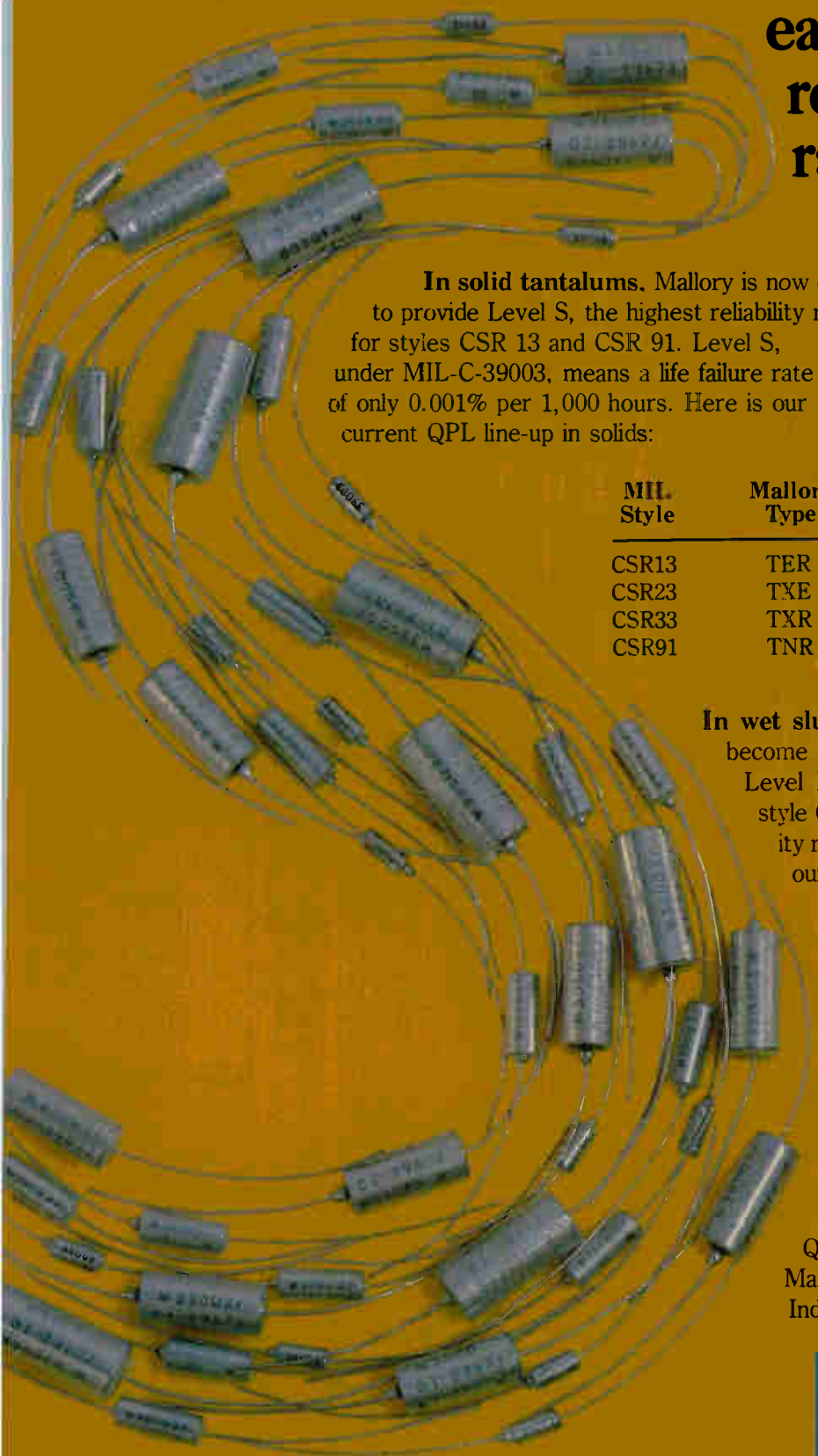

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CSR33	TXR	M, P
CSR91	TNR	M, P, R, **S**

