OPTIONS EXPAND FOR EMBEDDED CONTROLLERS

RAMDAC OPENS TRUE-COLOR WINDOWS

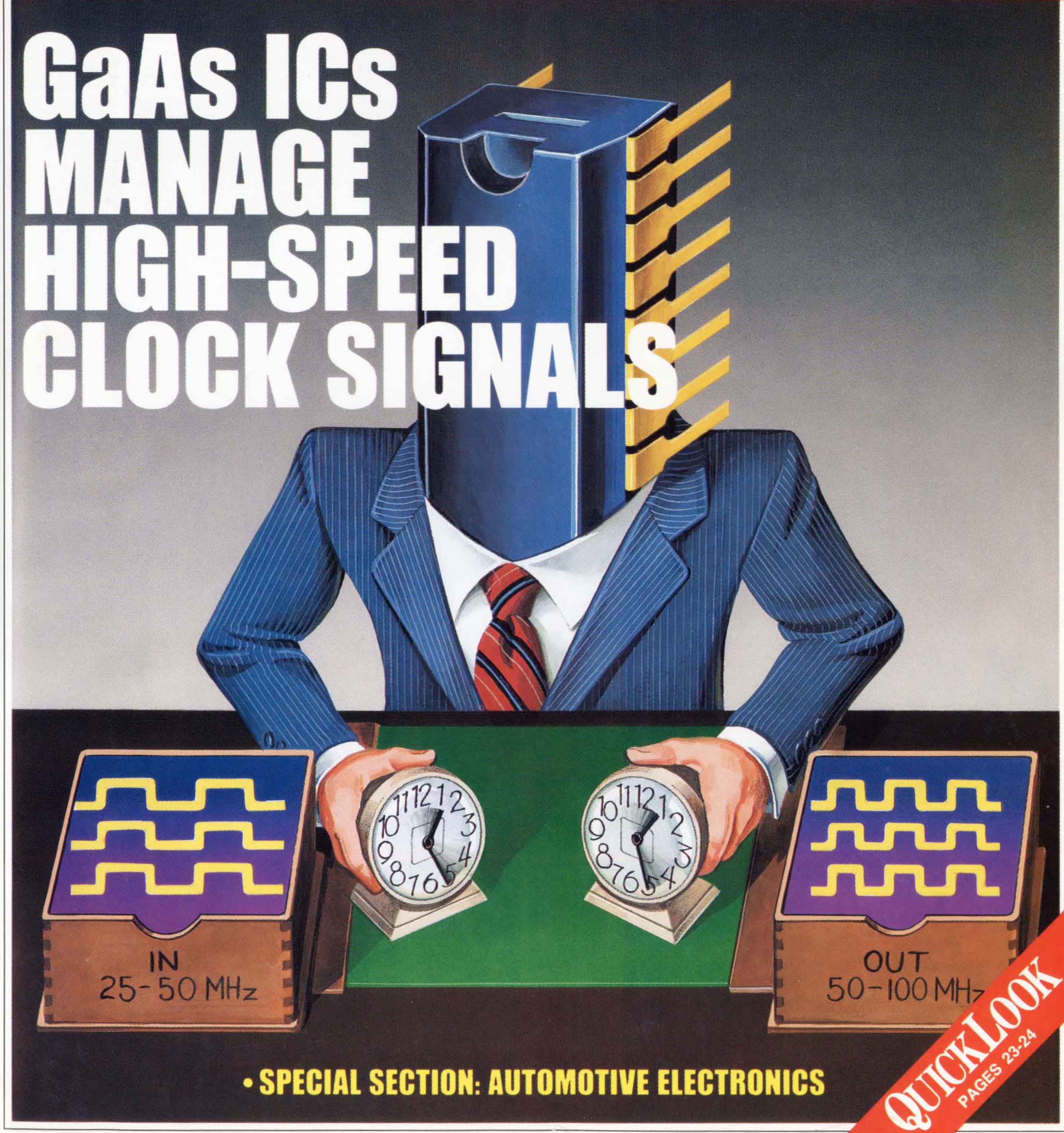
FOR ENGINEERS AND ENGINEERING MANAGERS — WORLDWIDE

ELECTRONIC DESIGN®

A PENTON PUBLICATION U.S. $5.00

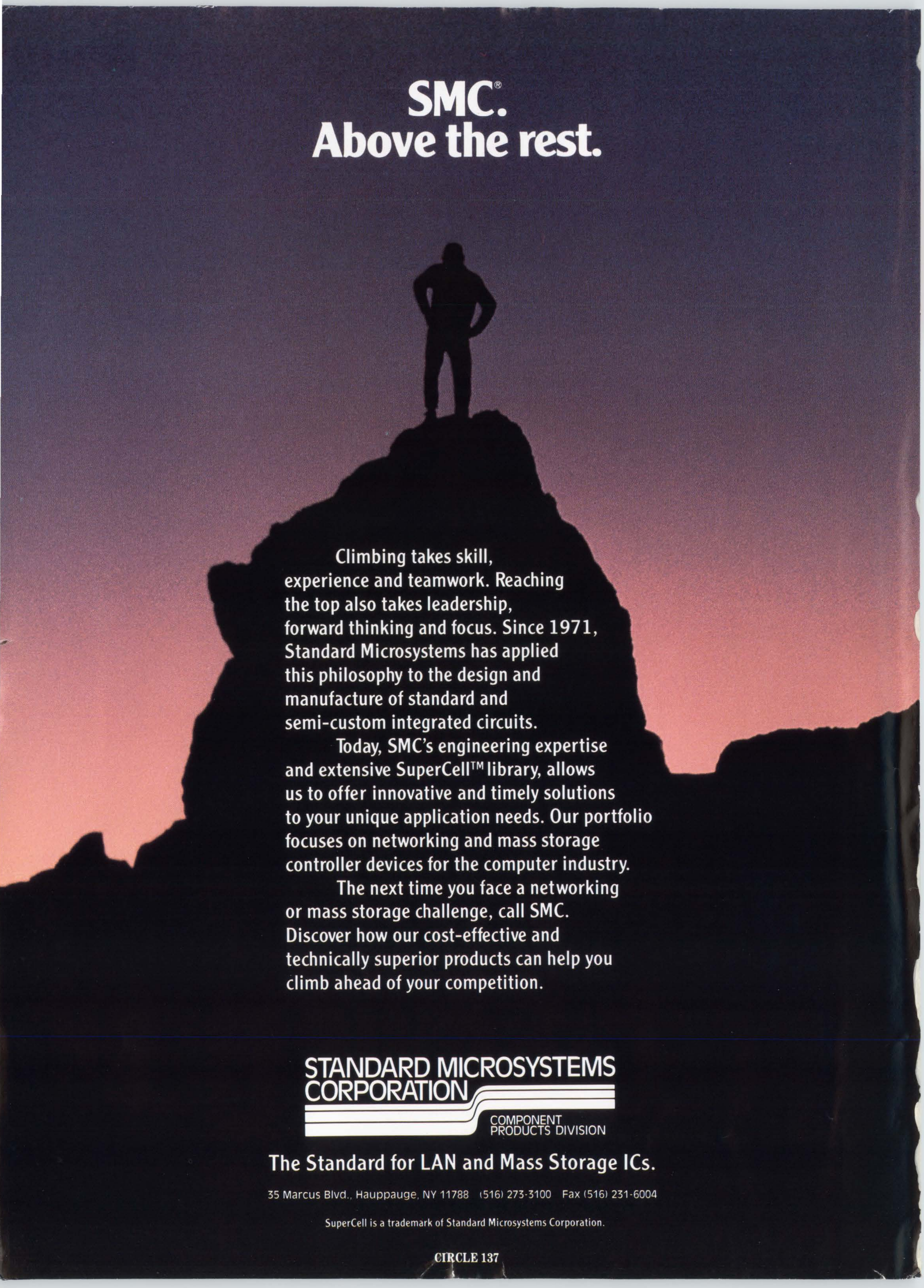
AUGUST 9, 1990

GaAs ICs MANAGE HIGH-SPEED CLOCK SIGNALS



• SPECIAL SECTION: AUTOMOTIVE ELECTRONICS

QUICKLOOK PAGES 23-24


SMC.®
Above the rest.
Climbing takes skill, experience and teamwork. Reaching the top also takes leadership, forward thinking and focus. Since 1971, Standard Microsystems has applied this philosophy to the design and manufacture of standard and semi-custom integrated circuits.
Today, SMC's engineering expertise and extensive SuperCell™ library, allows us to offer innovative and timely solutions to your unique application needs. Our portfolio focuses on networking and mass storage controller devices for the computer industry.
The next time you face a networking or mass storage challenge, call SMC. Discover how our cost-effective and technically superior products can help you climb ahead of your competition.
STANDARD MICROSYSTEMS CORPORATION
COMPONENT PRODUCTS DIVISION
The Standard for LAN and Mass Storage ICs.
35 Marcus Blvd., Hauppauge, NY 11788 (516) 273-3100 Fax (516) 231-6004
SuperCell is a trademark of Standard Microsystems Corporation.
CIRCLE 137

Control Tower

When it comes to motion control products, Hewlett-Packard towers over the rest with a more diversified and innovative line of solutions. Giving you one source to meet all your design needs.

Just look at our award-winning HEDS 9000 series of encoder modules. Using HP's unique optical technology, these modules are the ideal building blocks for creating precision high-speed linear or rotary applications.

Your choices include everything from a 3-channel module for industrial applications to the small footprint of our 9700 collection for business equipment.

Control panel: the HRPG series.

For front panel applications, turn to our RPG series of potentiometers. Offering you full configuration flexibility, improved rotational feel, and small footprint, HP delivers the perfect line of data entry devices for your test, medical, analytical, and computer equipment.

Controlled performance: the HCTL series.

Our new line of high-speed HCTL ICs give you high performance servo control in low-power CMOS. The result: superior performance and more microprocessing power left over for your laboratory, medical, and industrial automation designs.

And because these motion control solutions come from HP, you're assured of our on-going commitment to excellence in service, support, and reliability.

So why take a chance, when you can take control. With motion control products from HP. Call for our free brochure: **1-800-752-0900, ext. 1497.**

There is a better way.

HEWLETT PACKARD

CIRCLE 110

CG08005

National Semiconductor

"All I'm doing is applying technology to solve the world human communications."

HOW NATIONAL SEMICONDUCTOR IS HELPING YOU MEET THE CHALLENGES OF NEXT-GENERATION DATACOM AND TELECOM SYSTEMS.

Mike Evans, National Semiconductor's Director of Strategic Applications, Integrated Systems Group, talks about applying high-performance VLSI solutions to communications problems.

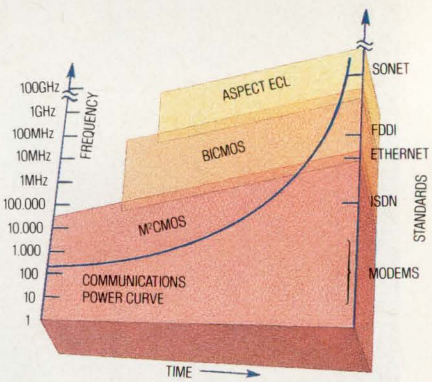
Achieving single-chip integration for IEEE 802.3 local area networks.

"We're already a generation ahead in Ethernet chip design. We're the LAN market leader and the de facto standard in the industry. And now we've set a new standard in analog and digital integration with SONIC, for 'Systems-Oriented Network Interface Controller.' It combines a controller, an encoder/decoder, and a phase-locked loop onto a single chip that delivers a data rate of 10Mbits per second.

"It's the first device that implements all 802.3 network management functions. And the first capable of embedding the Ethernet control functions in 32-bit computer systems. High performance, low power, small footprint."

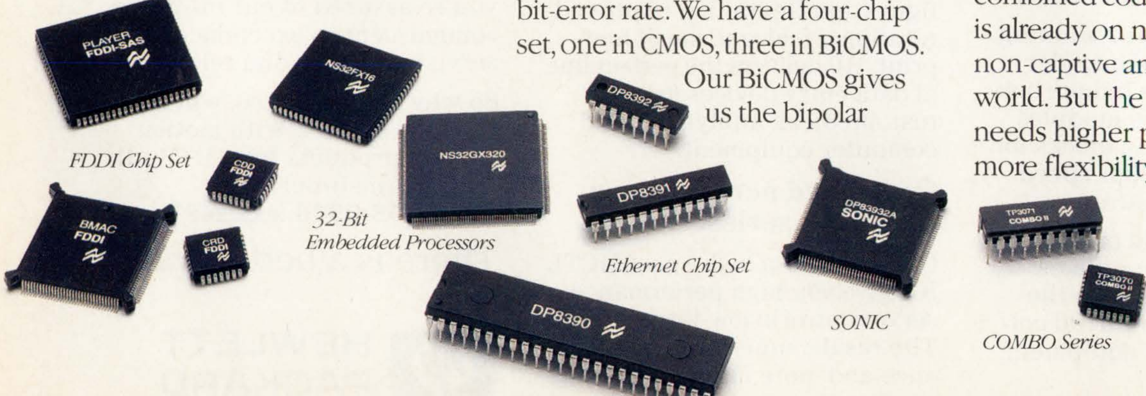
Setting the pace for tomorrow's fiber-optic solutions with FDDI.

"This is a quantum leap from Ethernet. Fiber Distributed Data Interface. It's the backbone of next-generation LANs. And it delivers at an incredible 100Mbits per second, and with an incredibly low bit-error rate. We have a four-chip set, one in CMOS, three in BiCMOS. Our BiCMOS gives us the bipolar speed necessary for these data rates, with the CMOS density for high-speed logic functions. And we're already adding a fifth chip — a high-performance system interface. This is the frontier — and we're right on the edge of it."



Creating the world's first analog programmable CODEC/filter.

"Here's another example of how we're building on our leadership position. Our COMBO I, combined coder/decoder and filter, is already on nearly half of the non-captive analog linecards in the world. But the telecom market needs higher performance and more flexibility, so we've given



FDDI Chip Set

32-Bit Embedded Processors

Ethernet Chip Set

SONIC

COMBO Series

the world's most advanced
's most ancient problem:

them the COMBO II. Second-generation, proven technology, fully qualified, fully characterized, in production. And it's the only one in the world that is fully programmable for gain *and* hybrid balance *and* time-slot assignment *and* A- or μ-law..."

Bringing unprecedented power and flexibility to fax designs.

"If you think facsimile is 'old' technology, then you haven't seen our solution yet. Actually our *range* of solutions – you can go from low-end designs to high-end designs without rewriting a single line of code. Full 32-bit processing power. Optimizing your fax functions, but also allowing you to utilize the processor for other functions when it's not sending or receiving faxes. So you can do PostScript calculations, laser printing, network management. Single chip, single box, single company."

Putting the pride of National to work for you.

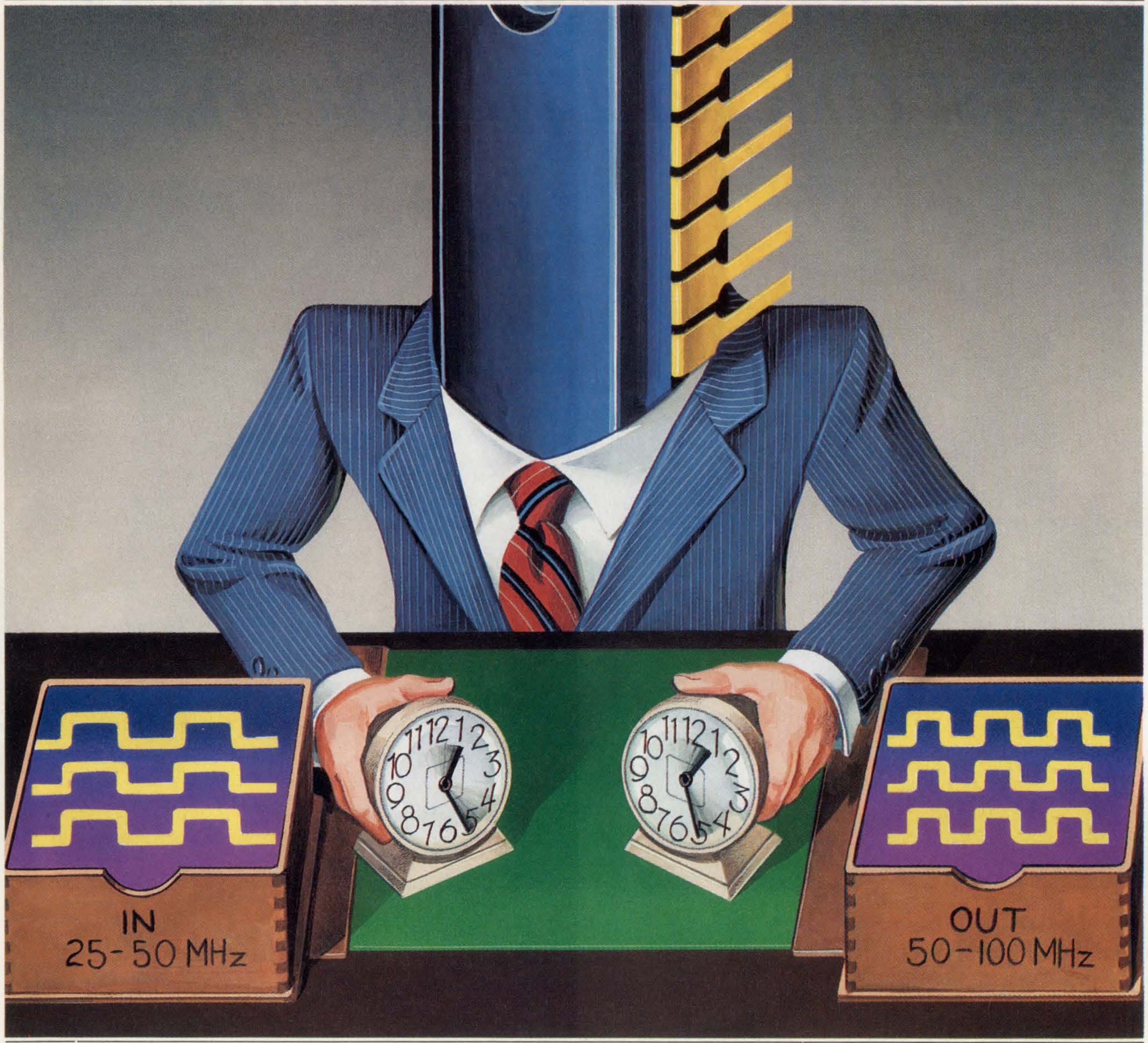
"You know, communications affects the whole world. But the first step in communicating is overcoming our natural reluctance to do it. If I wanted to talk to communications experts, I'd call National. That's where it starts."

1-800-NAT-SEMI, Ext. 601

National Semiconductor

AUGUST 9, 1990 VOL. 38, NO. 15

ELECTRONIC DESIGN



Certificate of Merit
Winner, 1988
Jesse H. Neal Editorial
Achievement Awards

WHAT'S YOUR OPINION?

• How important are analog design skills for engineers in the future?
• How do the design skills of today's EE graduates stack up against those of young engineers of the past?

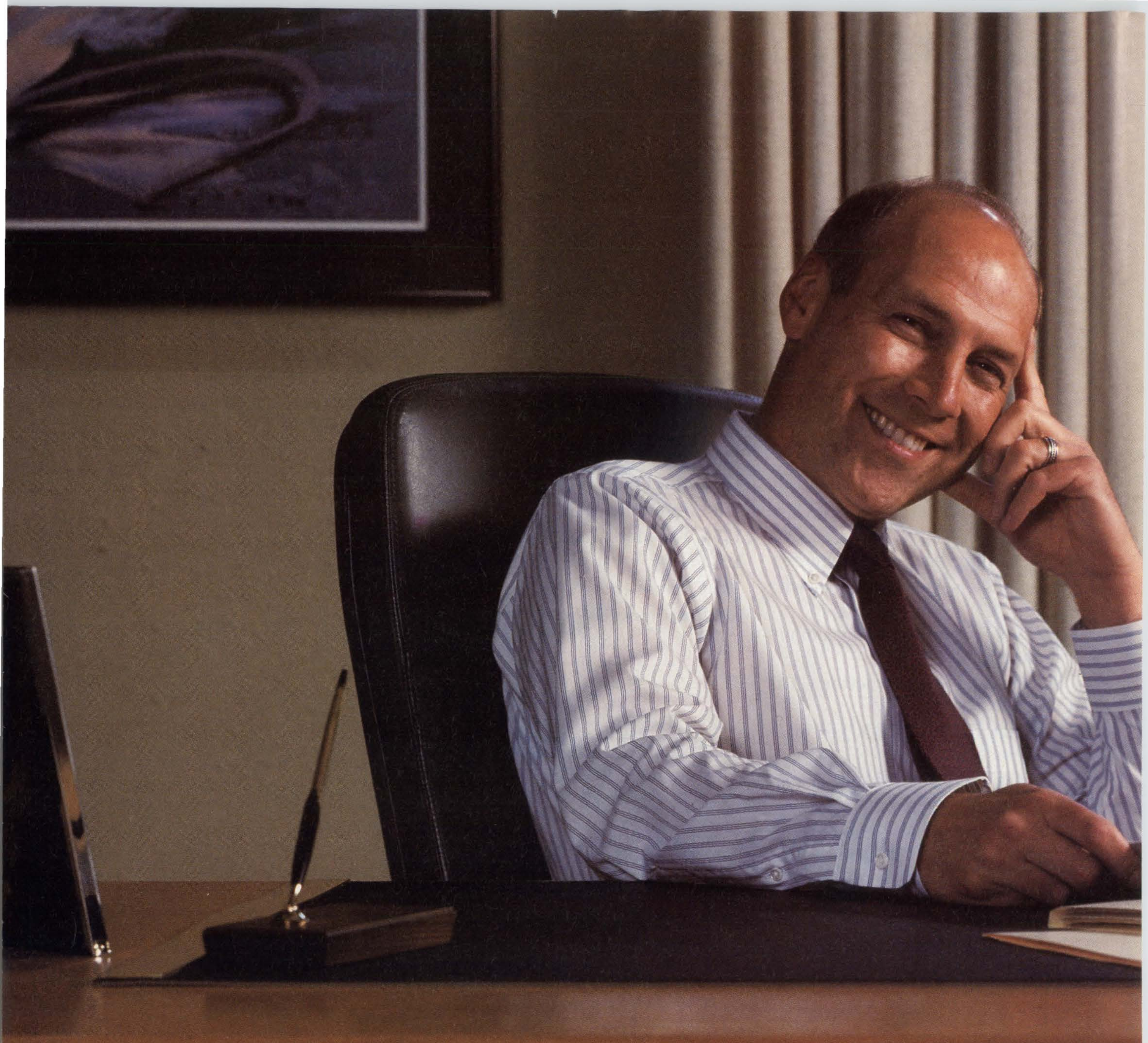
Send us your opinions on these questions on our Reader Opinions fax: (201) 393-0637. Or, mail your responses to ELECTRONIC DESIGN, Reader Opinions, 611 Route 46 West, Hasbrouck Heights, NJ 07604.

COMING NEXT ISSUE

• Special Report: Advanced Computer Technology—Six experts assess future advances
• A preview of the International Test Conference—boundary-scan testing takes the spotlight
• The ins and outs of designing with DSP chips
• Using new delta-sigma d-a converters
• First details on new mixed-signal simulators
• Plus regular features:
Ideas for Design
Quick Look
Technology Advances

ELECTRONIC DESIGN (USPS 172-080; ISSN 0013-4872) is published semi monthly by Penton Publishing Inc., 1100 Superior Ave., Cleveland, OH 44114. Paid rates for a one year subscription are as follows: $75 U.S., $140 Canada, $230 International. Second-class postage paid at Cleveland, OH, and additional mailing offices. Editorial and advertising addresses: ELECTRONIC DESIGN, 611 Route #46 West, Hasbrouck Heights, NJ 07604. Telephone (201) 393-6060. Facsimile (201) 393-0204.

For subscriber change of address and subscription inquiries, call (216) 696-7000.
POSTMASTER: Please send change of address to ELECTRONIC DESIGN, Penton Publishing Inc., 1100 Superior Ave., Cleveland, OH 44114.

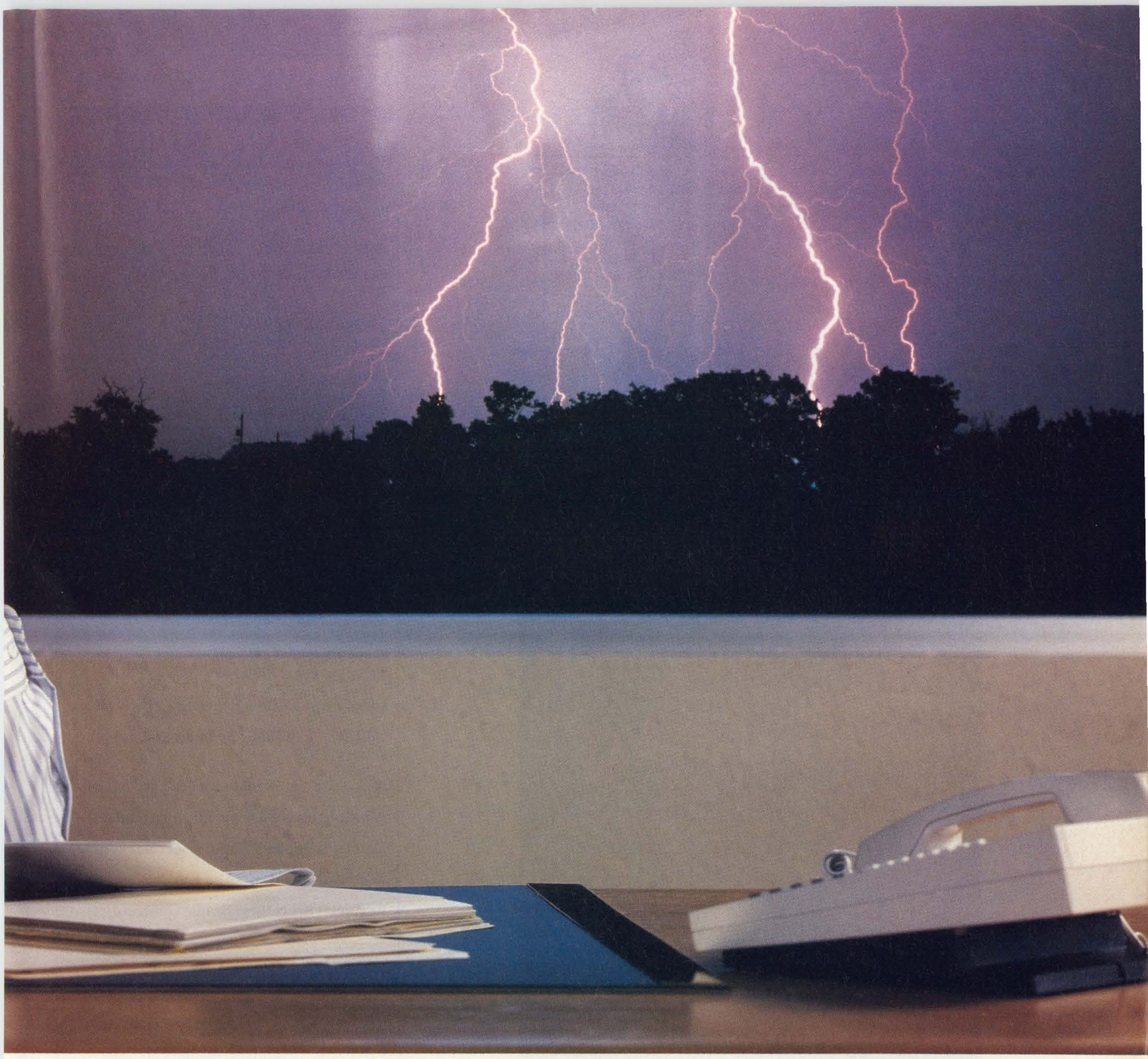


THIS MAN MANAG
MULTIPLE DESIGN DISCIPLIN
DEADLINES THAT COULD KIL

The dilemma rears its ugly head time and time again. Do the impossible. By tomorrow. Worse yet, do it with an intimidating hodge-podge of design automation tools and data formats. And while you're at it, make sure all these tools and data play together freely and efficiently. No problem. Right?

To avoid this kind of chaos, you need to consider a fundamental change in your engineering strategy. Which is why we now offer you our Concurrent Design Environment.™

Simply put, the Concurrent Design Environment allows tools from virtually any source to work together. Within it, our new Falcon Framework™ lets you assemble precisely the design automation environment your situation requires — without sacrificing the considerable benefits of integration. And our OpenDoor℠ program ensures that your choice of tools includes the best the entire industry has to offer.



ELECTRONIC DESIGN

Editor-in-Chief: Stephen E. Scrupski

Executive Editor: Roger Allan

Managing Editor: Bob Milne

Senior Editors: Frank Goodenough, Milt Leonard, John Novellino

Technology Editors:
Analog & Power: Frank Goodenough
Communications & Industrial: Milt Leonard (San Jose)
Components & Packaging: David Maliniak
Computer-Aided Engineering: Lisa Gunn
Computer Systems: Richard Nass
Semiconductors: Dave Bursky (San Jose)
Test & Measurement: John Novellino

News Editor: Sherrie Van Tyle

New Products Editor: Susan Nordyk

Field Bureaus:
West Coast Executive Editor: Dave Bursky (San Jose)
Boston: Lawrence Curran
Dallas: Jon Campbell
Frankfurt: John Gosch
London: Peter Fletcher

Chief Copy Editor: Roger Engelke, Jr.

Editorial Production Manager: Donna A. Ullio

Associate Art Director: Alice Topf

Administrative Assistant: Janis Kunkel

Editorial Support Supervisor: Mary James

Editorial Assistant: Ann Kunzweiler

Editorial Secretary: Bradie Guerrero

Editorial Offices: (201) 393-6272

Advertising Production: (201) 393-6093 or FAX (201) 393-0410

Production Manager: Michael McCabe
Production Assistants: Donna Marie Bright, Doris Carter, Eileen Slavinsky

Circulation Manager: Elaine Brown
Subscription Inquiries: Mary Lou Allerton (216) 696-7000

Promotion Manager: Clifford Meth

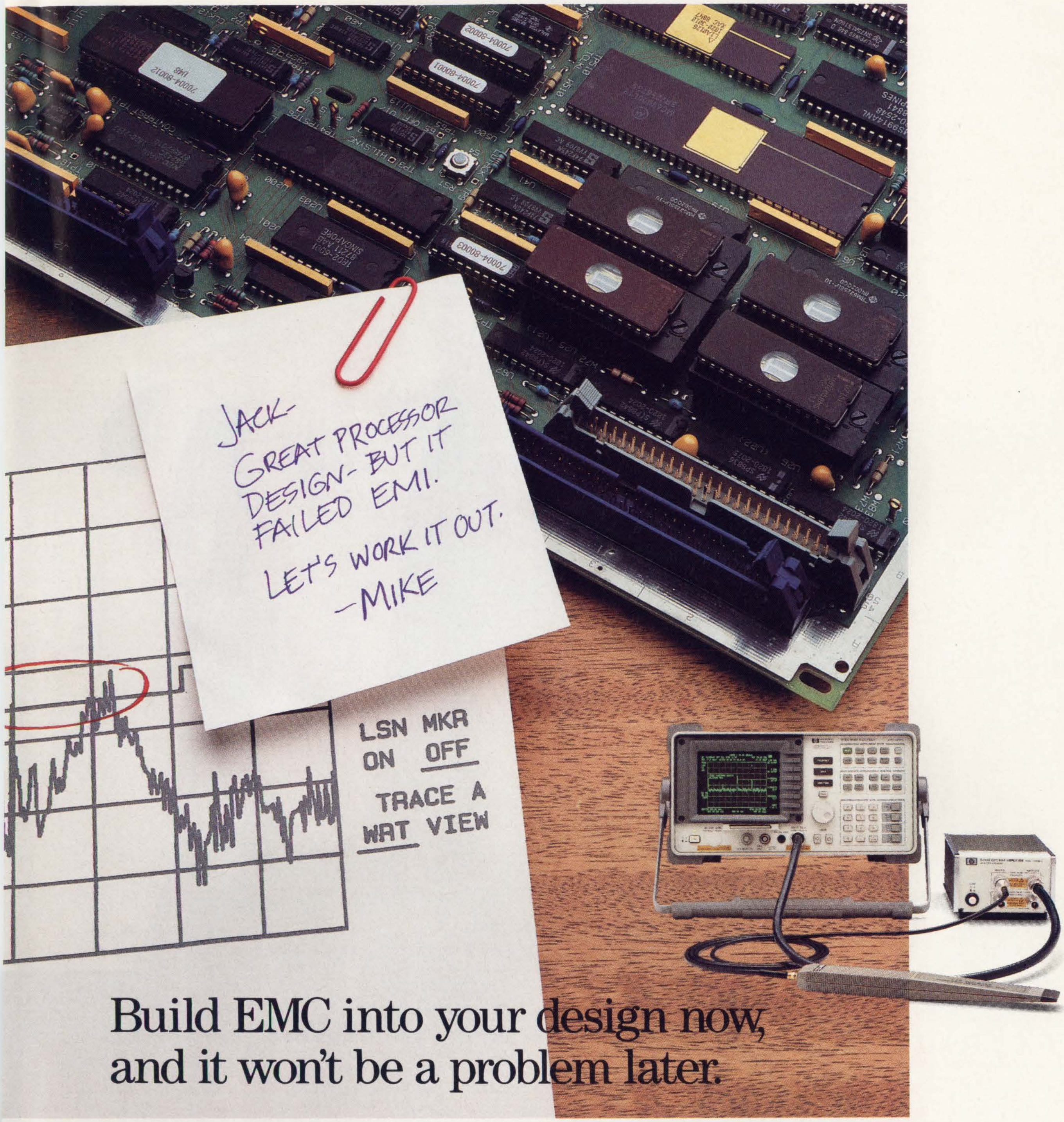
Reprints: Helen Ryan (201) 423-3600

Group Art Director: Peter K. Jeziorski

Computer Systems Administrator: Anne Gilio Turtoro

Published by Penton Publishing
Vice President-Editorial: Perry Pascarella
Group Editorial Director: Leland Teschler

Publisher: Paul C. Mazzacano



Build EMC into your design now, and it won't be a problem later.

With all the new regulations surrounding electromagnetic compatibility (EMC), the best way to avoid costly delays is to locate problems as early as possible. Two new HP EMC solutions make that easy.

The HP 84100A Design Development Solution helps you correct problem areas at the design stage. It pinpoints hot spots on breadboards and prototypes using a spectrum analyzer with software memory cards that simplify troubleshooting.

The HP 84110A Pre-Production Solution gives you added confidence that your designs will pass compliance. It has all the analysis capability, software and accessories you need to uncover conducted and radiated emission problems before final EMI testing.

So, find out how to build EMC into your designs. For information about HP's full line of EMC solutions and design training programs, call **1-800-752-0900.*** Ask for **Ext. 1351,** and we'll send you our EMC Measurement Solutions fact kit.

There is a better way.

HEWLETT PACKARD

CIRCLE 109

*In Canada, call 1-800-387-3867, Dept. 502

See Us At IEEE EMC Symposium, Booth 212 and 214

Now there's a smarter way to get a single-channel SCC.

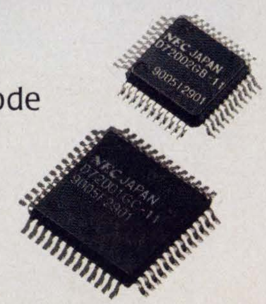
Cut a better deal with NEC's single-channel serial controller.

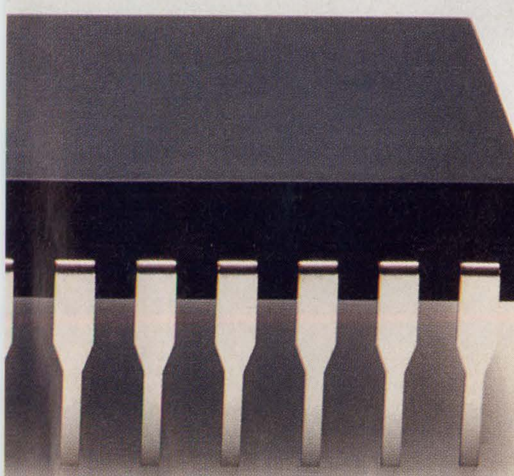
Successful engineers cut waste to create efficient designs. And we think it's pretty wasteful to buy a dual-channel serial communications controller when your system only uses one channel. That's why NEC developed the μPD72002, a single-channel version of our 72001 multi-protocol serial controller.

For single-channel data communications, our 72002 is the cost-efficient choice.

If you need two channels, our 72001 is a proven performer. Both devices offer advanced features, including:

- ☐ Functional superset of the 8530 SCC.
- ☐ SDLC/HDLC/SYNC/ASYNC protocol control.
- ☐ Two baud-rate generators per channel.
- ☐ A pair of transmit data-length registers per channel.
- ☐ Digital phase locked loop per channel.
- ☐ Speeds up to 2.5Mbps.
- ☐ 12.5MHz system clock.
- ☐ CMOS with standby mode for reduced power consumption.
- ☐ DIP, PLCC and plastic quad flat packages.





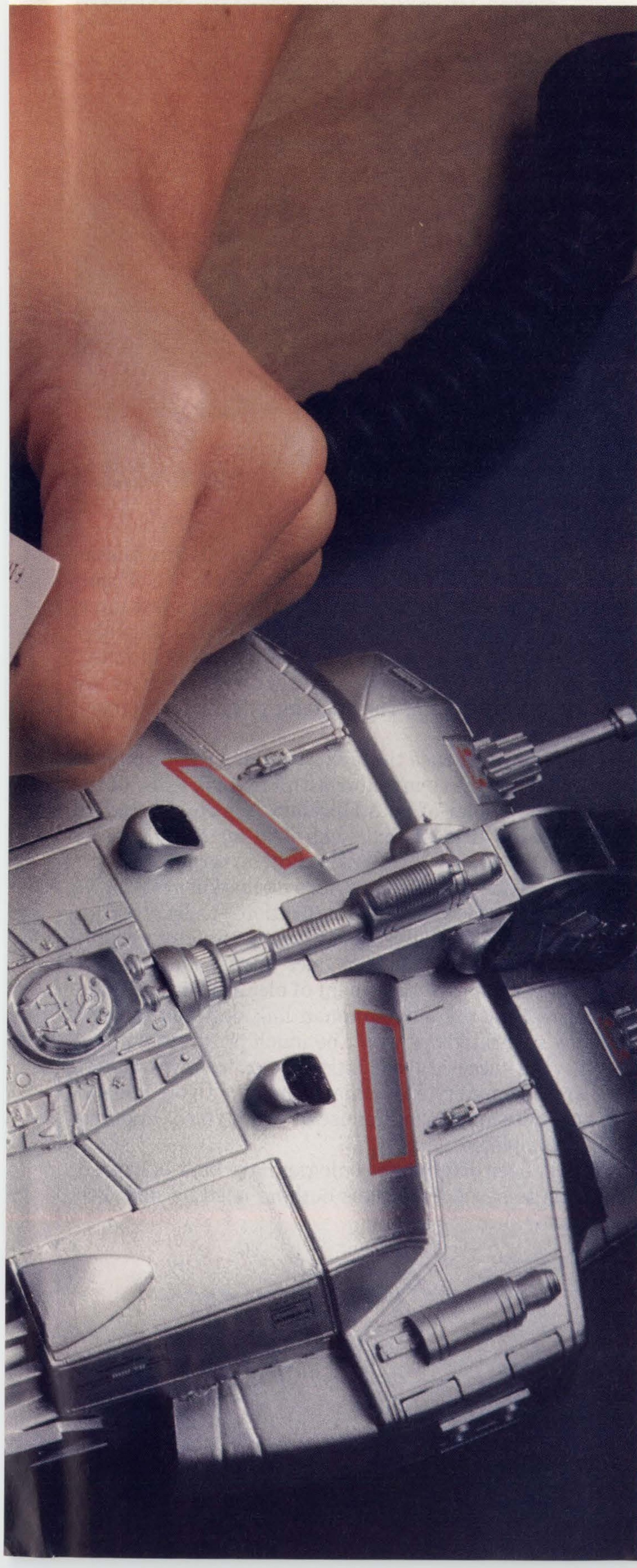
Our 72001/002 lineup gives you unique flexibility in meeting both cost and performance goals. For more information, contact NEC today.

NEC

CIRCLE 85

From Star Wars

to Price Wars



Our High Rel/Aerospace linear array experience is paying off for companies with high-volume, low-cost applications.

Symbol Technologies is a good example. A tiny Raytheon instrumentation amplifier helped them combine both bar code scanner and decoder in a single, lightweight, handheld unit—that's tough enough to take a five foot drop onto concrete.

Symbol also took advantage of our *Win-Win* program. It let them get to market quickly with a semicustom array, then shift to full custom as sales volumes increased.

Win-Win is fast, flexible, and makes good business sense because it eliminates the risk of getting into a full custom array before you're really ready.

Raytheon is committed to analog technology. From our design kits and engineering support to our fab and plastic assembly facility. We have the experience it takes to help you develop creative, cost effective solutions.

Find out how. Call **1-800 722-7074** for our new analog brochure.

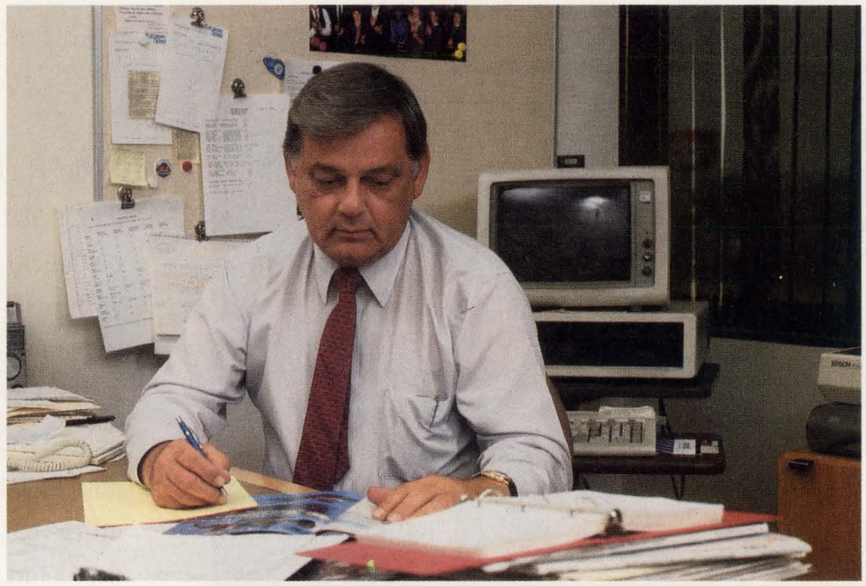
Raytheon Company, Semiconductor Division.
350 Ellis St., Mountain View, CA 94039.

CIRCLE 146

Raytheon

Where quality starts with fundamentals

EDITORIAL



NOYCE ON EDUCATION

It's already been a couple of months since Robert Noyce died in Austin, Texas, where he moved to direct operations at Sematech, the consortium for semiconductor manufacturing technology. Noyce's last interview may have been one of his most profound, published in the July/August, 1990 issue of Intel Corp.'s house organ "Microcomputer Solutions." Here he noted, among other things, "We need to decide now whether we are going to make an investment in education. The outcome of that decision will be with us for the next 40 to 50 years."

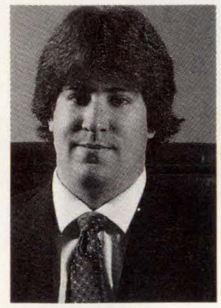
Few will deny that Robert Noyce earned the right to predict for the next 40 to 50 years. His achievements—as the co-inventor with TI's Jack Kilby of the integrated circuit and as a co-founder of both Fairchild Semiconductor and Intel Corp.—will be with us for at least that long. And his comments on education, albeit posthumously recorded, are again right on target.

With all due respect to the leaders of the American education system, we believe that few experts exist in the process of education—at least not as expert in the same sense that Noyce was an expert in semiconductor technology. Education is not a rigorous science, as is physics—cause and effect in people are not as predictable as, say, the movement of electrons in a conductor or semiconductor. Just about the only common link between the two disciplines is that, in today's world, there won't be much progress without large upfront investments. But successful education programs involve more than money. The home and community environment must actively support the education process, and there must be a promise of employment opportunity when the education is completed.

The tributes to Noyce have been offered, the eulogies have been delivered. What could possibly remain to be said? Perhaps nothing need be said. Perhaps what's needed is action.