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CLR17	XTV	L, M, P
CLR65	TLX	L, M, P, R
CLR69	TXX	L, M, P, **R**

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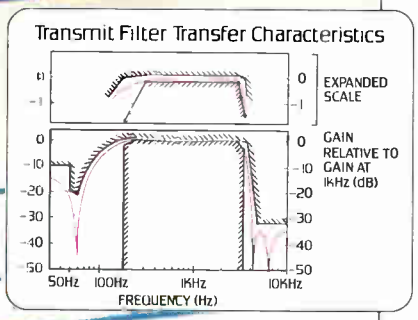

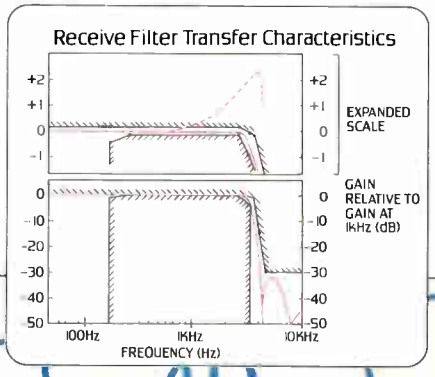

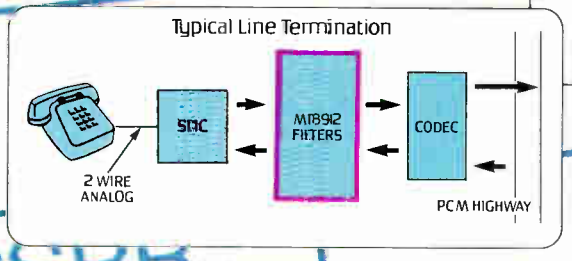

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BUILDING BETTER COMMUNICATIONS

Circle 194 on reader service card

Products Newsletter

Casual English elicits computer instructions

Forth Inc., of Hermosa Beach, Calif., has contracted with Excalibur Technologies Corp., of Albuquerque, N. M., to develop a data-base management package for the Apple II that responds to such casual commands as "Computer, how many machinists work here?" or "What percentage of project X is complete?" **Using Savvy, Excalibur's Z80-based adaptive pattern-recognition processor,** the Forth-based system will be able to recognize written words strung together in idiomatic phrases and translate these imprecise patterns into precise computer commands. Savvy is not deterred by extra spaces, misspellings, typing errors, or questions it has not previously answered; and if it fails to act on a command, the user can teach it the meaning of the phrase that caused the failure. Ready in March 1982, the system will sell for under $1,000. Future versions of Savvy will understand Spanish commands, as well as English, or a mixture of both.

Interface card relays and converts computer commands

The 9702, an initial offering from North Coast Automation Inc., Chesterland, Ohio, is a single-card motor-control interface that has 12- or 16-bit resolution for controlling two axes thanks to two on-board DAC-80– or DAC-71–type digital-to-analog converters. Offered with or without a built-in ±15-V power supply, each **Multibus-compatible 9702 series board accepts inputs from two position encoders** and supplies two analog voltages for driving motors based on microcomputer commands. Prices range from $865 for the 12-bit version without supply to $1,195 for the 16-bit model with on-board power supply. Delivery takes three weeks.

Teletype emulator mates CRT terminals with ASR teleprinters

With the TTY communications package, Codex CDX-68 terminals now can support both interactive time-sharing and administrative-message switching. Codex Corp., Mansfield, Mass., claims **reduced terminal and network costs through terminal integration** of the three most common dialing protocols: teletype, 3275, and 2780/3780; the latter two already were supported by the CDX-68. With the addition of the teletypewriter protocol, which can be licensed for $100, the terminals can emulate ASCII automatic send-receive teleprinters, and will be compatible with Teletype Corp.'s ASR-33, -35, and -43 systems.