Stephen E. Scrupski
Editor-in-Chief

Graphics Mature, But At What Price?



RICHARD NASS
COMPUTER SYSTEMS

Displays on graphics workstations are nearing the point where the improvements in resolution are can't be seen by the human eye. On the other hand, monitor manufacturers are struggling to keep up with rapidly rising pixel refresh rates now possible with higher-speed ICs. However, such performance improvements—higher resolution and faster refresh rates—are expensive. The question is: How much will users pay for this high performance? Makers of high-end graphics systems will be looking for conclusive evidence, one way or the other, as they display their wares at the Siggraph '90 Computer Graphics Conference, August 6th to the 10th, in Dallas, Texas.

In today's market, a 1280-by-1024 monitor's cost (about $3000) is about the most users seem willing to spend on a display. Units with a resolution as high as 2048-by-2048 pixels are available, but they still cost much more: up to $50,000 with today's technology, primarily because of expensive CRT technology. As manufacturers begin to supply users with alternative, potentially lower-cost monitor technologies, such as color LCD, high-res display prices should start to drop. This may even put added pressure on CRT developers to innovate lower-cost CRT technology.

Consequently, the next few years will see only those users who need high resolution move to 2048-by-2048 displays. Rather than higher resolution, the most significant improvements probably will be refinements in CRT design to improve overall display quality and convenience (such as flatter screens, shorter depths, etc.), or in high-resolution flat-panel screens, making them larger (greater than 15-in.-diagonal) at an affordable price.

For example, Dolch Computer Systems, San Jose, Calif., developed a mere 10-in. display with a resolution of 640 by 480, which represents a solid starting point for the active-matrix LCD technology. Using a thin-film transistor (TFT) method, the Dolch VGA-compatible display is a step above standard electroluminescent or gas-plasma displays. It boasts a contrast ratio of 100 to 1, five times that of conventional LCDs and a typical response time of just 40 ms, compared with the LCD's usual spec of 300 ms.

One key issue facing graphic-workstation designers is integrating different data-handling functions, such as image processing, volume rendering, and interactive graphics. Users typically would prefer to perform all of their graphic analyses on one system, rather than jump from one specialized system to another to get the optimum data-displaying method. Because the need for visualization and the amount of data that requires the integrated technologies has grown so rapidly, workstation makers had to turn integration from wishful thinking into reality.

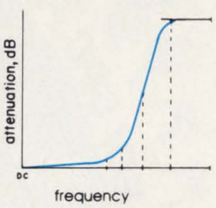
Another issue to be discussed at Siggraph involves tuning up the graphics processing system. Producing graphics involves more than just displaying an image. Many imaging requirements reside in a "graphics" environment in order to offload the CPU from graphic-specific tasks. As a result, it's free to handle memory and move data around quickly. The graphics processor then performs the graphics-oriented operations, such as zooming, panning, rotations, and clipping. Users are now finding that the bottleneck once located in the processor has shifted. Statistics indicate that up to 80% of computing time is spent processing I/O information to disks, peripherals, or to the graphics subsystem. The standard solution of increasing the processing power won't help ease the bottleneck. Therefore, it's likely that vendors will now focus their resources on increasing I/O performance. I/O specifications will be highlighted instead of the MIPS that are always tossed about. And because the high number of MIPS can't be utilized effectively, those numbers may be leveling off.

FILTERS

dc to 3GHz *from* $11^{45}

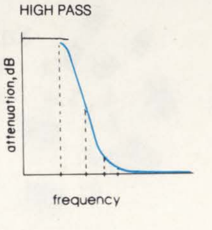
lowpass, highpass, bandpass, narrowband IF

- less than 1dB insertion loss • greater than 40dB stopband rejection
- 5-section, 30dB/octave rolloff • VSWR less than 1.7 (typ) • meets MIL-STD-202 tests
- rugged hermetically-sealed pin models • BNC, Type N; SMA available
- surface-mount • over 100 off-the-shelf models • immediate delivery



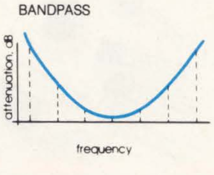
low pass dc to 1200MHz

MODEL NO.	PASSBAND, MHz (loss <1dB) Min.	fco, MHz (loss 3db) Nom.	STOP BAND, MHz (loss>20dB) Max.	(loss>40dB) Max.	Min.	VSWR passband typ.	stopband typ.	PRICE $ Qty. (1-9)
PLP-10.7	DC-11	14	19	24	200	1.7	18	11.45
PLP-21.4	DC-22	24.5	32	41	200	1.7	18	11.45
PLP-30	DC-32	35	47	61	200	1.7	18	11.45
PLP-50	DC-48	55	70	90	200	1.7	18	11.45
PLP-70	DC-60	67	90	117	300	1.7	18	11.45
PLP-100	DC-98	108	146	189	400	1.7	18	11.45
PLP-150	DC-140	155	210	300	600	1.7	18	11.45
PLP-200	DC-190	210	290	390	800	1.7	18	11.45
PLP-250	DC-225	250	320	400	1200	1.7	18	11.45
PLP-300	DC-270	297	410	550	1200	1.7	18	11.45
PLP-450	DC-400	440	580	750	1800	1.7	18	11.45
PLP-550	DC-520	570	750	920	2000	1.7	18	11.45
PLP-600	DC-580	640	840	1120	2000	1.7	18	11.45
PLP-750	DC-700	770	1000	1300	2000	1.7	18	11.45
PLP-800	DC-720	800	1080	1400	2000	1.7	18	11.45
PLP-850	DC-780	850	1100	1400	2000	1.7	18	11.45
PLP-1000	DC-900	990	1340	1750	2000	1.7	18	11.45
PLP-1200	DC-1000	1200	1620	2100	2500	1.7	18	11.45



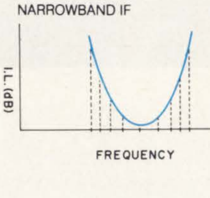
high pass dc to 2500MHz

MODEL NO.	PASSBAND, MHz (loss <1dB) Min.	Min.	fco, MHz (loss 3db) Nom.	STOP BAND, MHz (loss>20dB) Min.	(loss>40dB) Min.	VSWR passband typ.	stopband typ.	PRICE $ Qty. (1-9)
PHP-50	41	200	37	26	20	1.5	17	14.95
PHP-100	90	400	82	55	40	1.5	17	14.95
PHP-150	133	600	120	95	70	1.8	17	14.95
PHP-175	160	800	140	105	70	1.5	17	14.95
PHP-200	185	800	164	116	90	1.6	17	14.95
PHP-250	225	1200	205	150	100	1.3	17	14.95
PHP-300	290	1200	245	190	145	1.7	17	14.95
PHP-400	395	1600	360	290	210	1.7	17	14.95
PHP-500	500	1600	454	365	280	1.9	17	14.95
PHP-600	600	1600	545	440	350	2.0	17	14.95
PHP-700	700	1800	640	520	400	1.6	17	14.95
PHP-800	780	2000	710	570	445	2.1	17	14.95
PHP-900	910	2100	820	660	520	1.8	17	14.95
PHP-1000	1000	2200	900	720	550	1.9	17	14.95



bandpass 20 to 70MHz

MODEL NO.	CENTER FREQ. MHz F0	PASS BAND, MHz (loss <1dB) Max. F1	Min. F2	STOP BAND, MHz (loss > 10 dB) Min. F3	Max. F4	(loss > 20 dB) Min. F5	Max. F6	VSWR 1.3:1 typ. total band MHz	PRICE $ Qty. (1-9)
PIF-21.4	21.4	18	25	4.9	85	1.3	150	DC-220	14.95
PIF-30	30	25	35	7	120	1.9	210	DC-330	14.95
PIF-40	42	35	49	10	168	2.6	300	DC-400	14.95
PIF-50	50	41	58	11.5	200	3.1	350	DC-440	14.95
PIF-60	60	50	70	14	240	3.8	400	DC-500	14.95
PIF-70	70	58	82	16	280	4.4	490	DC-550	14.95



narrowband IF

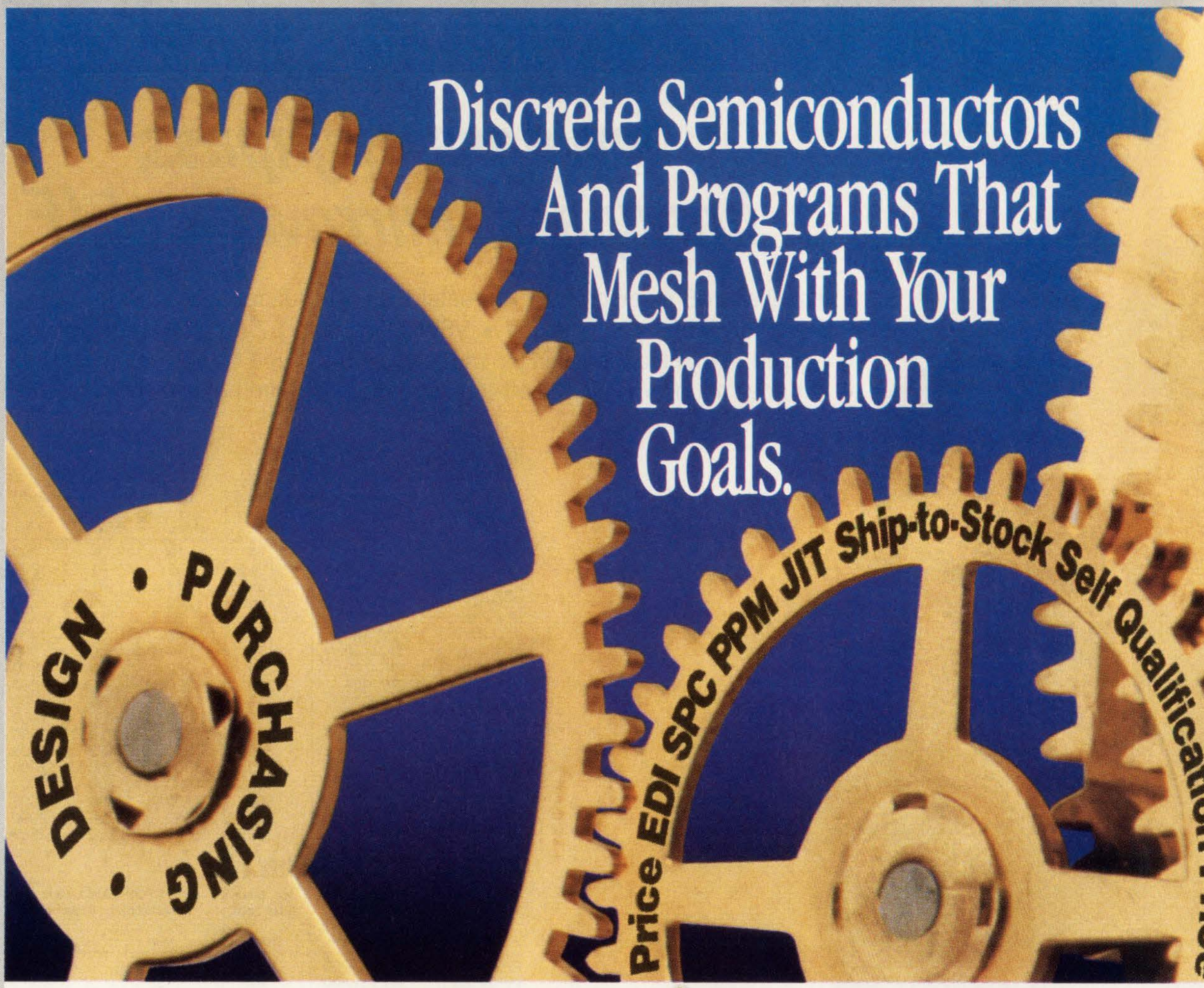
MODEL NO.	CENTER FREQ. MHz F0	PASS BAND, MHz I.L. 1.5dB max. F1-F2	STOP BAND, MHz I.L. > 20dB F5	F6	STOP BAND, MHz I.L. > 35dB F7	F8-F9	PASS-BAND VSWR Max.	PRICE $ Qty. (1-9)
PBP-10.7	10.7	9.5-11.5	7.5	15	0.6	50-1000	1.7	18.95
PBP-21.4	21.4	19.2-23.6	15.5	29	3.0	80-1000	1.7	18.95
PBP-30	30.0	27.0-33.0	22	40	3.2	99-1000	1.7	18.95
PBP-60	60.0	55.0-67.0	44	79	4.6	190-1000	1.7	18.95
PBP-70	70.0	63.0-77.0	51	94	6	193-1000	1.7	18.95

Mini-Circuits

P.O. BOX 350166, Brooklyn, New York 11235-0003 (718) 934-4500 FAX (718) 332-4661 TELEX 6852844 or 620156 **WE ACCEPT AMERICAN EXPRESS**

CIRCLE 103

F132-2 REV. ORIG.



Whether you design, specify or manufacture, one discrete semiconductor source simplifies your decisions. And cuts your costs. It's Philips Components Discrete Products Division.

We'll provide you with more than the broadest lineup of high-performance discrete semiconductors in all standard metal, plastic and glass packages.

You can count on Philips Components to help you improve design-to-development efficiency. To help you reduce time and costs—with SPC, JIT, Ship-to-Stock, EDI, PPM.

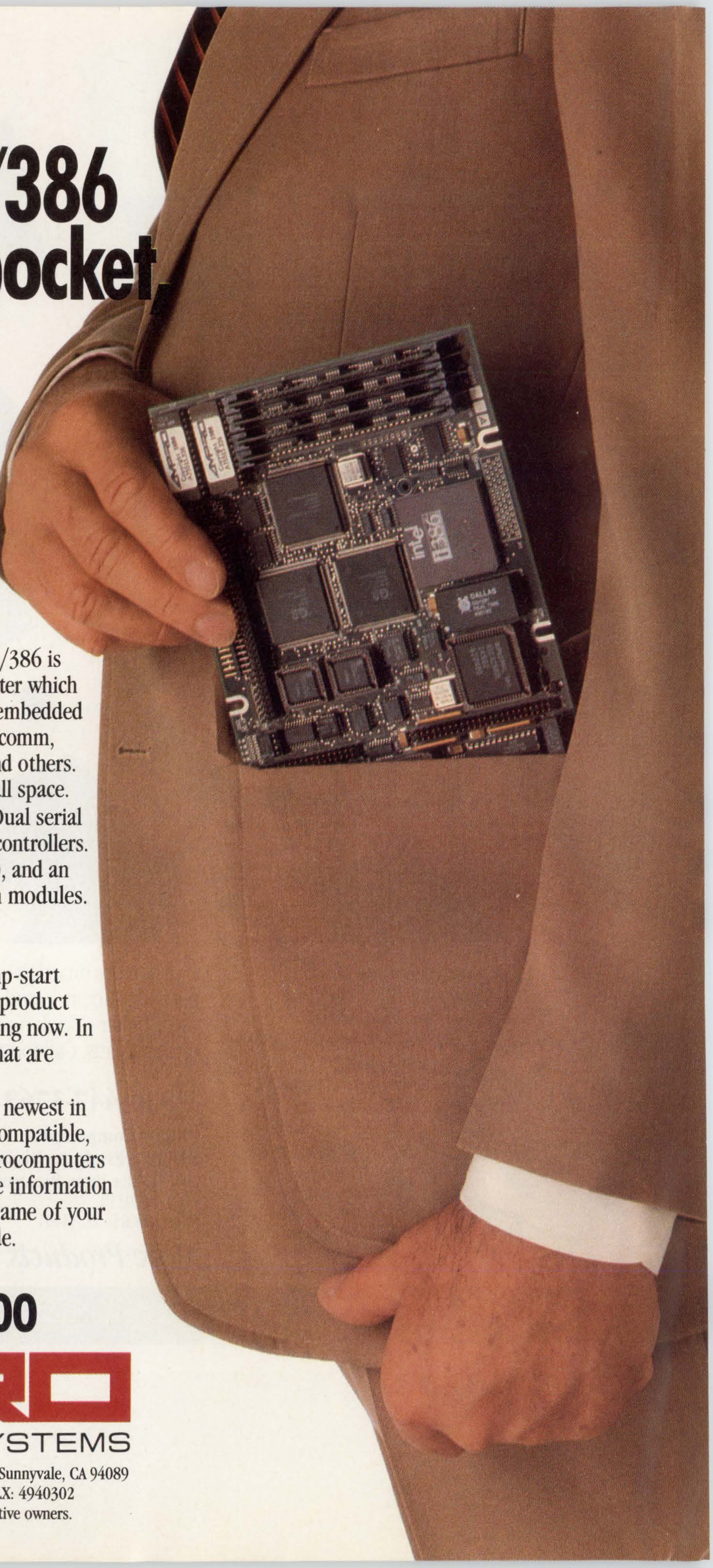
Surface Mount Switching Diodes & Transistors • Bandswitch & Varicap Diodes Schottky Diodes • Rectifier Diodes Reference & Zener Diodes • Darlingtons RF & Broadband Transistors • FETs Temperature Sensors

Small Signal Switching Diodes & Transistors • Bandswitch & Varicap Diodes • Schottky Diodes Reference & Zener Diodes • High Voltage Transistors • Darlingtons FETs • RF & Broadband Transistors Optocouplers

Philips Components


MANUFACTURING • MANUFACTURING •

If the new Little Board™/386 fits in your pocket, think how it would fit in your product.



Big power. Small package. Little Board/386 is a complete, 32-bit, 20MHz, 80386 computer which occupies just 5.75″ X 8″. It's perfect for embedded applications such as instrumentation, telecomm, network servers, data acquisition, CAM and others. Anywhere that you need big power in small space.

A complete 386.™ 1 or 4 Mbytes DRAM. Dual serial ports and parallel port. Floppy and SCSI controllers. Plus solid state disk (EPROM or NovRAM), and an expanding list of MiniModule™ expansion modules. You can even add standard PC and AT form factor boards.

Priced right. Little Board/386 can jump-start you in 386-based, embedded-processor product development. Little Board/386 is shipping now. In quantity. And, we can deliver at prices that are more than competitive.

Answers. Now. Little Board/386 is the newest in our complete family of IBM PC and AT-compatible, single board systems. If you embed microcomputers in your products, call today for complete information on Little Boards, MiniModules and the name of your nearest Ampro representative. Worldwide.

Call Toll Free:

1-800-966-5200

AMPRO

SINGLE BOARD SYSTEMS

Ampro Computers, Inc., 1130 Mountain View/Alviso Rd., Sunnyvale, CA 94089
TEL: (408) 734-2800. FAX: (408) 734-2939. TLX: 4940302

All trade marks are the property of their respective owners.

CIRCLE 149

ELECTRONIC DESIGN

QUICK LOOK

EDITED BY SHERRIE VAN TYLE

1-MINUTE OPINIONS

Is the IEEE truly serving its membership?

I've been an IEEE member for 12-plus years now, with no regrets at all. There is a lot of voluntary work involved, so you can't complain too much. Some of the publications are great; I have a large pile that I haven't read through. There are a lot of academic papers—I would like to see more practical examples that I can immediately come to grips with and apply in my work. **James D. Traill**, *Tokyo, Japan*

For a not-for-profit organization with so many volunteers in different societies, I believe IEEE is serving its membership. I do not mean that there is no room for improvement. However, in the local chapter that I belonged to, there are so many workshops and seminars—from how to grow in your own profession to how to start your own business. A lot of time and energy has been put in by those volunteer organizers. It is a self-service organization. I don't think it is fair to lay back and say that it didn't serve me well enough. **Janpu Hou**, *Bridgewater, N. J.*

What is the goal of the IEEE? Is it to help distribute information and push forward technology? I think that these are the goals of the IEEE and the IEEE is doing fine on these goals. I do not feel that the IEEE needs to be a union for engineers; nor should there be a union for engineers. **Richard Lokken**, *Milwaukee, Wis.*

Instead of surveys and public opinion polls, which seem to have the intent of IEEE bashing, you would serve your engineering readers better by sending your writers out to report the actions taken by IEEE PACE groups.

How can your readers know that despite any hearsay resulting from the previous reputation of the IEEE, that there are volunteers working within the IEEE structure to help the "working" engineers, including the unemployed? The tone set by your magazine in both "1-Minute Opinion?" and the career survey is such that it debases the efforts of the IEEE volunteers.

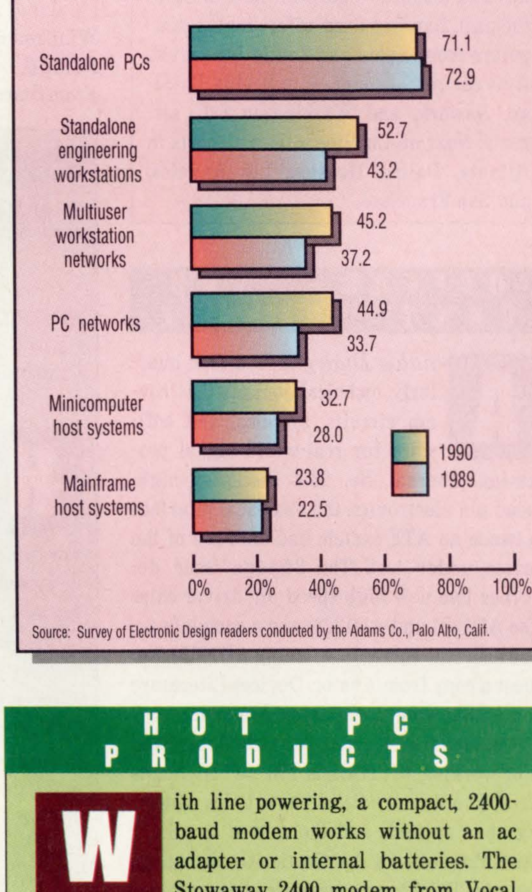
In addition to the EA, the IEEE has on-line services for jobs. It has a national network, plus local BBS services, which on Long Island include a message area: "jobs for L.I. engineers." A number of IEEE volunteers have been fighting what they call ESP—engineering shortage propaganda. We have other groups—the Consultants Network, the Retired Engineers, and the group that I chair: the Small Business Development Group for engineering entrepreneurs and engineer-owned businesses.

Remember, the IEEE is a volunteer organization. Anyone with a complaint about what the IEEE does (or does not do) needs only to become an active mem er to be able to participate with us in improving the member services. **Marlene S. Farber**, *East Meadow, L. I.*

What's your opinion on the IEEE? ... or how about the importance of analog design skills ... or the quality of today's EE graduates. See the table of contents (p. 5) for a complete list of questions and fax your opinions to (201) 393-0637. Or mail your opinions to Quick Look, Electronic Design, 611 Route 46 W, Hasbrouck Heights, NJ 07604.

CAE SURVEY

Which systems do you use for automated design (including CAE or CAD), 1990 vs. 1989?



Source: Survey of Electronic Design readers conducted by the Adams Co., Palo Alto, Calif.

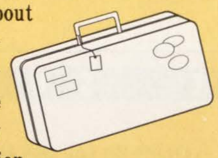
HOT PC PRODUCTS

With line powering, a compact, 2400-baud modem works without an ac adapter or internal batteries. The Stowaway 2400 modem from Vocal Techologies Ltd. instead derives power from its serial port connection to a computer and from the phone line, which is how conventional telephones operate. Compatible with the AT command set, the modem, which has dimensions of 2.2 in. by 3 in., slides easily into a shirt pocket or the pouch for a laptop or notebook computer.

Because it can be tucked behind other equipment and doesn't need to be monitored, the modem also may find use in embedded applications. The Stowaway 2400, which sells for $295, is available from Vocal Technologies, 3032 Scott Blvd., Santa Clara, CA 95054; phone (408) 980-5181; fax (408) 980-8709.

TIPS ON TRAVEL

• **MAKE** productive use of downtime in the airport or during in-room time at your hotel. More and more hotels, like the Radisson in Irvine, Calif., offer computers and peripheral equipment for rent; special phones in the rooms ease modem connection. When booking a room, check with the particular hotel about computer facilities—reservationists at toll-free numbers rarely have this information.



• **LUGGING** a portable computer through airports could well be a thing of the past. LapStop Corp. offers laptop computers from Apple and Zenith for rent at Avis car rental counters in Boston, Chicago, Newark, and Washington D.C. airports. Next on LapStop's list—airports in Atlanta, Dallas, Houston, Los Angeles, and San Francisco.

BEST SELLERS

Which technical books are the most popular in Silicon Valley?

ELECTRONICS:

1. *SPICE: A Guide to Circuit Simulation and Analysis Using PSPICE.* Paul Tuinenga. Prentice-Hall, 1988. ***$21.***
2. *Noise Reduction Techniques in Electronic Systems*, 2nd ed. Henry W. Oh. Wiley, 1988. ***$42.95.***
3. *Microelectronics Packaging Handbook.* Rao R. Tummala, Eugene Rymaszewski. Van Nostrand-Reinhold. ***$94.95***
4. *Logic Design Principles.* Edward McClusky. Prentice-Hall, 1986. ***$58.60.***
5. *Art of Electronics.* Paul Horowitz, Winifred Hill. Cambridge University Press. ***$49.50.***

COMPUTER SCIENCE:

1. *Object-oriented Analysis.* Peter Coad and Edward Yourdan. Prentice-Hall, 1990. ***$29.80.***
2. *Object-oriented Design with Applications.* Grady Booch. Addison-Wesley, 1990. ***$37.25.***
3. *Envisioning Information.* Edward R. Tufte. Graphics Press, 1990. ***$48.***
4. *Computer Architecture: A Quantitative Approach.* John L. Hennessy and David A. Paterson. Morgan Kaufman, 1990. ***$54.95.***
5. *A Practical Guide to Structured Systems Design*, 2nd ed. Meilir Page-Jones, Prentice-Hall, 1988. ***$39.***

From Stacey's Bookstore, 219 University, Palo Alto, CA 94301; (415) 326-0681.

OFFERS YOU CAN'T REFUSE

Analog Dialogue is a free quarterly technical journal that covers circuits, systems, and software for real-world signal processing. Journal No. 23-4 discusses high-speed pin electronics, the electrical interface between an ATE system and each pin of the device under test. The 24-page issue describes two new high-speed pin driver chips (the AD1321 and AD1322) and a complete active load (the current-switching AD1315). Request a copy from Analog Devices Literature Center, Shawmut Rd., Canton, MA 02021.

Another free journal, for those interested in or working with OSI, is *The SPAG Standard.* The spring edition has articles on testing open systems and the role of the Standards Promotion & Application Group in open systems. The 12-page issue also has a glossary, which spells out 27 of the myriad abbreviations in the world of standards and OSI. For a copy, contact Karen Garside, SPAG sa, Avenue Louise 149, Box 7, 1050 Brussels, Belgium; phone (32) 2 5350811; fax (32) 2 5372440.

A new version of Motorola Inc.'s Data Disk has information on more than 13,000 of the company's ICs and components. The database, contained on a floppy disk, also has cross-references to 25,000 competitive devices. The free disk is available in IBM PC and Macintosh formats. Contact Motorola Data Disk Literature Distribution Center, P. O. Box 20924, Phoenix, AZ 85063; (800) 521-6274.

KMET'S KORNER

...Perspectives on Time-to-Market

BY RON KMETOVICZ
President, Time to Market Associates Inc.
Cupertino, Calif.; (408) 446-4458

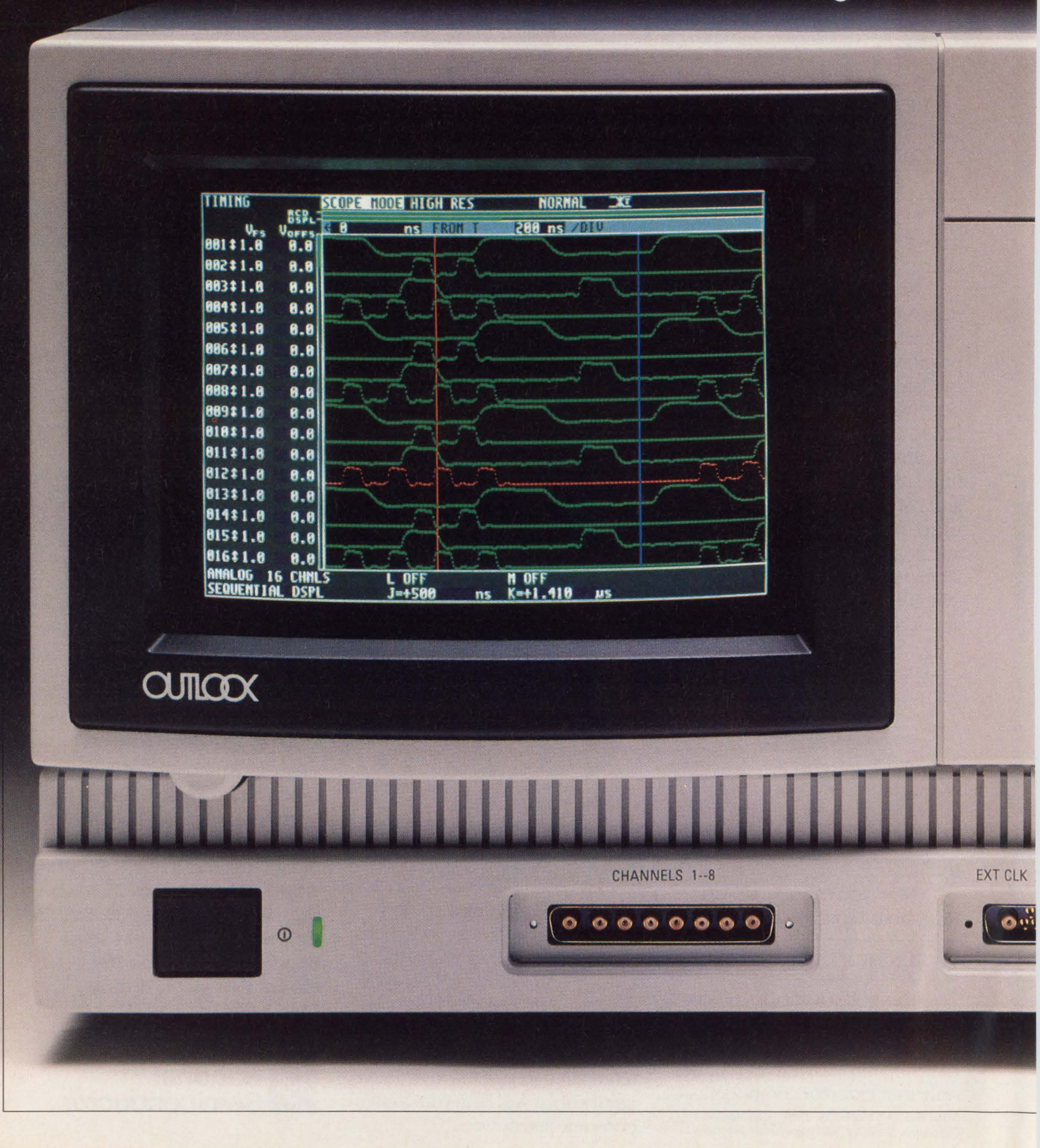
Having discussed first-of-a-kind, me-too-with-a-twist, and derivative classifications for new products, now I turn to next-generation products. These replace an aging product family that has little room left for market growth and that is being picked apart by the competition. For these products, time to market (TTM) is a prime concern. TTM shouldn't be so short that new products appear before they are needed, nor too long so that products reach the market too late.

Care must be taken to offer new capabilities, not just a smaller, faster, and less expensive version of the original. Next-generation products need to be in tune with the overall market, not merely redesigned versions of their predecessors! In all cases that I've studied, TTM was longer and engineering effort (number of person months) was higher on the next-generation product than on the first-of-a-kind effort. This suggests that a starting point for an estimate of TTM for a next-generation product is that it should least equal that of the TTM of the product about to be replaced.

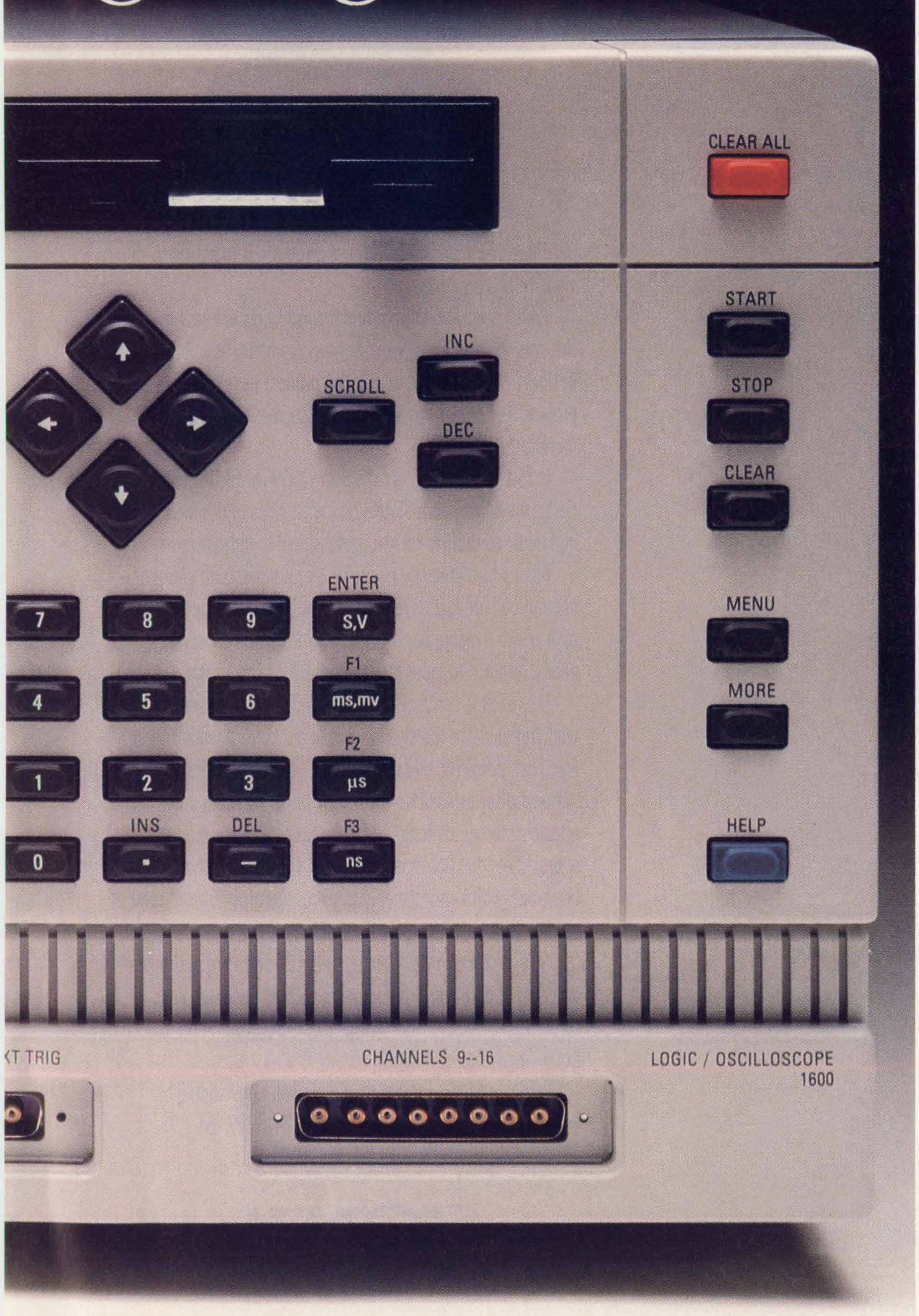
Often, improved competitiveness results because next-generation efforts move the entire organization in a new direction. With a next-generation program, Xerox reduced its dependence on a large number of material suppliers and established new manufacturing capability. Hewlett-Packard draws on technology from all over the world to maximize its efforts in laser printers. Apple, IBM, NCR, and TI have used next-generation efforts to integrate, fuse, and develop design-for-manufacturing and computer-integrated-manufacturing processes and systems. Cooperative alliances and development of next- generation products seem to be this year's hot strategic business issue.

Describing next-generation products is relatively easy since prior product descriptions already exist and data has been collected from the marketplace over the years. Likewise, knowledge about customer desires and the competition is highest for this type of product; in fact, next-generation products are often pulled into the market. Information culled from the market feeds the product-development process, creating a product that meets requirements set by the market. It is usually very clear to the development team what has to be done, but usually not too clear how to achieve project objectives. For this reason, next-generation efforts tend to produce major gains in an organization's tactical and logistical performance.

For 17 years you've been better look at your



trying to get a logic signals.



Sorry you had to wait so long.

Introducing the Model 1600 Logic/Oscilloscope

Now you can clearly see logic timing problems in analog form across as many as 160 channels—with logic analyzer triggering.

Look at both time alignment and signal fidelity simultaneously on lots of channels, and solve all kinds of measurement problems. Bus monitoring, for computers and peripherals. Termination problems. Ringing. Overshoot. Rise and fall times. Set-up and hold times.

And now, finally, you can test and time-align high channel-count test equipment. Calibration labs can now test and verify their ATE systems and ASIC verification systems.

The Logic/Oscilloscope lets you see it all, in exactly the format you want, with one machine. One screen. One group of parameters. One set of probes.

Display any channel, any place, relative to any other channel you want. Overlap two or more waveforms for easy comparison, and differentiate them in eight colors.

Easy-to-understand screens, prompted functions and a "Help" key make it easy to set up and take measurements without ever opening the manual.

Call (408) 374-2990 now and find out how to get a good look at the new Model 1600 Logic/Oscilloscope from Outlook.

You've waited long enough.

CIRCLE 121

OUTLOOK

Outlook Technology, Inc.
200 E. Hacienda Avenue, Campbell, CA 95008
Telephone (408) 374-2990 FAX (408) 374-9273

The way we build workstations, you'd think we had to use them ourselves.

We do.

There's nothing like some real world proof to establish the viability of a product.

Which is why you might find it comforting to know that the Sony NEWS® line of workstations are being used by real designers. On real chip, board, and product development projects. For one of the world's most successful electronics manufacturers: Sony.

In fact, Sony engineers are using NEWS workstations to design everything from SRAMs and other chips to advanced video and audio controllers for the professional broadcast markets.

All of which uniquely positions us to understand your engineering and product development needs. Because here is a case where the supplier is acutely aware of the consumer's needs. And has to meet those needs. On a daily basis.

The result is our very affordable NEWS 3710 desktop workstations—the latest additions to our current workstation line. Fast, powerful, and expandable, these R3000®-based systems offer extensive memory plus high capacity, cost-effective storage options—including Sony's unique magneto optical drives and DAT tapes. Of course, you can choose the black-and-white, grayscale, or high-resolution Trinitron® color monitor that best fits your application.

We even have most of the popular EDA software packages—including applications from vendors such as Cadence, Valid Logic, Data I/O, Synopsys, Racal-Redac, Silvaco and an ever-expanding roster of others.*

To find out more about why Sony's solutions should be your solutions, give us a call at 1-800-624-8999, ext. #96.

Then just sit back and watch the NEWS.

CIRCLE 100

SONY®

Sony Microsystems Company

Sony Microsystems Company, 651 River Oaks Parkway, San Jose, CA 95134 (408) 434-6644 FAX: (408) 954-0849 • Sony of Canada, Ltd., Ontario, Phone: (416) 499-1414 FAX: (416) 497-1774 • Sony Microsystems Europe, Koln, Phone: (0221) 59 30 42 FAX: (0221) 59 35 42 • Sony (Australia) Pty., Ltd., N.S.W., Phone: (02) 887-6666 FAX: (02) 887-4351 • International Sales Division, Tokyo, Phone: (03) 448-4041 FAX: (03) 448-4043 • *Some of the software mentioned herein may not be available for all NEWS models or for worldwide distribution. Call your Sony representative to check for availability.

MOLDING COMPOUNDS HASTEN IC DEMISE

An important cause in the degradation of the intermetallic region of the gold-wire-to-aluminum-bonding-pad interface has been identified in several types of IC devices. In a paper presented at the International Reliability Physics Symposium in New Orleans in March, it was reported that antimony trioxide—a common component of semiconductor molding compounds—is the overriding factor in causing "ball lift," leading to a near-complete loss of bond strength. The test results, reported by scientists from Dexter Electronic Materials, Olean, N.Y., contrast sharply with earlier reports that antimony trioxide improves wire-bond reliability in dry environments. Dexter disclosed that the commonly used substance actually weakens many molding compounds. Using ion-scavenging additives with specific types of flame retardants solves the problem. Dexter's scientists believe that their test procedures will help screen molding compounds and benefit many applications. DM

ASIC MAKERS PROMOTE STANDARD TEST PORT

Several leading ASIC suppliers have formed a specification group to enhance and promote a standard test-access port for on-chip test structures developed by CrossCheck Technology Inc., San Jose, Calif. The group's first meeting discussed how to improve and extend the test circuitry while ensuring compatibility with independently developed application software tools, such as fault-simulation and automatic-test-pattern-generation (ATPG) programs. With a standard port, ASIC designers could use the same application software to design ASICs with different suppliers. Members include Fujitsu Ltd., Harris Semiconductor Corp., LSI Logic Corp., and Raytheon Co. The group, all of which are licensees of CrossCheck technology, decided that the test port should be usable as a standalone port or with the IEEE-1149.1 test-access port for board testing. The patented test structure is a grid with many test points embedded in the ASIC's base array. Using the grid and specially developed ATPG software, designers can get faster high fault coverage than with conventional techniques. JN

SERVER BRINGS BACK MINI MEMORIES

The recently announced VAX 4000 model 300 "server" from Maynard, Mass.-based Digital Equipment Corp., closely resembles the minicomputer of yesteryear. The VAX is the first that DEC designed and optimized specifically for client-server operation, coming on the heels of the company's proclamation that client-server computing will rule in the 1990s. Fully compatible with other members of the VAX family, the server can utilize the extensive library of existing application software. The pedestal-enclosure machine occupies less than 20 $ft.^2$ and doesn't require any special air conditioning or a separate computer room. Systems start at $127,000. The server, as well other products, were announced at DECWorld '90. RN

SMARTMODELS RUN SIMULATIONS WITH MAX

Board-level simulation with the Max family of erasable programmable logic chips from Altera Corp., San Jose, Calif., has just become possible thanks to behavioral software models created for the EPLDs. The simulation models, called SmartModels, from Logic Automation Inc., Beaverton, Ore., enable designers to simulate the EPLDs as standalone devices and simulate the entire system, into which the EPLDs are inserted. One option available for the models is a "window" feature that allows designers to view some of the inner workings of the EPLDs. With the window viewports, designers can set breakpoints, single-step through instructions, change register values, and group various registers or bits together to form a cluster that can be observed as one entity. SmartModels will be available next quarter for the four current Max family members, and for two soon-to-be-released additions to the Max EPLD family. Contact Rick Denker at Logic Automation, (503) 690-6900. DB

HDTV'S FIRST IMPACT TO HIT COMPUTER INDUSTRY

ACM Siggraph, the Association of Computing Machinery's Special Interest Group on Computer Graphics, forecasts a greater emphasis on computer graphics applications as high-definition television (HDTV) shifts into niche markets. According to ACM's report, "HDTV & the Quest for Virtual Reality," HDTV will influence the evolution of desktop workstations significantly. According to the study, HDTV and workstation designers must replace bulky CRT screens with flat-panel displays, and adapt to higher-capacity communications channels. The study examines the current state of HDTV hardware and the probable future direction of the technology and its marketplace. The study, which was recorded on videotape, serves as a buying and planning guide for users with production and closed-circuit applications. It offers manufacturers, programmers, and educators a thought-provoking analysis and forecast of the HDTV movement. Also, the debate on standards, program delivery, and interactivity is addressed. The report was released at the Siggraph '90 conference. For information on obtaining the tape, call (800) 523-5503. RN

Spice Model Creates Better GaAs ICs

By correcting several deficiencies in existing models, a new Spice model allows designers to more accurately represent GaAs metal-semiconductor field-effect transistors (MESFETs). For instance, in most existing Spice models (like Raytheon-Statz Spice models), the correct drain conductance can be predicted only for a small range of drain current values. The new model, developed by TriQuint Semiconductor Inc., Beaverton, Ore., rectifies this problem by making pinch-off voltage a function of drain voltage, and by correcting self-heating more efficiently. It also incorporates several features unique to GaAs technology, and more accurately predicts small-signal parameters over many bias conditions. As a result, the improved model delivers more realistic results for gain compression and other nonlinear parameters. The model is available now to TriQuint customers, and may soon be included with commercial Spice programs. For more information, call (503) 644-3535. LG