16-bit microcomputer programs in eight languages

Altos Computer Systems' 8086-based ACS8600 single-board 16-bit microcomputer can supply up to eight users with up to 1 megabyte of main random-access memory, plus up to 80 megabytes of on-line floppy- and Winchester hard-disk storage. **With error detection and correction and a memory management system,** a basic configuration with 512-K bytes of memory, a 10-megabyte hard disk, and floppy-disk backup lists for $12,990. The four operating systems supported are Xenix, CP/M 86, MP/M 86, and Oasis-16, and programs can be written in Basic, Cobol, Pascal, Fortran, CIS-Cobol, RM-Cobol, Pascal/M-86, and C-Basic-86. The San Jose, Calif., firm will begin deliveries in January of 1982.

TI adds ROMs with special vocabularies

Added to Texas Instruments Inc.'s family of speech 128-K read-only memories are the VM61003 with 147 weather and time words, the 128-item VM61004 for military uses, and the VM61005 with 135 items for avionic markets. **In lots of 100, each goes for $9.75.** The devices from the Dallas firm will be available in December.

Career outlook

From teacher to programmer

Massachusetts teachers whose careers have been sunk by budget cuts may be buoyed by a business- and government-funded program to learn computer programming. Project Straight (for short-term retraining and advanced instruction geared to high technology) kicks off this month with a 1,000-hour pilot course funded by the state Department of Education.

The course aims to produce 50 programming graduates over a 26-week period, and could become a model for similar courses across the state, says project manager F. Nelson Burns. Massachusetts computer firms like Digital Equipment Corp., Wang Laboratories, and Nixdorf Computer's U. S. branch are lending executives, programmers, and personnel workers as advisers.

Steering. The advisers form a steering committee that suggests admission standards and curriculum content and counsels students on their career transition. According to Burns, Wang and Nixdorf programmers will even share teaching chores with instructors at the Greater Lowell Regional Vocational Technical School in Tyngsboro, Mass., where the initial course is being held.

"These inputs should help us tailor the coursework to industry's needs and turn out highly employable graduates," says Burns. He adds that as the course progresses the program will encourage contacts between students and industry and also open up recruitment opportunities.

Burns thinks computer users like banking and insurance firms will be the major recruiters of programming graduates, so course instruction is based on the applications-oriented programs such companies offer their own employees. "We're teaching programming skills in a linear sequence, the same a programmer uses to solve applications problems," he notes. "It's a much more hands-on approach than you'll find in most computer-science degree programs, where several subjects are taught simultaneously."

Although one steering-committee member cautions that firms aiding in Project Straight do not guarantee they will hire program graduates, Ralph A. Crusius, vice president and assistant to the president at Wang Laboratories, observes, "there certainly is a need for entry-level programmers, and any measure to increase the talent pool will get a lot of interest and support."

Project Straight's initial emphasis will be on Cobol-language programming, though later instruction will include Basic, RPG, Assembly, and perhaps some Pascal, Burns notes. Students, who pay a $300 tuition fee, will work on Wang, Xerox, and Honeywell computers at the Tyngsboro school. For these former teachers, whose jobs evaporated in a series of state-wide budget cuts this year, the program provides an avenue off the unemployment line into an industry with a high demand for their new skills.

Burns says that chances of further funding to extend Project Straight "look very bright; we're already looking at another potential course start-up in January."

The center serves 2,400 students during its normal operating hours, and is large enough to accommodate several Project Straight courses running concurrently. While the first course, which begins Nov. 23, emphasizes Cobol applications, the second will probably focus on word-processing and basic-language training, according to Burns. "We don't want to flood the market with just one kind of skill," he says.

"Technical vocational schools are natural centers for this kind of program," Burns asserts. "They have the equipment already in place, and they normally stand empty every afternoon and weekend." If Project Straight expands to fill those underused facilities, he believes, there will be plenty of raw talent waiting to move in. Applicants for the first Project Straight course came from 67 different Massachusetts communities. Newly unemployed teachers comprise a large segment of potential students, points out Burns, "and that group alone amounts to about 7,000 people." **-Linda Lowe**