Megabit Flash EPROM Performs Sector Erase

Unlike the simple flash memory chips that just erase the entire chip, a 1-Mbit flash memory's space divided into 128 sectors of 1 kbyte each. Each sector of the 128-kword-by-8-bit memory from Philips Components-Signetics Corp., Sunnyvale, Calif., can be erased and rewritten independently. The entire chip can also be erased, as is the case with the simpler chips. The 48F010 is the first flash memory chip from Philips-Signetics to come as a result of a technology-sharing agreement inked between Seeq Technology Inc., San Jose, Calif., and Philips in the fall of 1989. Philips is an alternate source for the previously released Seeq megabit flash memory. Data in the 48F010 can be read in 200, 250, or 300 ns (depending on the speed grade), and can be stored in just 0.5 ms/byte. The 48F010 requires a 12-V supply for the erase/program cycle and can endure 100 such cycles; screening can yield units with 1000-cycle ratings. Future chip versions will be able to endure up to 10,000 erase-program cycles. DB

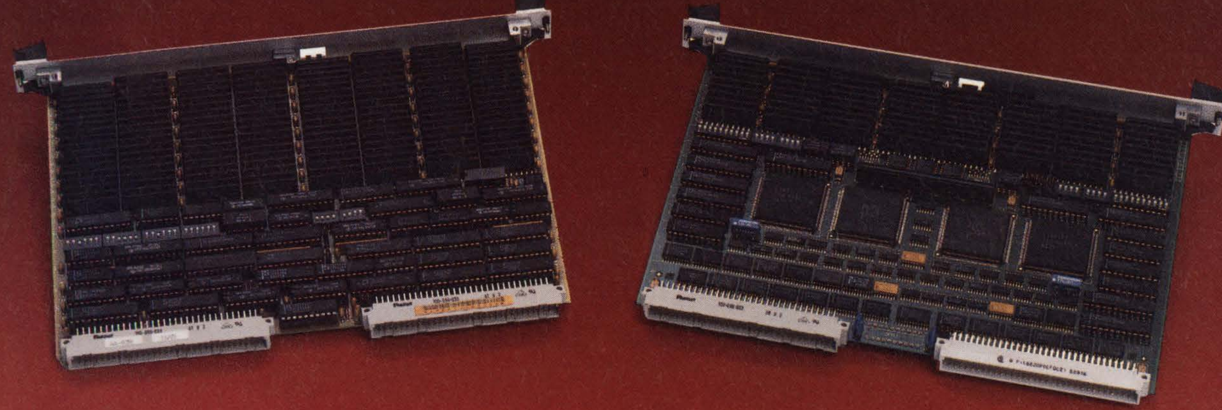
Process Merges Tungsten Deposition, Etchback

An integrated metallization system to create interconnections, or vias, between metal layers in multimetal layer ICs has been developed to reduce wafer-processing cycle time and particle-induced defects. The system, developed by Applied Materials Inc., Santa Clara, Calif., combines chemical vapor deposition (CVD) of tungsten with tungsten etchback and maintains the wafer under vacuum throughout the processing sequence to avoid airborne contaminants. After receiving the CVD tungsten deposition, the wafer is then transferred to the etchback chamber where a magnetically enhanced reactive ion etching removes the tungsten blanket at a rate greater than 7000 A/min., but leaves tungsten in the contacts or via holes. At this point, the etch system removes any residual tungsten and the adhesion layer on the oxide surface using a highly selective overetch step. To prevent plug recess, the system—called the Precision 5000 WCVD—uses an end-point-detection scheme based on multiline optical emission. This detects the interface between the blanket tungsten film and the underlying adhesion layer. ML

Submicron BiCMOS Packs 300 Kgates/Chip

A next-generation biCMOS process with drawn features as small as 0.8 μm makes it possible to pack 300,000 gates on a chip. Up to 120,000 ECL gates (including embedded RAMs), or 200,000 to 300,000 biCMOS gates, as well as mixed ECL, TTL, or CMOS I/Os can be integrated. Dubbed ABIC IV (advanced biCMOS IV) by its creator, National Semiconductor Corp., Santa Clara, Calif., the process can implement loaded ECL gates with delays as short as 50 ps, biCMOS gates with delays of less than 200 ps, and CMOS gates with loaded delays of about 400 ps. The process employs twin buried layers and double-diffused npn transistors to get 15-GHz cutoff frequencies for the bipolar devices. In addition, contactless self-aligned structures with polysilicon sidewall silicidation are used. Silicide also coats the source, drain, gate, base, and emitter regions to reduce contact resistances. Short polysilicon local interconnections are also silicided. Tungsten plugs are used in the dielectric contact holes between metal layers so that subsequent metal layers are deposited on planar surfaces, thus eliminating step-coverage problems. With the planar layers, four levels of metal can be used for device interconnections, resulting in high wiring densities. DB

The Highest Density, Fastest, VME-Compatible Memory



Clearpoint, of course!

Advanced Chip Technology and Design

Get up to 64 MB of fast, VME-compatible memory in a single slot. Designed with state-of-the-art 4 Mb DRAM technology, Clearpoint's VMERAM-FP1 assures higher reliability through lower component count. Each of Clearpoint's VME-compatible boards supports all VMEbus addressing and data transfer types–block mode (BLT), unaligned (UAT), and address only (ADO).

The Fastest Byte Parity

The VMERAM-FP1, available in 4 to 64 MB, provides the fastest sustained block transfer timing available. Typical operating speeds boast 74 ns read and 100 ns write.

Our company-wide pledge to deliver reliability and performance.

CLEARPOINT

Quality Commitment

Error Detection and Correction Options

Clearpoint offers several EDC boards for the VMEbus and the VSB subsystem bus. Our proprietary second generation EDC chip set allows for reduced chip count while providing advanced EDC logic.

- VMERAM-EC1: Featuring Clearpoint's exclusive "extra bit" technology, 24- and 32-bit addressing, and 8-, 16-, and 32-bit data transfers, VMERAM-EC1 is available in 2 to 64 MB densities.
- VMERAM: The VMERAM is the low-cost alternative for EDC memory, with pricing comparable to parity memory. The VMERAM is available in 2 to 16 MB densities.
- VSBRAM-EC1: Features include "extra-bit" EDC and dual 64-bit caches for simultaneous transfer capabilities. Dual-ported for the VMEbus and VSB subsystem bus, the VSBRAM-EC1 is available in 2 to 64 MB densities.

The Clearpoint Difference

Clearpoint is a leading vendor in the VME marketplace, with the most comprehensive service program available. All Clearpoint memory products are covered by a lifetime warranty and a toll-free technical support hotline. Dedicated inventory in multiple locations worldwide support our 24-hour replacement program.

Call or write to receive the facts:

- ❒ Product/Services Catalog
- ❒ Designer's Guide
- ❒ Spec Sheets
- ❒ Newsletter
- ❒ Applications Video
- ❒ Quality Assurance Information

CLEARPOINT®

Clearpoint Research Corporation
35 Parkwood Drive
Hopkinton, MA 01748
1-800-CLEARPT
(1-800-253-2778)

CIRCLE 124

Before you buy development

One glance at the advertising in this magazine and you know your embedded design involves mega choices. But too much of a good thing may lead to one thing: confusion.

We can help clear this up, for free. With the articles and technical notes you see above.

Because whether you're an old hand or just starting out, they'll provide timely insights and techniques. To help you get to market first.

Learn which development tools are right for your project. Do you need emulation or simulation? And just how can you debug less and enjoy it more.

These papers are based on Applied Microsystems' experience at setting up over 12,000 systems

For the name of your nearest distributor in Europe, call 44-(0)-296-625462. Europe Fax 44-296-623460. Or contact Applied Microsystems Corporation, Ltd., Chiltern Court, High Street, Wendover,

The Intel i960 32-Bit Embedded Processor Family: Low Risk Solutions for High-Performance Embedded Designs

*B*ecause successful designs require *more* than just a single embedded processor, Hamilton/Avnet carries the Intel i960 32-bit Embedded Processor Family.

Featuring i960 Superscaler architecture with up to 66 MIPS of performance, the i960 Family includes a broad performance range of 32-bit embedded processors, as well as the peripheral components, coprocessors, and development tools to ensure the success of your designs.

Peripheral components that include Intel's 82596, 32-bit ethernet processor; 27960 burst EPROM; 85C960 and 85C508 EPLDs; and evaluation boards.

And Hamilton/Avnet can further support your design with Intel development tools, such as the ICE-960KB; development software; technical literature; design application notes; and technical specialists. For details, simply send in the coupon below, or call toll free, **1 (800) 442-6458.**

FREE DEMO DISKETTES!

- ☐ I'd like more information on the Intel i960 Family, including the i960 development tools demo diskette.
- ☐ Please have a Hamilton/Avnet representative call on me.

Name ______

Title ______

Company ______

Address ______

City ______

State ______ Zip ______

Phone ______

Application ______

Mail to: Hamilton/Avnet Electronics
Dept. 175, P.O. Box 9000, San Fernando, CA 91341-9981

Offer expires October 31, 1990.

CIRCLE 127

Hamilton Avnet
ELECTRONICS
AN AVNET COMPANY

People Dedicated to Service, Committed to Quality

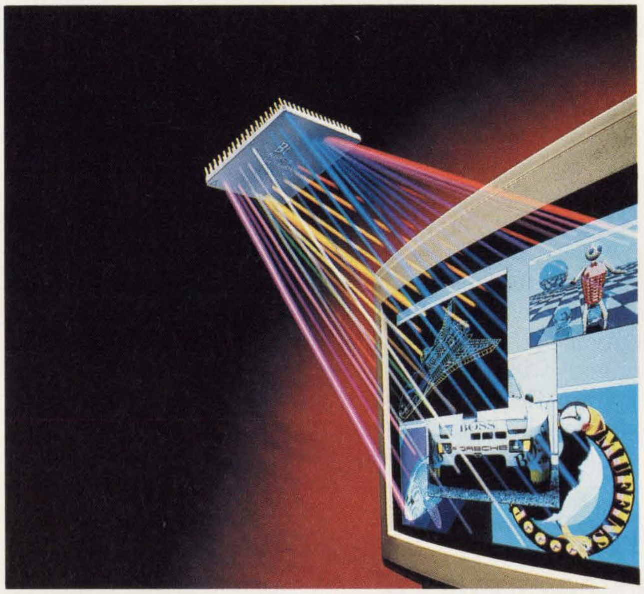
X-WINDOWS GETS TRUE COLORS SIMULTANEOUSLY

Thanks to a RAMDAC with a unique architecture and a virtual-resource scheme, X-window terminals can now have true colors simultaneously for all windows. The RAMDAC, dubbed the Bt463, was developed jointly by Brooktree Corp., San Diego, Calif., and Digital Equipment Corp., Maynard, Mass. The chip's virtual-resource scheme enables each X-terminal window to have its own color map and the associated pixel data that's structured uniquely by the graphics chip without any color degradation.

The Bt463 operates at 110 to 170 MHz and is the first commercially available monolithic IC that offers a high-resolution true-color palette *(see the figure)*. According to Brooktree, the device's mapping functions are completely different from any other RAMDAC's, and is the key to its performance.

The chip's lookup tables have enough storage space to switch between a full eight-plane pseudo-color and a full 24-plane true-color display. By adding the pixel-mapping function, called window-type tables, the lookup table can be subdivided into 16 smaller tables, depending on the window types being supported. The window-type tables offer the ability to switch on a pixel-by-pixel basis for different visual types (gray-scale, true-color, or pseudo-color). In addition, they make it possible for a window to be set at any depth. For example, one window can have a 24-plane true-color format, another a 12-plane true-color format, and still another an 8-plane pseudo-color or gray-scale format.

The Bt463 is constructed so that each residing application can have control over its own lookup table. Before the Bt463, the application that last touched the lookup table (the application on top) would modify the table. This confused all of the other applications running on the screen at that time.



At 170 MHz, the chip can achieve 1/2-pixel resolution—at 110 MHz, that equates to 1/4-pixel resolution. The chip, which contains a standard microprocessor interface, isn't designed exclusively for DEC hardware. It isn't X-window specific either, just window specific.

The chip's pixel ports are reconfigurable on a pixel-by-pixel basis, offering the flexibility for multiple display modes. The reconfigurability feature also makes the frame buffer more efficient because the same buffer can be used for pseudo- and true color.

The RAMDAC lets DEC—one of the key instigators behind the X-windows software standard—promote the graphical user interface as a standard more easily.

RICHARD NASS

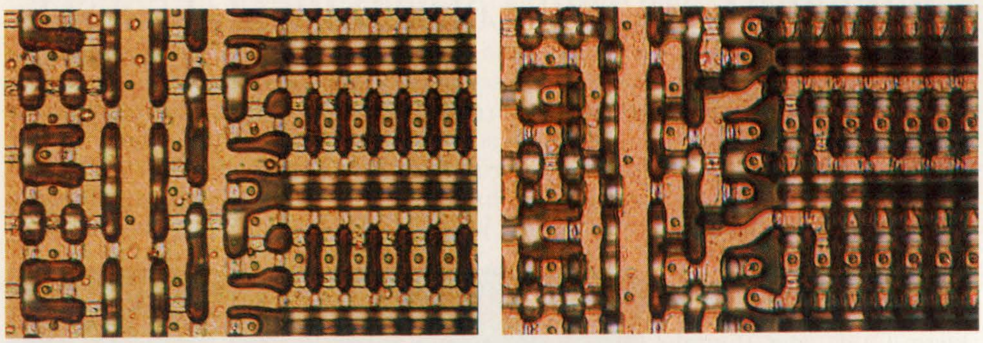
INSTANT GATE ARRAYS HAVE WIRING CONFIGURED BY LASER

A proprietary laser-patterning process has been developed that eliminates many drawbacks of other fast-turnaround patterning schemes. It also lets premetallized gate arrays be configured in minutes. By predefining a two-level-metal X-Y matrix of wiring above the gate array, Chip Express Corp., Santa Clara, Calif., can pattern both layers at the same time, thus eliminating processing steps of other fast-turnaround gate arrays. That promises to reduce the turnaround time for gate arrays to 1 to 5 days.

Although the scheme can theoretically work with almost any gate array, its key is the custom X-Y wiring grid for each array family. However, to ensure no hitches on the first product release, the company, along with International Microelectronic Products Inc., San Jose, Calif., developed its own family of gate arrays with predeposited metalization grids. The CMOS arrays have 3000, 6000, and 10,000 gates, and typical loaded gate delays of 500 ps.

Because the grid sits atop a standard chip, the company expects utilization to be near that of fully mask-configured arrays. To "instant" program a gate array, the base array is coated with metal. The metal is then patterned to form the first-level grid, an oxide insulating layer is deposited, and the second metal level is deposited and patterned. Tiny window regions are next etched away in the oxide regions formed between the grid of second-layer metal lines, to expose the programming points on the first metal layer *(see the figure, p.36, left part)*.

For accurate laser positioning and minimal vaporized aluminum-wiring redepositing, a thin, proprietary antireflection material is deposited over the chip surface. Wafers can then be stockpiled for configuration at any time. An array is configured under the proprietary Quick laser-micromachining system. About an hour later (for up to 12,000-gate arrays), a configured chip



emerges *(see the figure, right part).*

Post-processing removes the antireflection coating and any redeposited aluminum. A sealant cap layer is used to protect the chip. Chips can then be tested with customer test vectors and then delivered.

All of this works well for a few chip samples with a turnaround of 1 to 5 days. However, when a few dozen to a few hundred chips, there are two alternatives through IMP. The first is the OneMask production option, which allows all metal lines to be patterned in a single etch step.

Most double-level-metal arrays require four mask steps to custom-create the two wiring layers, resulting in a much longer processing cycle. For major production volumes, the second option lets IMP create custom metal masks for the Chip Express arrays to further optimize performance. For either option, customers can deal directly with IMP.

Chip Express doesn't plan to sell its laser system initially, but hopes to become a "service house," making possible designs in either of two modes. Customers can provide a circuit net list and test vectors created with the library of macrocells supplied by Chip Express and standard tools from popular workstation vendors. Chip Express will then do the layout (a fuse cut list) and supply post-layout parameters for final simulation before signing off.

Alternatively, customers can purchase the layout software tools from the company and do all placement and routing. Then they just supply a final approved fuse pattern and test vectors.

Contact Adi Gamon, (408) 988-2445.

DAVE BURSKY

GaAs Comes Of Age In Low-Cost Downconverter

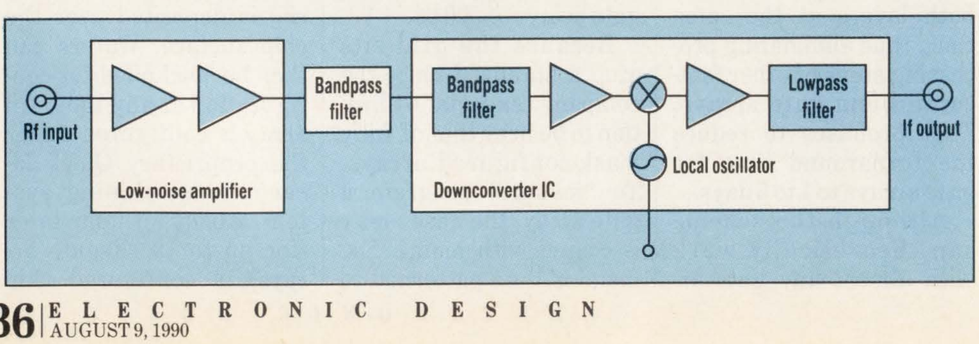
Gallium arsenide's days as a bridesmaid may finally be over. For years, proponents of GaAs technology have predicted that the material's time was just around the corner. It took longer than originally thought to turn that corner, but Anadigics Inc., has done so. The Warren, N.J., company is producing more than 70,000 GaAs downconverter ICs a month to fulfill a 1-million-piece order from British Satellite Broadcasting. This is the largest production run of any GaAs IC.

The Anadigics low-noise block downconverter is mounted in the Ku-band antenna's feedhorn. The circuit drops the incoming 11.7-to-12.5-GHz signal to 950-to-1750 MHz, a frequency range than can be sent through coaxial cable to the indoor direct-broadcast satellite (DBS) receiver. The downconverter and a preceding two-stage low-noise amplifier also boost the signal by 50 dB *(see the figure).* The Anadigics IC replaces more than 50 discrete components used in older-generation downconverters.

To win the British Satellite order, Anadigics had to come up with a way to produce large numbers of GaAs ICs with a higher yield and lower price than is typical for the GaAs industry. To do that, the company bought moderately priced, commercially available equipment and modified it to fit the project's needs. Production technology was also improved to increase yields.

Furthermore, the company developed a quick-turn design cycle that went from mask tape to device to evaluation in just 2 weeks. The whole cycle requires only 4 weeks, compared with a typical 16 weeks.

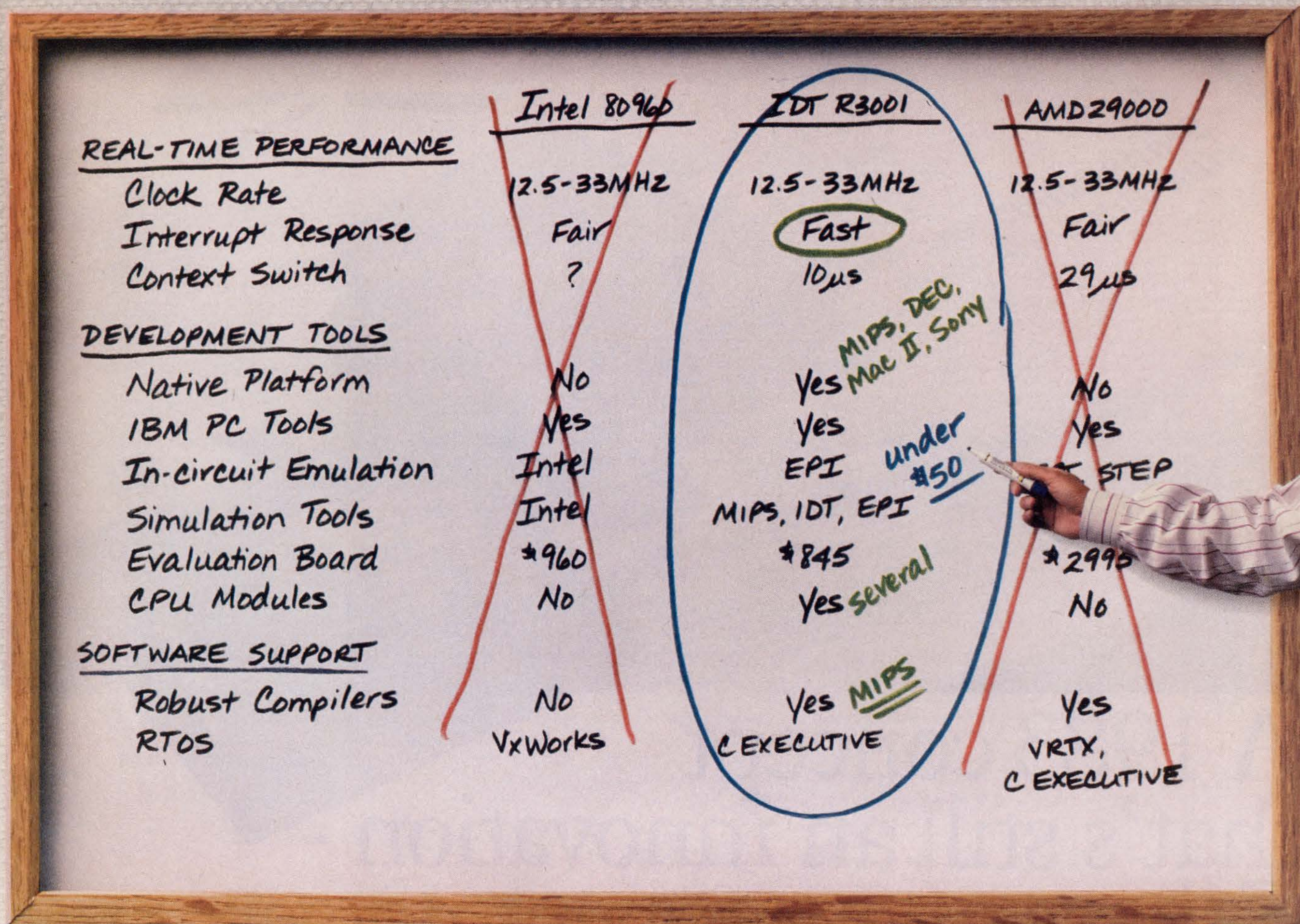
The chip was packaged in a modified TO-5 can that costs less than $1, rather than the $10 or more for a specialized microwave package. In fact, the whole chip sells for under $8. The discrete components being replaced cost from $5.50 to $7, depending on quantity. However, the IC also permits a smaller and simpler antenna, reduces manufacturing and test costs, and improves reliability and consistency.



The 12-GHz Ku-band transponders, which have transmitters in the 100-W range, make it possible for home receivers to use antennas of less than 1 m and costing about $500. This compares with C-band systems in the U.S. with 3-m antennas and price tags of $1500 and up.

JOHN NOVELLINO

Embedded RISC

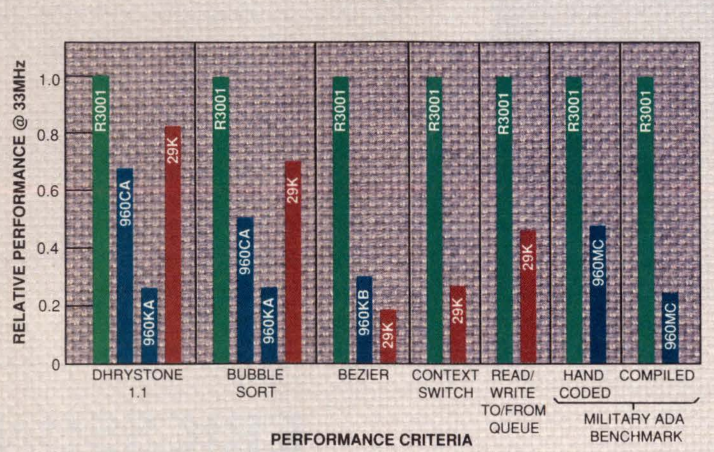


Get the Facts

When evaluating RISC processors for embedded applications, you need real benchmark data from independent sources. The *R3001 Performance Comparison Report* is a collection of the original third-party data used in the graph below.

Benchmark Your Code

Of course, we know that published data can't give you all the information. You'd prefer to perform benchmarks for your specific application, and our six technology centers are equipped to do just that — bring us your code and we'll run your benchmarks!



Sources: *Electronic Engineering* Magazine, *High-Performance Systems* Magazine, *Microprocessor Forum* Conference Fall 1989, *Independent Assessment Benchmark Report* Atlantic Research Corporation

RISController is a trademark of Integrated Device Technology.

You Can Count On Us

IDT offers a full array of complementary high-performance system building blocks for all your applications. Contact us today and get the facts: an R3001 Data Pak and R3001 Performance Comparison Report.

IDT Corporate Marketing
P.O. Box 58015
3236 Scott Blvd.
Santa Clara, CA 95052-8015

(800) 345-7015
FAX: 408-492-8454

When cost-effective performance counts

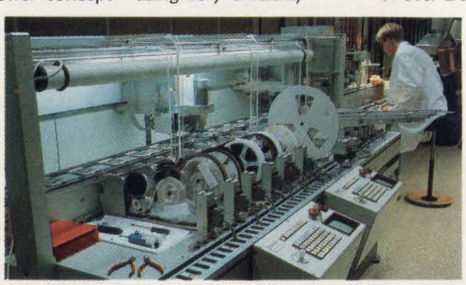
Integrated Device Technology

CIRCLE 131

A 1983 concept that's still an innovation - Ericsson component power

If you've only just discovered the economy, reliability and flexibility of component power, don't worry. Even some power supply manufacturers think it's new!

In fact, component power concept - using very efficient, high frequency DC/DC converters as complete power 'components' for distributed power architecture - was introduced by Ericsson way back in 1983. And EriPower™ modules have since been proven in thousands of applications worldwide.



The PKA & PKC, DC/DC converters are produced on fully automated lines to guarantee consistently high quality and reliability

The PKC In-Card, 15-18 Watt DC/DC converters provide ultra low profile

The first product, the PKA 25 to 40 Watt converter, set the standard and is still the market leader by far. Using hybrid construction and 300 kHz switching it's the world's smallest converter to offer full power operation at 85°C. And with ceramic capacitors for filtering and effective thermal management design, it has a demonstrated MTBF of over 200 years!

This same concept applies to the 15 and 18 Watt PKC. With a footprint smaller than a credit card, these sub-miniature converters offer the unique option of In-Card low profile mounting. The mechanical design allows the center of the module to rest in a slot in the PCB, giving a maximum height of just 8.5mm.

The PKA and PKC can be easily paralleled for higher power applications and they make ideal components for n+1 parallel redundancy applications.

If your product demands innovative power supplies, yet needs the security of well proven solutions from a reliable source, call Ericsson. And let our technology lead help maintain yours.

Sweden	Ericsson Components AB, Stockholm, Tel: (08) 721 70 59 Fax: (08) 721 70 01
Australia	Ericsson Components Pty Ltd, Victoria, Tel: (03) 480 12 11 Fax: (03) 484 36 45
France	Ericsson Composants SA, Gyancourt, Tel: (01) 30 64 09 00 Fax: (01) 30 64 11 46
Hong Kong	Ericsson Components AB, Wanchai, Tel: (05) 756 640 Fax: (05) 834 5369
Great Britain	Ericsson Components AB, Coventry, Tel: (0203) 553 647 Fax: (0203) 225 830
Italy	Ericsson Components Srl, Milano, Tel: (02) 551 81 597 Fax: (02) 545 97 31
Norway	Ericsson Components A/S, Oslo, Tel: (02) 6 50 190 Fax: (02) 644 138
United States	Ericsson Components Inc, Richardson, TX, Tel: (214) 480 83 00 Fax: (214) 680 10 59
West Germany	Ericsson Components GmbH, Engen, Tel: (07733) 500 10 Fax: (07733) 5927

CIRCLE 87

ERICSSON

Two Clock-Generation Circuits Simplify High-Speed TTL System Design By Delivering Clock Signals With Skews Under 500 ps.

Eliminate Signal Skews With GaAs Clock Chips

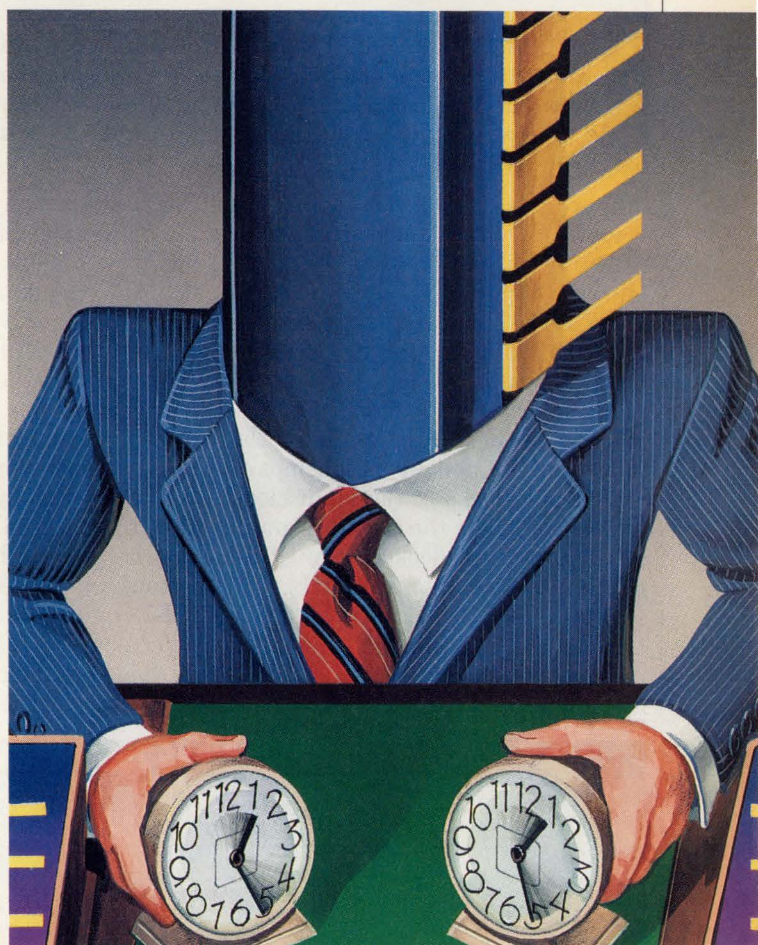
DAVE BURSKY

One of the most difficult aspects of high-speed system design is distributing minimal-skew high-speed clock signals across one or several circuit boards. Often, board designs have to be "tuned" by adding inverter strings or delay lines to reduce clock skews. Such tuning lowers the maximum performance because the board must operate with worst-case trims. Yet another problem is distributing high-speed clock signals across multiple circuit boards so that the clocks can all be synchronized.

Although ECL systems have dealt with both issues for years, the latest crop of high-speed TTL-compatible systems now face this same problem as clock speeds go to 33 or 50 MHz and beyond. A 5-ns clock skew across a large board or system caused by improper buffering or system design could detract as much as 20% from the throughput in systems that run at 40 MHz.

By trimming the clock skew between clock output lines to less than 500 ps, most skew-related performance degradations can be eliminated. A pair of gallium-arsenide-based timing support chips, the GA1110 and 1210 from Gazelle Microcircuits, accomplish just that. They offer flexible and programmable control of timing-signal edges for systems with clock frequencies of 25, 33, 40, or 50 MHz, or with double-frequency clocks of up to 100 MHz.

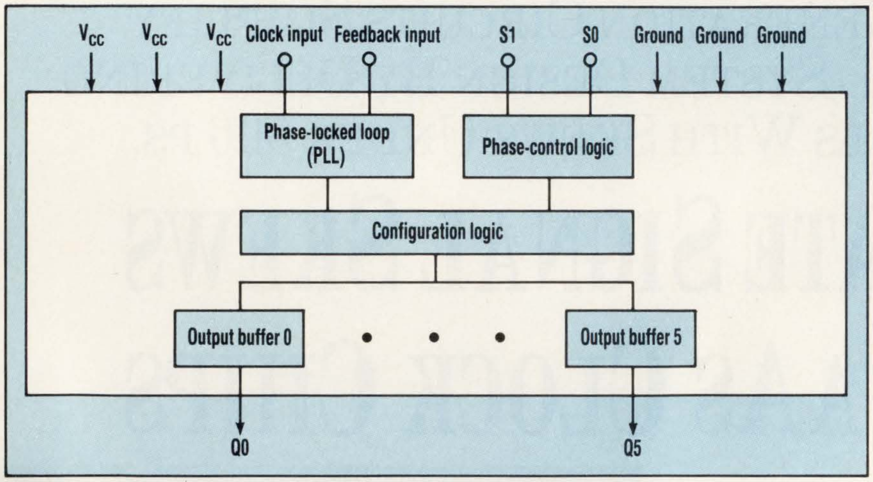
The GA1110 can generate as many as five TTL clock signals that are phase-



and frequency-synchronized to a master clock, adjust the clock edges in 2-ns steps, and buffer the clock signals for distribution. The GA1210 generates multiple output-clock signals at double the input frequency. Those clocks are also phase-aligned to the input clock.

In its basic configuration, the GA1110 serves as a multiple-output, zero-skew clock buffer. Inputs and outputs are all TTL compatible, with each

CLOCK GENERATOR CIRCUITS



1. CONTAINING A 500-MHz PHASE-LOCKED LOOP, the multi-output Gazelle GA1110 clock generator delivers five buffered outputs that are phase and frequency synchronized to the input clock. By using S1 and S0 control inputs and a feedback path, the clock output edges can be adjusted in 2-ns steps to provide early or late clocks, or an inverted clock.

output able to deliver symmetric waveforms with an output drive of ±24 mA. Output lines can be paralleled if higher drive currents are needed. The chip generates five identical phase-aligned output clock signals, as well as one 180° phase-aligned output clock, from a periodic reference clock *(Fig. 1)*. Both the phase and frequency relationships of the output clocks to the input clock are controlled by the circuit through an on-chip phase-locked loop (PLL) that operates at about 500 MHz.

Proprietary PLL circuitry, similar to that employed in the company's previously released Hot Rod serial communication circuits, eliminates the need for any external components to support internal phase locking at up to 500 MHz. That makes the GA1110 very simple to use. A sixth clock output serves as the feedback signal to the PLL and synchronizes the outputs to the input clock. Multichip clock chains and clock trees can now be easily configured thanks to the tight skew control.

There's no requirement, however, that the external feedback connection be directly hardwired from an output pin to the feedback input (FBIN) pin. Additional logic can be inserted in the feedback path as long as the signal arriving at the FBIN pin is derived directly from one of the output pins, and it maintains the output pin's frequency. The internal PLL will adjust the output clocks to ensure zero phase delay between the FBIN and CLKIN signals. This feature is very handy when custom chips must be synchronized to the system clock. There's one caveat, though: The signal at the FBIN pin must stay continuous (it can't be a gated or conditional signal) to ensure synchronization.

A pair of active-high control signals, S1 and S0, combined with the feedback of an output clock signal to the FBIN, enables users to select any of 14 timing relationships between the five output clocks *(Table 1)*. Consequently, the clock edges can be placed in precise, digitally-controlled 2-ns increments (+ or –) relative to the input and feedback clock phase. In systems where clocks must be sequential, or where wiring-trace and loading mismatches develop, the chip can supply the early or late clocks. When the chip is powered up, or the system clock is reset, the PLL requires a short time period (T_{sync}) to lock onto the signal.

In a typical system, designers may require several low-skew outputs, one early clock, one late clock, and one inverted clock. Such a system can be satisfied by setting S1 low, S0 high, and connecting Q0, Q1, or Q4 to the FBIN input (row 3 of table 1). The result is that Q0, Q1, and Q4 will be phase-aligned to the input clock, Q3 provides the early clock (by one 2-ns increment), Q2 delivers the late clock (also by one 2-ns step), and Q5 supplies the inverted clock.

Output clock signals are generated with 50/50 duty cycles, even if the input clock isn't completely symmetrical. Ratios of up to 75/25 for the input clock can be handled. Housed in a standard 16-pin DIP, the chip has three pins assigned for power and another three serve as ground lines. As a result, it permits more than adequate power-supply bypassing to eliminate noise. The chip operates from a 5-V supply and typically draws about 120 mA.

Working either in conjunction with the GA1110 or as a standalone circuit, the GA1210 delivers multiple

TABLE 1: TIMING OPTIONS FOR THE GA1110

Configuration number	Select pins		Outputs fed to feedback input pin	Output phase shift					
	S1	S0		Q0	Q1	Q2	Q3	Q4	Q5
1	0	0	Q0, Q1, Q2, Q3, or Q4	0	0	0	0	0	I
2	0	0	Q5	I	I	I	I	I	0
3	0	1	Q0, Q1, or Q4	0	0	t	-t	0	I
4	0	1	Q2	-t	-t	0	-2t	-t	I-t
5	0	1	Q3	t	t	2t	0	t	I+t
6	0	1	Q5	I	I	I+t	I-t	I	0
7	1	0	Q0, Q2, or Q3	0	t	0	0	-t	-2t
8	1	0	Q1	-t	0	-t	-t	-2t	-3t
9	1	0	Q4	t	2t	t	t	0	-t
10	1	0	Q5	2t	3t	2t	2t	t	0
11	1	1	Q0	0	t	t	-t	-t	-2t
12	1	1	Q1 or Q2	-t	0	0	-2t	-2t	-3t
13	1	1	Q3 or Q4	t	2t	2t	0	0	-t
14	1	1	Q5	2t	3t	3t	t	t	0

Notes: 1. t represents the incremental phase-shift adjustment (2 ns)
2. A 0 phase shift indicates the output is aligned to the clock input
3. A negative phase indicates the output precedes the input clock
4. A positive phase indicates the output follows the input clock
5. I indicates an inverted version of the input clock

TABLE 2: OUTPUT CHOICES FOR THE GA1210

Control pins		Clock output lines					
Enable 2-phase clocking	Invert Q1 output	Q0	Q1	Q2	Q3	Q4	Q5
0	0	1X	1X(I)	2X	2X	2X	2X
0	1	1X	1X	2X	2X	2X	2X
1	0	1X	1X(I)	2X	2X	PH1	PH2
1	1	1X	1X	2X	2X	PH1	PH2

Notes: 1. 1X is an output clock, a phase-aligned copy of the input clock signal.
2. (I) indicates inverted version of 1X clock (180° out of phase)
3. 2X is an output clock, a phase-aligned double-frequency copy of the input clock signal.
4. PH1 and PH2 are the first and second of two clock phases, synchronous to the input clock.

low-skew clock signals that are twice the frequency of the input clock, which can be as high as 50 MHz *(Fig. 2)*. The chip also generates several 1X clocks, one of which is fed back to the FBIN input so that the PLL can maintain synchronization.

All of the generated clocks (up to 100 MHz) are phase-aligned to the periodic clock input. Such a circuit solves the problem of distributing high-frequency clock signals in large systems. A low-frequency clock of 50 MHz or less can be distributed to each board and then doubled on the board by a GA1210, so that 50-to-100-MHz clocks can time the logic on that particular card.

Several different configurations can be set up on the chip to accommodate various system requirements through the Enable 2-phase Clocking (EN2) and Invert Q1 (INV1) control pins *(Table 2)*. In addition to supplying the 2X clock, the chip can be configured to generate non-overlapping two-phase clocks.

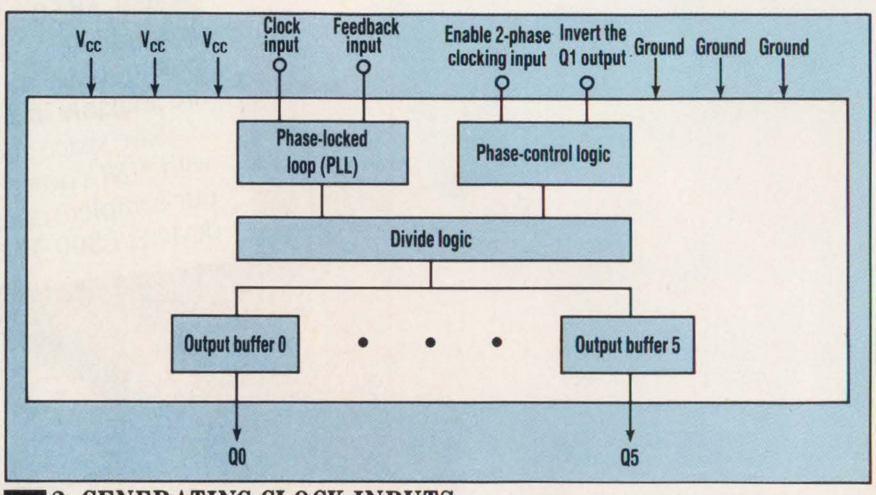
As with the GA1110, the clock multiplier accepts a master-clock input frequency from 25 to 50 MHz, has a maximum skew of 500 ps between outputs, recreates a 50/50 duty cycle on each output, and can drive up to 24 mA on each output line. The GA1210 also comes in a 16-pin DIP, and includes triple power and ground lines to minimize noise.□

PRICE AND AVAILABILTY

The GA1110 and 1210, which come in 16-pin DIPs, are immediately available. The commercial-temperature-range versions of the 25- and 33-MHz speed grades sell for $28.50 in 1000-unit quantities. The higher-speed grades will be sampled next quarter.

Gazelle Microcircuits Inc., 2300 Owen St., Santa Clara, CA 95054; Bob Gunn, (408) 982-0900. **CIRCLE 511**

HOW VALUABLE?	CIRCLE
HIGHLY	547
MODERATELY	548
SLIGHTLY	549



2. GENERATING CLOCK INPUTS **that are 2X or 1X multiples of the input clock, the GA1210 clock circuit can use its high-frequency PLL to synchronize the output clock signals to the input clock.**

The program in a switch.

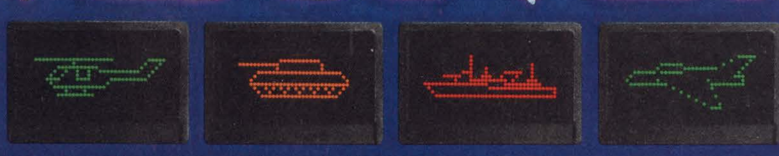
Introducing Vivisun Series 2000, the programmable display pushbutton system that interfaces the operator with the host computer. The user friendly LED dot-matrix displays can display any graphics or alpha-numerics and are available in green, red or amber. They can efficiently guide the operator through any complex sequence, such as a checklist, with no errors and no wasted time.

They also simplify operator training as well as control panel design. Four Vivisun Series 2000 switches can replace 50 or more dedicated switches and the wiring that goes with them. In short, Vivisun Series 2000 gives you more control over everything including your costs.

Contact us today.

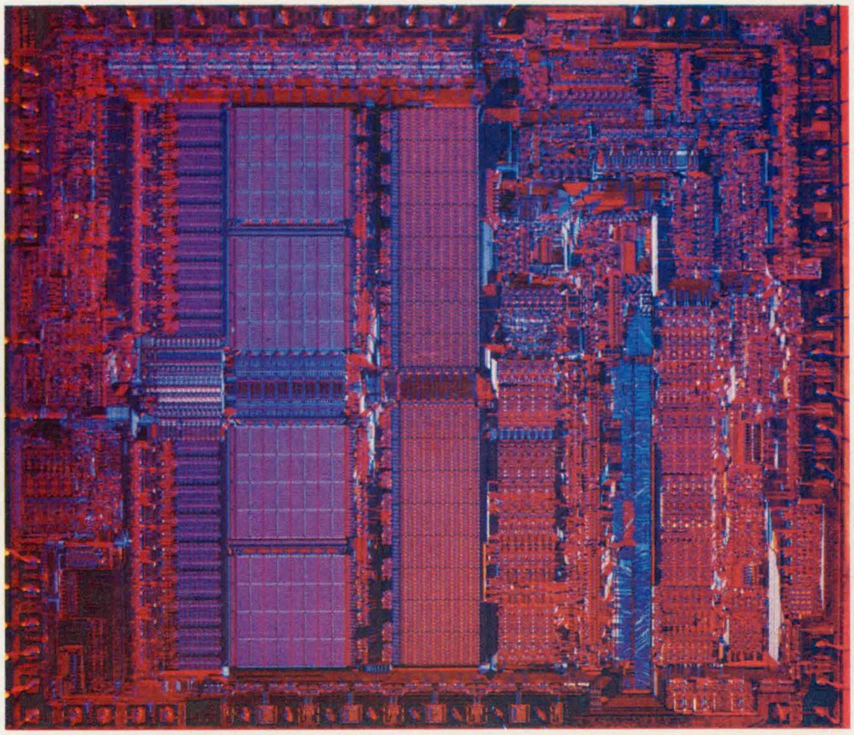
AEROSPACE OPTICS INC.
3201 Sandy Lane, Fort Worth, Texas 76112
(817) 451-1141 · Telex 75-8461 · Fax (817) 654-3405

SERIES
VIVISUN 2000™



Programmable display switches. Making the complex simple.