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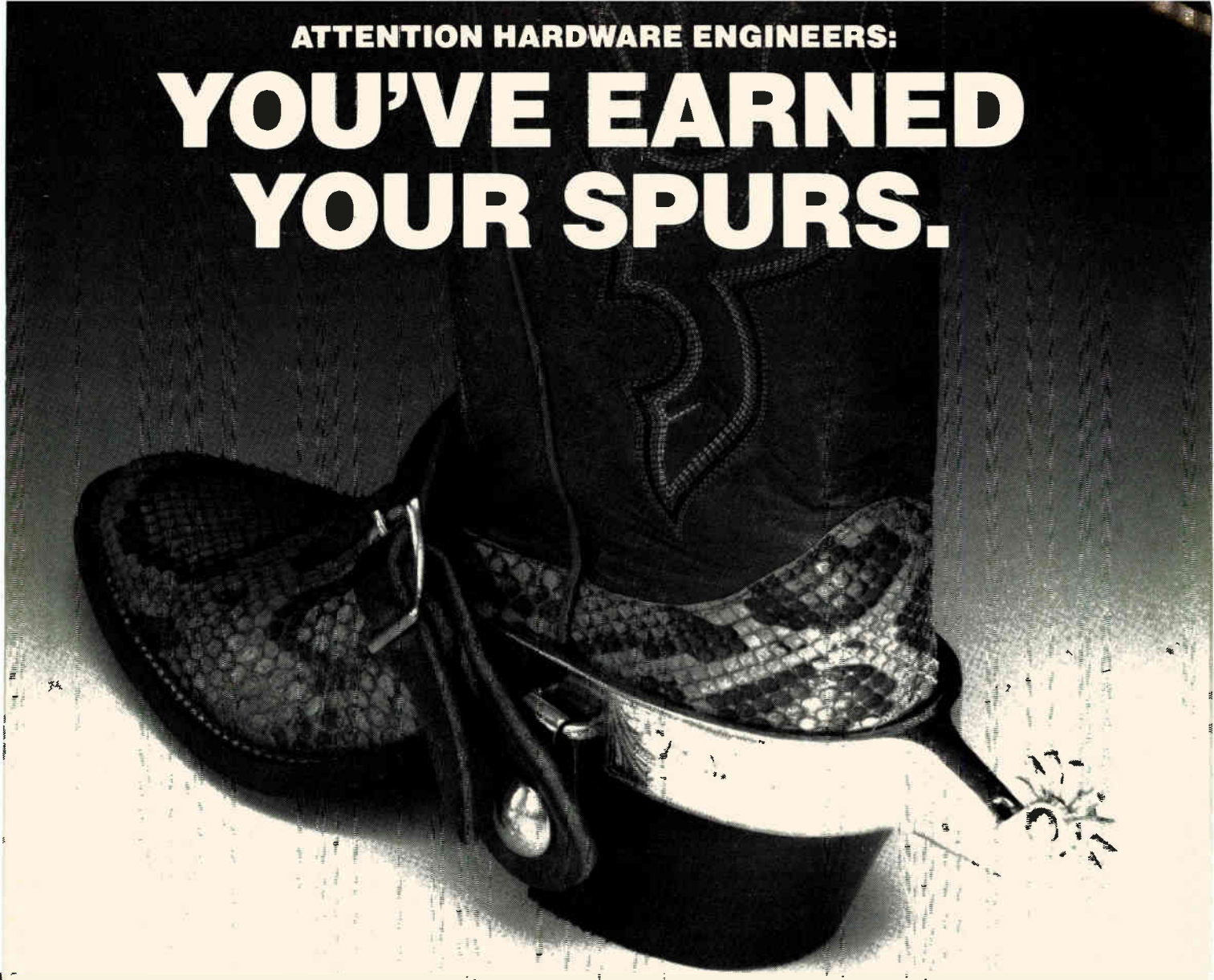

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15	30	45	60	75	90	105	120	135	150	165	180	195	210	225	240	255	270	347	362	377	392	407	422	437	452	467	482	497	702	717	960