CIRCLE 89



DAVE BURSKY

FOR EMBEDDED CONTROL, MICROCONTROLLERS SOLVE MOST NEEDS.

MICROCONTROLLER ICs OFFER MANY ON-CHIP FEATURES

Single-chip microcontrollers are evolving with more features and higher throughputs, and are packed with CPU, RAM, and nonvolatile memory (ROM, EPROM, or EEPROM), and other system resources. The ubiquitous chips can be found embedded in multiple quantities in almost every product that has some electronic circuitry. From their beginnings as 4-bit systems on a chip, they've progressed to 8-, 16-, and 32-bit subsystems.

Although a few Japanese manufacturers are still creating new 4-bit microcontrollers, most low-end embedded controllers are moving to the 8-bit plateau as the chips' tasks get more complex. A wider choice of third-party development tools is also available for 8-bit and larger microcontrollers, and so are some alternate sources—features lacking in the 4-bit arena.

The latest crop of 8-bit controllers offer a kaleidoscope of features that tackle nearly every application niche. Aside from the expected RAM, ROM, and EPROM options, more controller manufacturers are adding electrically-erasable memories as an on-chip feature, with some makers now eying the use of flash memories. Commonly available functions include timers, counters, serial ports, and parallel I/O ports.

Additional support functions becoming popular include interrupt controllers, large register files, and DMA controllers. Furthermore, manufacturers have created specialized I/O functions that include complex timer modules, pulse-width modulators, analog-to-digital and digital-to-analog converters (ADCs and DACs), and others for automotive system, telecommunication, consumer-equipment, and computer-peripheral applications.

On the whole, the older NMOS controllers have given way to CMOS. However, for applications that aren't power-critical, NMOS 8-bit controllers are still viable and cost slightly less than the newer CMOS chips. NMOS-device choices are somewhat limited to older- or first-generation architectures—the MCS-48 and 51 families originated by Intel Corp., Chandler, Ariz.; the 6805 series from Motorola Inc., Austin, Texas; and the Z8 from Zilog Inc., Campbell, Calif.; among others.

One way manufacturers can cut chip cost is to design a simple processor that performs its operations with minimum hardware by time-sharing the silicon resources. In previous designs, that approach worked because processor throughputs could handle the expected applications.

Today's demanding applications, however, require much higher performance. As a result, controller makers are taking two approaches to meet the customer's needs. The simplest approach is to up the clock frequency that the controller runs at. Over the past few years, clock frequencies have crept from 8 MHz up to 16 MHz, and later this year some suppliers expect to ship controllers that run at 20 MHz and beyond. Unfortunately, elevated clock frequency creates several problems—testing the chips at the higher speeds, potentially reduced yields of higher-speed devices (and thus a higher device price), and more generated radio-frequency interference caused by higher clock frequencies.

Alternatively, more silicon can be used to address the throughput issue. The processor's time-shared internal architecture can be restructured to a more parallel structure that enables multiple operations to be done in one clock cycle.

Many original low-cost 8-bit processors, such as the 80C51 family from Intel Corp.; the 68HC05 series from Motorola Inc.; the TMS7000 series from Texas Instruments Inc., Dallas; and the Z8 family from Zilog Inc.; require 8 to 12 clock cycles (1 to 2 μs) for one instruction to execute. In contrast, some of the latest 8-bit controllers—such as the H8 processors from Hitachi Semiconductor Inc., Brisbane, Calif.; the updated PIC family from Microchip Corp., Chandler, Ariz.; the K series chips from NEC Electronics Inc., Mountain View, Calif.; and the TMS370 family from TI—require just a few cycles (less than 500 ns) to complete an instruction. Consequently, for a much lower clock rate, the processor can perform the same work. The drawback is that more silicon area is needed for the more efficient processor core, increasing chip cost.

Today's workhorse processors, the 8-bit microcontrollers, come in a dazzling array of configurations. A well-established family, such as Intel's 80C51, which has several licensed alternate sources, contains more than two dozen commercial versions from Intel; Advanced Micro Devices Inc., Austin, Texas; Oki Semiconductor Inc., Sunnyvale, Calif.; Philips-Signetics Corp., Sunnyvale; Siemens Corp., Santa Clara, Calif.; and others.

The original CMOS versions in the MCS-51 family include the 80C51 with 4 kbytes of ROM and 128 bytes of RAM, and the 80C52, which includes 8 kbytes of ROM and 256 bytes of RAM. UV EPROM and ROM-less versions of both chips are also available. Other 80C51 resources include a pair of 16-bit timer-counters, a full-duplex serial port, 32 bidirectional I/O lines (four 8-bit ports), and a five-source interrupt structure with two priority levels. The C52 adds one more timer-counter and its interrupt source.

Intel's latest offering is the 87C51FC, which offers the largest on-chip program storage in the MCS-51 family: 32 kbytes of EPROM, doubling the memory of the company's previous version—the 87C51FB. Along with the expanded program memory, the chip packs an array of programmable counters with five I/O channels to handle complex timing applications with minimum CPU overhead. Either a windowed ceramic package or a one-time-programmable (OTP) plastic package can house the chip.

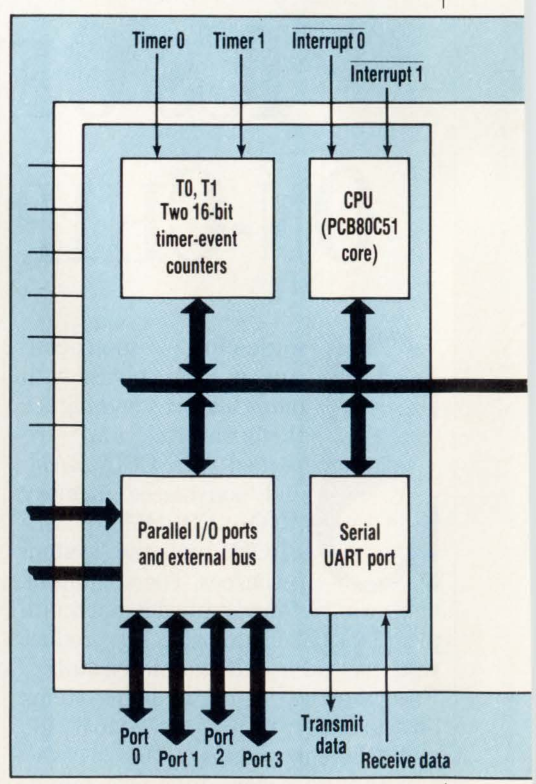
Additional 87C51FC resources include 256 bytes of RAM, a serial I/O port, three 16-bit timer-counters, and a two-level program lock to guard against software piracy. A simpler version of the chip, the 87C54, eliminates the complex counter array to trim the price. The chips are designed to handle some of the complex operations in automotive control systems, and can operate over a –40 to +125°C temperature range at either 12 or 16 MHz.

The 80C515, packing 48 I/O lines, a 16-bit watchdog timer, three additional 16-bit counter-timers, a full-duplex serial port, an 8-bit ADC, as well as 8 kbytes of ROM and 256 bytes of RAM, is an extended-I/O version of the 80C51 offered by AMD and Siemens. Housed in a 68-lead PLCC, the controller's ADC has eight multiplexed inputs and performs a conversion in 13 μs. When operating at 12 MHz, the controller executes most commands in about 1 μs. Higher-speed 16-MHz units are also available.

AMD and Siemens went in different directions for additional controllers based on the C51 CPU core. AMD created the 80C541, 521, and 321, as well as a forthcoming chip, the 80C324. The first three share a common architecture that includes 16 kbytes, 8 kbytes, or no ROM, respectively, and 256 bytes of RAM. The controllers have a dedicated watchdog timer and dual data pointers to reduce the CPU's access time to external memory. The C324 has all of the ROM-less 321's features plus a port-expansion mode that enables the chip to control up to fifteen 8-bit ports by multiplexing signals over its 8-bit Port 1.

Pushing towards the high-end of the 8-bit range, the SAB80C517 and 537 (ROM-less) from Siemens start with the 80C51 core, 8 kbytes of ROM, and 256 bytes of RAM. To that base the company added a complex compare-capture unit (CCU), a watchdog timer, a priority interrupt subsystem with four levels, a multiplication-division block, a second serial port, an 8-bit 12-channel ADC, eight data pointers for indirect addressing, and nine parallel I/O ports.

The CCU block includes one 16-bit



timer-counter, one 16-bit compare timer, one 16-bit reload-capture-compare register, four 16-bit capture-compare registers, eight 16-bit compare registers, the ability to perform concurrent compare operations, and up to 21 channels of compare outputs. The multiplication-division block tackles the math-intensive applications and delivers results on 32-bit numbers in just 4 to 6 µs.

In addition to the MCS-51-compatible chips, Siemens just signed a deal with SGS-Thomson Inc., Phoenix, Ariz., to alternate source and jointly develop future versions of SGS's S-series microcontrollers. The ST8 series from SGS is based on a core CPU that can address up to 32 kbytes of program memory and a 6-bit stack pointer (future versions will increase the pointer to 8 bits to address up to 256 bytes). The first two processors in the family, the ST8108 and 81E08, pack 8 kbytes of ROM and EPROM, respectively, 176 bytes of RAM, timers and serial I/O ports, as well as bidirectional I/O ports. Future members will include EEPROMS, ADCs, DACs, and other functions. SGS also has two other families, the ST6 to tackle the low-end applications, and the ST9 to handle the most complex 8-bit applications.

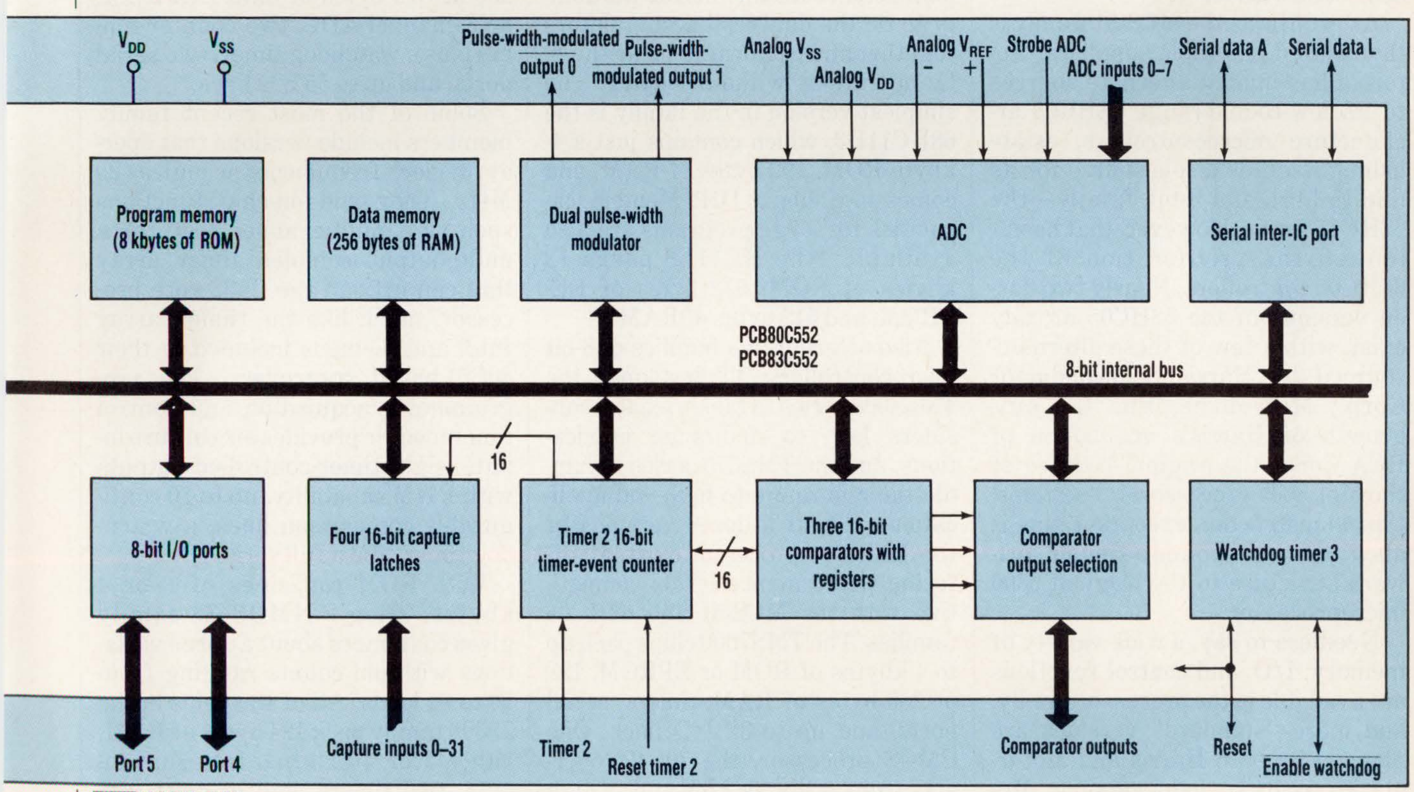
Tackling I/O-intensive applications, Philips-Signetics created an extended I/O processor—the 83C451—which offers seven 8-bit I/O ports in a 68-lead PLCC version. One unique port includes a "mailbox" feature that makes it possible for the port to serve as an I/O port or as a control and status register. The chip packs the same amount of RAM and ROM as the original 80C51.

A more complex version of the same chip—the 83C552—starts with the 80C52 memory and adds six byte-wide parallel ports, a 10-bit 8-channel ADC, two pulse-width-modulated (PWM) outputs, and an inter-IC bus serial port for chip-to-chip communications *(see the figure)*. Also available are an EPROM version, and a version without the ADC and PWM outputs and with only four ports.

Very large memories on a version similar to what Intel included on the 877C51FC are also on the horizon. Philips-Signetics plans to offer the 83C528 with 32 kbytes of EPROM and 512 bytes of RAM. In addition, the company will have two versions—the 83C053 and 054—both of which pack 192 bytes of RAM, and 8 or 16 kbytes of EPROM, respectively. These two chips are aimed at TV remote-control subsystems and pack a separate 128-byte display RAM and three digital video outputs.

Going in the low-cost and minimal-I/O direction, Philips-Signetics slimmed down the 80C51, creating the 83C751. It comes in a 24-pin skinny DIP (300-mils wide) and packs 19 I/O lines, one counter-timer, a single-level interrupt structure, 2 kbytes of ROM, and 64 bytes of RAM. A slightly larger version—the 83C752—comes in a 28-lead DIP or PLCC, and packs the same memory and counter-timer, but has three parallel ports (two 8-bit and one 5-bit parallel ports), an inter-IC serial interface, one PWM output with timer, and a five-channel 8-bit ADC. Both chips can't use off-chip memory.

Philips-Signetics is also upgrading its 80C51 direct-equivalent controllers so that they can operate at 20



ONE OF the most complex microcontrollers based on the 80C51 processor core is the PCB83C552 from Philips-Signetics. It packs an eight-channel ADC, a pair of PWM outputs, a pair of serial ports, multiple timer-counters, and a large number of I/O lines.

and 24 MHz. The 24-MHz unit becomes the fastest C51 controller available from any source and can execute typical commands in just 500 ns. The company hopes to be the first supplier to include EEPROM on an 80C51-based controller. Plans are underway to create the 83C851, an 80C51 with 256 bytes of EEPROM. One alternative to EEPROM for the 80C51 is a battery-backed version offered by Dallas Semiconductor Corp., Dallas, Texas. By embedding a long-lifetime battery-backed RAM in the same package as an 80C51-equivalent controller, Dallas devised a controller that can retain data for about 10 years, if used in accordance with its data sheet.

Although many C51-based CMOS controllers can operate at voltages down to about 2.5 V, even lower operating-voltage requirements led designers at Philips-Signetics to create another version of the C51—the 83CL410. The CL410 was designed with static CMOS logic and can operate with supply levels of just 1.5 V, or draw less than 1 mA when operated at 3 V and 3 MHz.

As prolific as the MCS-51 family is thanks to its multiple suppliers, Motorola has limited alternate sources to its low-to-mid-range 68HC05 architecture microcontrollers, establishing itself as a sole-source for its mid-to-high-end 8-bit family—the 68HC11 series. However, that hasn't limited the proliferation of the 68HC05 controllers. Nearly two dozen versions of the 68HC05 already exist, with a few of these alternate-sourced by Harris Semiconductor Corp., Melbourne, Fla. (an outgrowth of Harris's acquisition of RCA Corp., the original licensee of the Motorola processors). The chips' typical instruction execution time is about 1 μs and contain a similar software structure to the original 6800 microprocessor.

Needless to say, a wide variety of memory, I/O, and control functions are available in the processor family, and more "standard" versions are planned by both Harris and Motorola. To create so many versions, Motorola implemented a customer-specific adaption program that tries to match similar customer requests with similar features and then to turn all of the requests into a common piece of silicon that can be offered commercially. The company also expects to add such capabilities as handling high voltages for display driving or high-current outputs to directly drive small motors.

For more demanding applications, Motorola offers the 68HC11 family, the first microcontrollers to offer RAM, ROM, and EEPROM on one chip. The original HC11 processor packed 256 bytes of RAM, 512 bytes of EEPROM, and 8 kbytes of ROM, as well as a timer, both simple and complex serial ports, multiple parallel I/O ports, an 8-channel ADC, and a watchdog timer. One forthcoming HC11 processor will include no ROM, but will offer demultiplexed address and data lines, 1 kbyte of RAM, and 512 bytes of EEPROM—the 68HC11F1. Additional processors with larger on-chip memories are also in development.

The HC11 processors execute a superset of the original 6800 and 6801 instruction sets and include the ability to tie the dual 8-bit accumulators together and perform 16-bit arithmetic operations without looping. The simplest version in the family is the 68HC11D3, which contains just a 4-kbyte ROM, 192 bytes of RAM, and comes in a 40-pin DIP. Memory capacities for large programs are also available—the HC11E9 packs 12 kbytes of ROM, 512 bytes of EEPROM, and 512 bytes of RAM.

Also offering two families of 8-bit microcontrollers, TI developed the TMS7000 series to tackle what it considers low- to mid-range applications, and the TMS370 series to handle the mid-range to high-end applications. About a dozen versions of the TMS7000 processor exist, all offering performance levels competitive with the MCS-51 and 68HC05 families. The TMS7000 chips pack up to 4 kbytes of ROM or EPROM, 128 or 256 bytes of RAM, timers, serial ports, and up to 32 I/O lines. One CMOS processor, the 70C42, operates from as low as 2.5 V and as high as 6 V. At the low value, the chip must run at a much-reduced clock frequency—800 kHz, maximum—rather than the 5 to 6 MHz when powered by a 5- or 6-V supply.

Employing a more complex CPU core, the TMS370 series chips compete more with the 68HC11 and the K-series from NEC Electronics. TI actually divided its 370 family into several sub-families, which total close to two dozen choices. The sub-families consist of the 370Cx10, Cx3x, and Cx5x series. The Cx10 aims at the lower end of the higher-performance range, the Cx3x for slightly more complex applications, and the Cx5x solves the high-I/O and large memory needs of the most challenging applications.

Various members of the Cx10 series offer up to 4 kbytes of program ROM or EEPROM, 128 bytes of RAM, another 256 bytes of data EEPROM, a counter-timer and a watchdog timer, a serial port, and up to 22 I/O lines. More formidable applications might use the Cx5x processors, which pack up to 16 kbytes of ROM or EPROM, or 4 kbytes of EEPROM, as well as 256 or 512 bytes of RAM, 256 or 512 bytes of data EEPROM, an 8-channel ADC, two counter-timers plus a watchdog timer, two serial ports, and up to 55 I/O lines.

Some of the most recent family members include versions that operate at clock frequencies as high as 20 MHz. They add on-chip functions such as a multichannel ADC, or a multi-output complex timer array that can offload the Cx32 core processor, much like the timing array Intel and Siemens included in their 80C51-based controllers. The programmable acquisition and control timer module provides six capture inputs, eight timer-controlled outputs with PWM capability, up to 20 configurable comparison lines, a watchdog timer, and a full serial port.

With ROM capacities of 2 or 4 kbytes, Zilog's NMOS Z8 family gives customers about a dozen variations with pin counts ranging from 28 to 64 leads. All of the chips in the Z8600 family pack 124 bytes of RAM, either 1 or 4 external interrupt inputs, two timers, and in most versions, both an asynchronous serial port and another simpler, synchro-

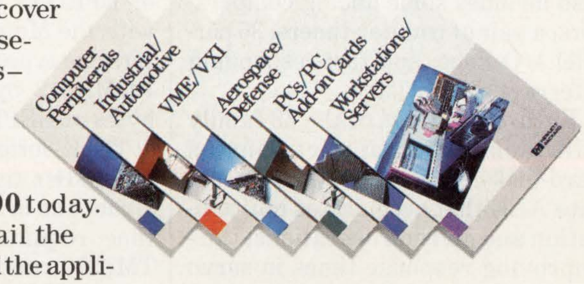
Frustrated with microprocessor system debugging?

Here's free help in making the connections.

Plug into our new series of application notes today. And learn how to save time and aggravation when you're debugging microprocessor systems and busses.

Find out how an HP preprocessor literally makes it a snap to connect your microprocessor to an HP logic analyzer. And see how completing your HP logic analysis system with a preprocessor will speed and simplify measurements and data analysis. You'll also discover the industry's broadest selection of preprocessors – over 60 models support more than 70 microprocessors and busses.

So call **1-800-752-0900** today. Ask for **Ext. 1404** or mail the reply card and we'll send the application information you need from our FREE series of six industry-specific application notes.



There is a better way.

HEWLETT PACKARD

nous serial port. The CMOS Z8 family includes over 15 processors that have as few as 18 and as many as 40 pins. On-chip memory ranges from 2 to 8 kbytes of ROM or EPROM, while RAM is either 124 or 236 bytes.