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1	16	31	46	61	76	91	106	121	136	151	166	181	196	211	226	241	256	271	348	363	378	393	408	423	438	453	468	483	498	703	718
2	17	32	47	62	77	92	107	122	137	152	167	182	197	212	227	242	257	272	349	364	379	394	409	424	439	454	469	484	499	704	719
3	18	33	48	63	78	93	108	123	138	153	168	183	198	213	228	243	258	273	350	365	380	395	410	425	440	455	470	485	500	705	720
4	19	34	49	64	79	94	109	124	139	154	169	184	199	214	229	244	259	274	351	366	381	396	411	426	441	456	471	486	501	706	900
5	20	35	50	65	80	95	110	125	140	155	170	185	200	215	230	245	260	275	352	367	382	397	412	427	442	457	472	487	502	707	901
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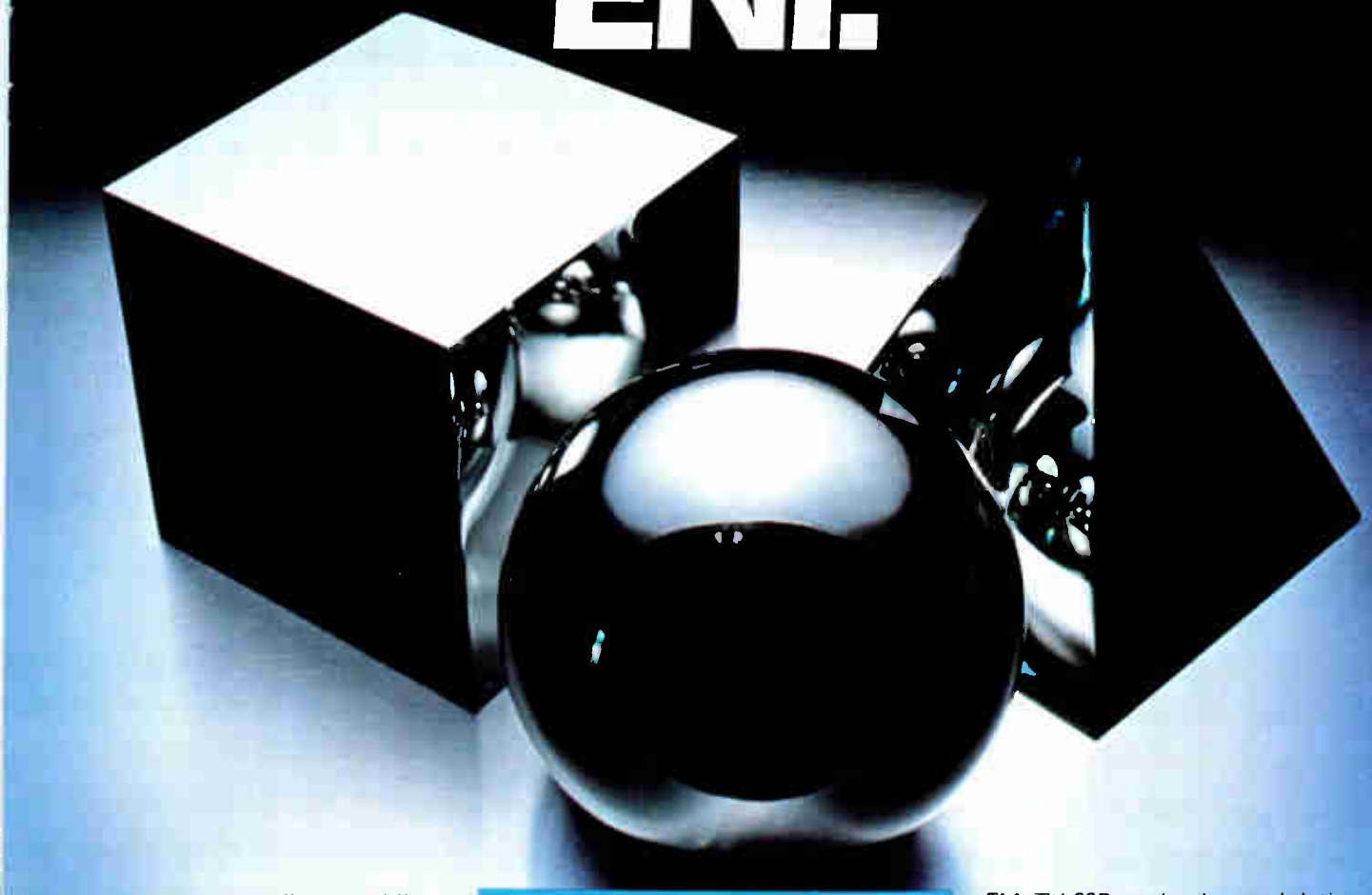

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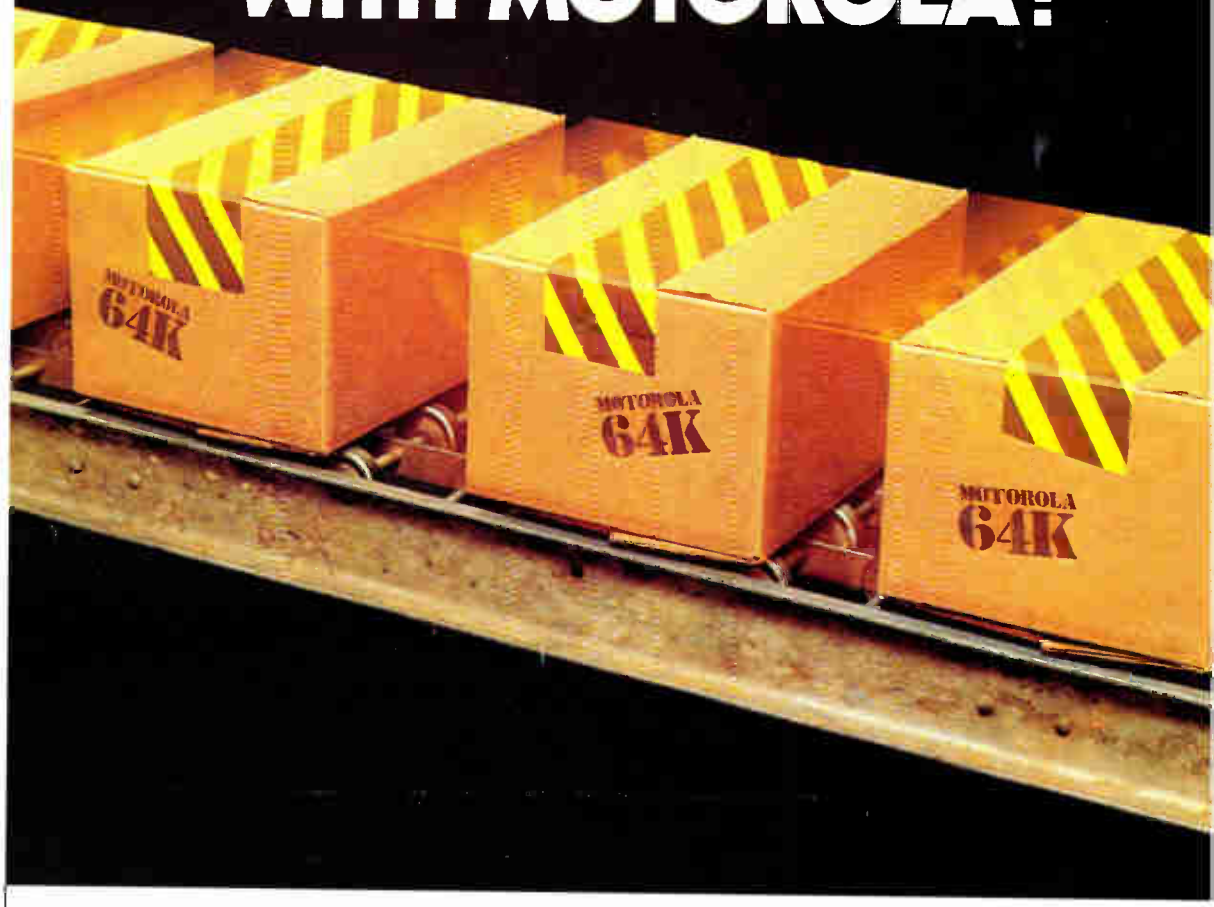

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