Several Z8 versions are designed to retain data when the power supply dips as low as 2 V, and they can operate from 3 to 5.5 V with clock speeds of 2, 8, or 12 MHz. When running at 12 MHz, the average instruction executes in about 1 µs. Some also include analog comparators to perform level-sensing operations and programmable timers with programmable prescalers (the Z86C08, 09, 30, 40 and the ROM-less C90).

The company's older NMOS Super 8 processor will soon be converted to CMOS, thus reducing power, possibly increasing the on-chip ROM to 16 kbytes, the RAM to 512 bytes, and improving performance. The NMOS version packs many resources—a DMA controller, high-performance math instructions and commands to support threaded-code languages such as Forth, a large 128-kbyte address space, a complex interrupt-service unit that responds to an interrupt in just 600 ns, a pair of counter-timers, a full-duplex serial port, and 40 parallel I/O lines.

One version of the Z8, the Z86C27, is optimized for television control, and contains an 8-kbyte ROM, 256 bytes of RAM, a separate 180-byte character RAM, 4-kbyte character ROM, and 13 PWM outputs with 6 or 8-bit resolution (except for one that offers 14-bit resolution). The chip also includes some analog comparators, a pair of counter-timers, 36 parallel I/O lines, and fast-responding interrupt control logic.

Future members of the Z8 family will tackle such applications as hard-disk control, thanks to a separate ALU that accelerates multiplication and division operations, thus improving response times in servo control loops.

In addition to offering an alternate source to the old Intel MSC-48 family, Mitsubishi America Inc., Sunnyvale, has a family of over thirty 8-bit controllers in its proprietary M50xxx and M37xxx families that are software-compatible with the 6500 family instruction-set processors. On-chip ROM ranges from 3 to 16 kbytes on the smallest to largest units, with RAM growing from a minimum of 96 bytes to 512 bytes at its maximum.

Minimum instruction execution times range from about 2.5 µs when a 3.2 MHz clock is employed, to just 670 ns when the chips run from a 12-MHz clock. The 6502 processor core is also used by NCR Corp., Colorado Springs, Colo., to create custom custom microcontrollers, while Rockwell International, Newport Beach, Calif. has developed a single-chip controller with 2 kbytes of RAM and 64 bytes of RAM.

Depending on the chip in Mitsubishi's family, there can be from 14 to 48 I/O lines, asynchronous or synchronous serial ports, ADCs, DACs, PWM outputs, counter-timers, and special features including vacuum-fluorescent or liquid-crystal display drivers, telephone-tone generators, or variable-threshold comparators. A complex chip, the M37409M2, combines the controller, 192 bytes of dual-ported RAM, 320 bytes of normal RAM, 4 kbytes of ROM, three full-duplex serial ports, an 8-bit timer, and two byte-wide I/O ports.

Targeting the high-throughput applications, the K-series processors from NEC offer designers highly efficient CPUs. The company currently has close to 20 devices defined and in production, with more to be released before year's end. In the K2 family, versions are available with RAMs as large as 1 kbyte and ROMs or EPROMs of up to 32 kbytes. As with the Motorola 68HC11, NEC offers one type that packs 16 kbytes of ROM, 512 bytes of RAM and 512 bytes of EEPROM—the uPD78244.

The K-series is crafted for speed—at 12 MHz the K2 chips execute instructions in 333 ns—about half the time required by the 68HC11 or TMS370 controllers. Due later this year are 16-MHz versions that cut the instruction cycle time to 250 ns. Serial I/O ports, counter timers, and multichannel ADCs and DACs are common on most devices in the K series. One carryover from the previous uPD7800 family of 8-bit controllers is an improved on-chip peripheral management unit that offloads the CPU core from handling interrupts and greatly reduces the processor's response time to interrupts.

Hitachi's H8 series also offers high speed, executing instructions in as little as 200 ns. It comes with a wide variety of memory and I/O options, including EPROM, OTP, ROM, and ROM-less versions. First off the production line is the H8/532, an 8-bit unit with an ADC, 1 kbyte of RAM, 32 kbytes of EPROM, eight timers,a high-performance serial port, and 65 I/O lines.

Yet another controller family is available from Fujitsu Microelectronics Inc., San Jose, Calif.—the MB89700 series. The controllers pack up to 16 kbytes of ROM or EEPROM, 512 bytes of RAM, an 8-bit 8-channel ADC, multiple counter-timers, a serial port, and up to 53 parallel I/O lines. They also have a relatively high-performance instruction set, executing the shortest commands in just 500 ns when running at 12 MHz.

Tackling the high-speed but low-end, minimal-feature set needs in the market, Microchip offers two simple controllers that rip through their instructions at just 200 to 400 ns each. The PIC16C54 and C55 have small ROMs and RAMs—just 512 bytes of EPROM and 32 bytes of RAM—and low-pin counts—18 and 28 pins, respectively—to keep the chip prices to less than $1 in large quantities, for the smallest unit.

Another high-speed offering comes from joint effort by National Semiconductor Corp., Santa Clara, Calif., and Sierra Semiconductor Corp., San Jose, Calif. The COP800, which also goes after the low end of the market, comes in versions with ROM or EEPROM on-chip and contains a simple mix of the basic I/O functions—parallel ports, counter-timers, and simple serial ports that tie into National's family of serial peripheral support chips.□

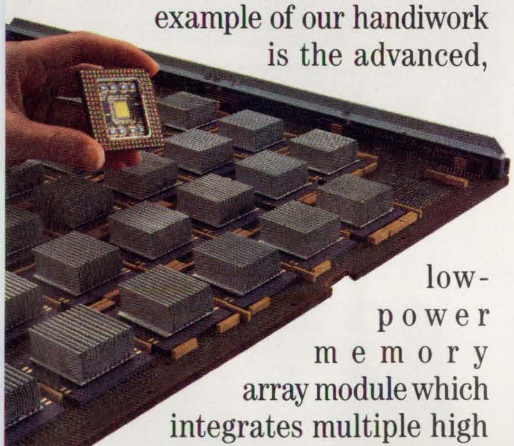
HOW VALUABLE?	CIRCLE
HIGHLY	544
MODERATELY	545
SLIGHTLY	546

MOTOROLA

YOU'RE READING A MOTOROLA ASIC AD.

It may not look like one, but it is. You see, even the world's most advanced semiconductor technology means nothing until someone puts it to good use. Someone like Unisys.® So while this may look like an ad for the powerful new Unisys A16 computer, it isn't. It's really a testimony to the power of partnerships.

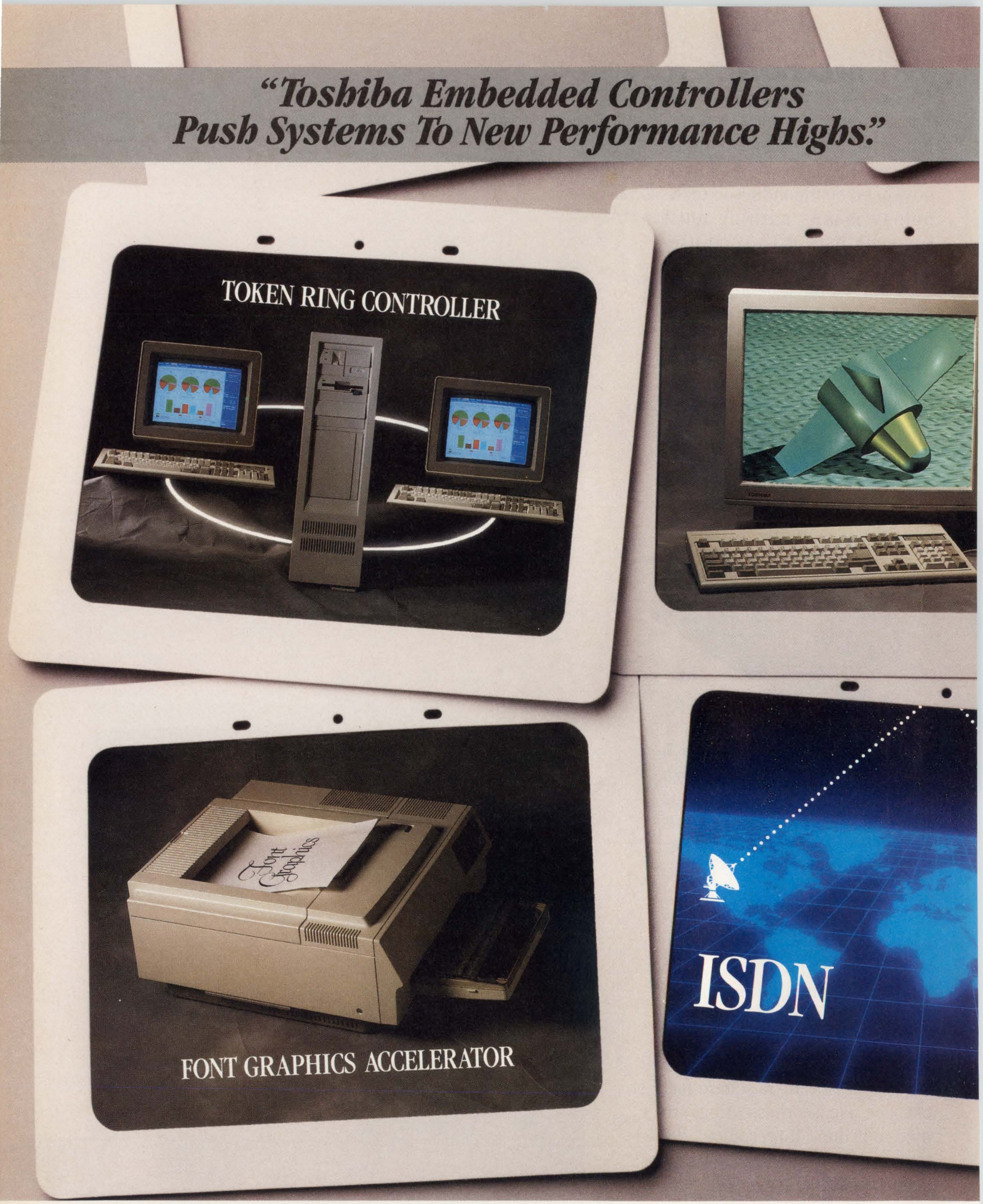
Unisys joined forces with Motorola's ASIC division in applying leading-edge technology to meet customers' needs. An example of our handiwork is the advanced,



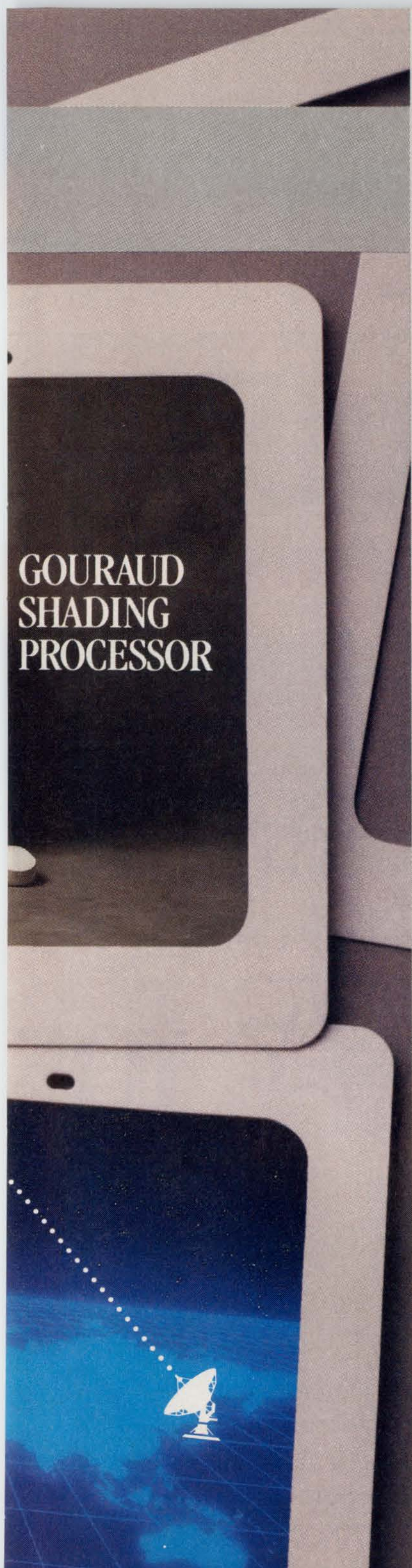
low-power memory array module which integrates multiple high speed memories with our semicustom ECL arrays, dramatically reducing interface delays.

But please, don't get so caught up in the A16's exceptional cost/performance ratio. Don't be overwhelmed by its incredible performance and reliability. Or its environmental efficiencies in electricity and cooling. There's more to life than mainframe performance housed in a unit that requires less than 10 square feet of space. Please, these things are nice, but don't forget about the teamwork and technology that made it possible.

UNISYS



"Toshiba Embedded Controllers Push Systems To New Performance Highs."
TOKEN RING CONTROLLER
FONT GRAPHICS ACCELERATOR
ISDN



"But what's in it for us today?"

"A full line of embedded controllers for our integrated systems, which means we can drop man-years of software development."

"You mean we can do it all with hardware, and achieve orders of magnitude greater performance?"

"Yes, this is what we have been looking for. When can we get started?"

"I've got Toshiba here today!"

It's true. With Toshiba's highly integrated line of embedded controllers, you won't have to rely on slow, memory-hungry software routines any more. Instead, a single embedded chip implements complex algorithms. The result—a system running at least an order of magnitude faster than even optimized software routines.

This advanced line-up of embedded controllers is a product of Toshiba's leadership in CMOS technology. Each offers a single chip embedded solution to a specific application. All provide significant advantages in system speed and throughput over other products on the market. And they provide a higher level of system integration.

If you're designing laser or print-shop quality printing systems, for instance, the TC8511F Font Graphics Accelerator (FGA) provides the full set of font rasterizing algorithms. For everything from common fonts to the most demanding graphics characters. Rasterizing is conducted with algorithms for Bezier curves, straight lines, arcs and ellipses.

The Gouraud Shading Processor (GSP), on the other hand, provides for the smooth shading of 3-D or 2-D graphic displays. The solution is based on a Gouraud shading procedure, and is intended especially for PC and workstation displays.

The Token Ring Controller (TRC) is an IEEE 802.5 based LAN controller utilizing token ring protocol. It also includes MAC operations, supports bridge functions, and is 16/4 Mbps software switchable as well. The TRC operates with a Toshiba BiCMOS media driver.

For international standard communications, the ISDN protocol controller meets the CCITT basic rate interface recommendations. It is suitable for broad applications such as digital telephone, facsimile, terminal adapter and other ISDN terminals.

There's a good deal more to tell you about these advanced embedded controllers. But we just don't have the room. If you'd like technical literature for any of them, give us a call at 1-800-888-0848, ext. 517. We'll fill in whatever details you need. *Service is our key component.*

In Touch with Tomorrow

TOSHIBA

TOSHIBA AMERICA ELECTRONIC COMPONENTS, INC.

CIRCLE 107

CSM-89-001-1

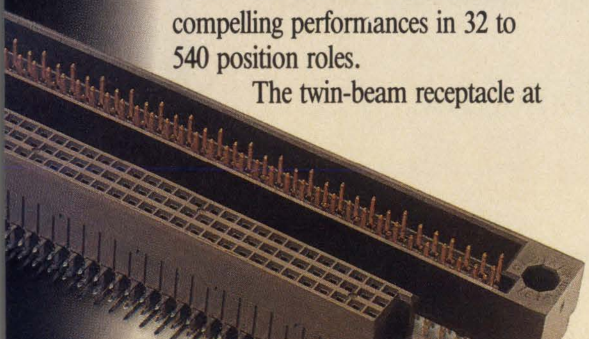
MINNESOTA, Electric Components Sales, (612) 933-2594; **MISSISSIPPI,** Montgomery Marketing, Inc., (205) 830-0498; **MISSOURI,** D.L.E. Electronics, (316) 683-6400, R.W. Kunz, (314) 966-4977; **MONTANA,** Components West, (206) 885-5880; **NEVADA,** Elrepco, Inc., (415) 962-0660; **NEW JERSEY,** Nexus Technology, (201) 947-0151; **NEW MEXICO,** Summit Sales, (602) 998-4850, (505) 345-5003; **NEW YORK,** Nexus Technology, (201) 947-0151; **NEW YORK** (Upstate), L.D. Allen, (315) 437-8387; **NORTH/SOUTH CAROLINA,** Montgomery Marketing, Inc., (919) 467-6319, (919) 851-0010; **NORTH/SOUTH DAKOTA,** Electric Component Sales, (612) 933-2594; **OHIO,** J.R. Thornberry, (216) 247-0060, (614) 792-5171; **OKLAHOMA,** MIL-Reps, (214) 644-6731; **OREGON,** Components West, (503) 684-1671; **PENNSYLVANIA,** Nexus Technology, (215) 675-9600, J.R. Thornberry, (412) 745-8441; **TENNESSEE,** Montgomery Marketing, Inc., (205) 830-0498; **TEXAS,** MIL-Reps, (512) 346-6331, (713) 444-2557, (214) 644-6731; **UTAH,** Straube Associates Mountain States, Inc., (801) 263-2640; **VIRGINIA,** D.G.R., Inc., (301) 583-1360; **WASHINGTON,** Components West, (206) 885-5880, (509) 922-2412; **WEST VIRGINIA,** D.G.R., Inc., (301) 583-1360; **WISCONSIN,** Carlson Electronics, (414) 476-2790, Electronic Component Sales, (612) 933-2594; **WYOMING,** Straube Associates Mountain States, Inc., (303) 426-0890; **CANADA, BRITISH COLUMBIA,** Components West, (206) 885-5880; **ONTARIO,** Electro Source, Inc., (416) 675-4490, (613) 592-3214; **QUEBEC,** Electro Source, Inc., (514) 630-7486.

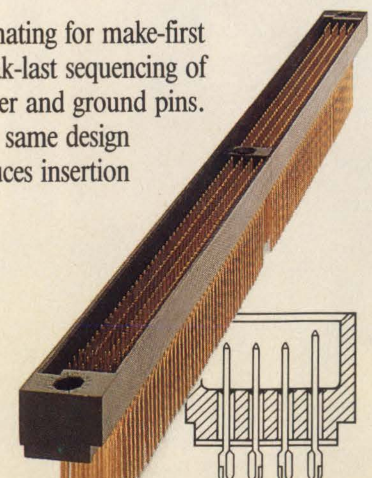
"... ★★★★ for

AMP TBC (Twin-Beam Contact) Connectors steal the show for high-density, high-pin-count affordability. Three- and four-row versions deliver compelling performances in 32 to 540 position roles.

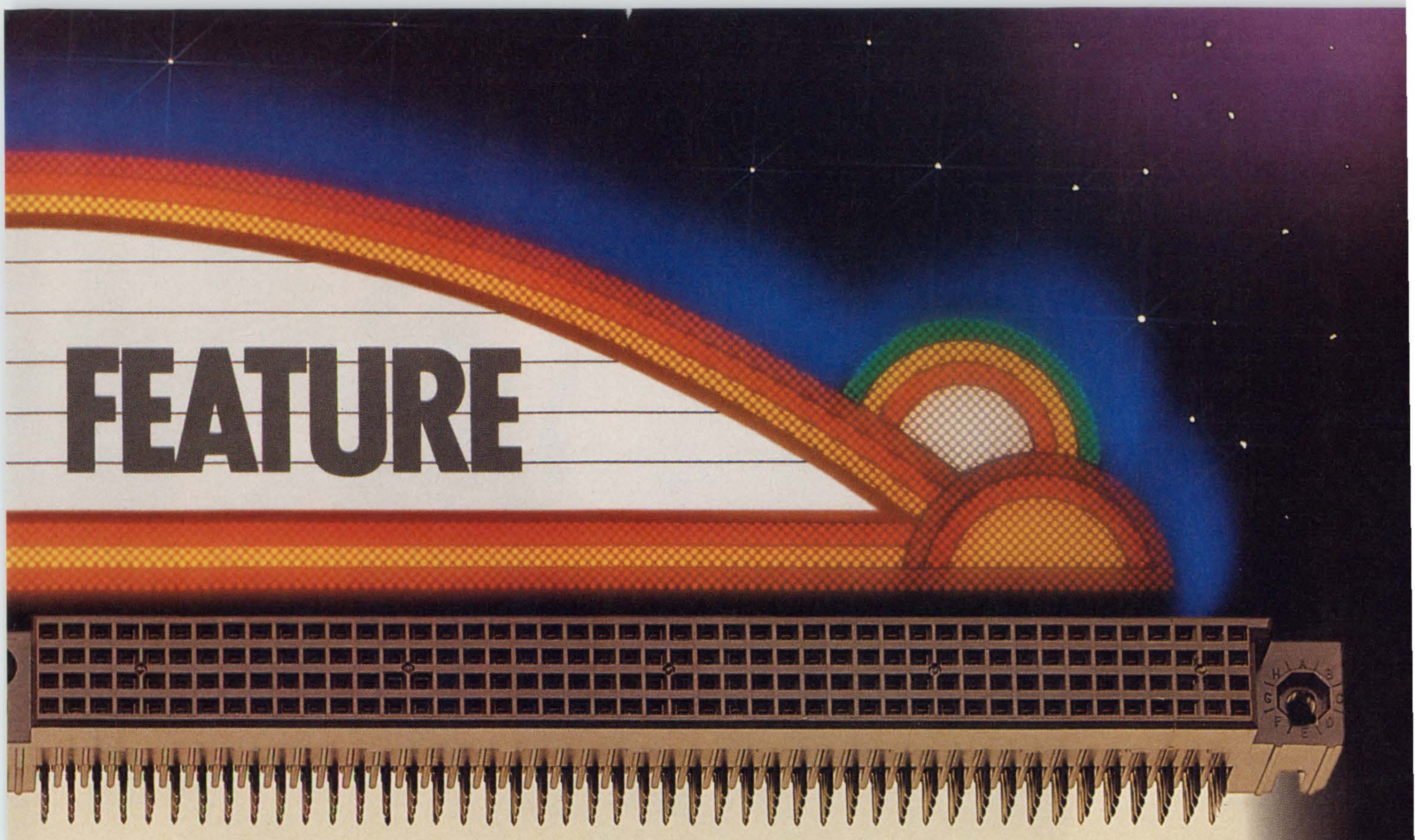
The twin-beam receptacle at the heart of the TBC Connector represents the very best of AMP engineering—the greatest economy of material consistent with design excellence. It provides two-point contact (with gold-over-nickel plating), and the BeCu base assures high normal forces of 50 grams/contact (end of life minimum) for solid dependability.

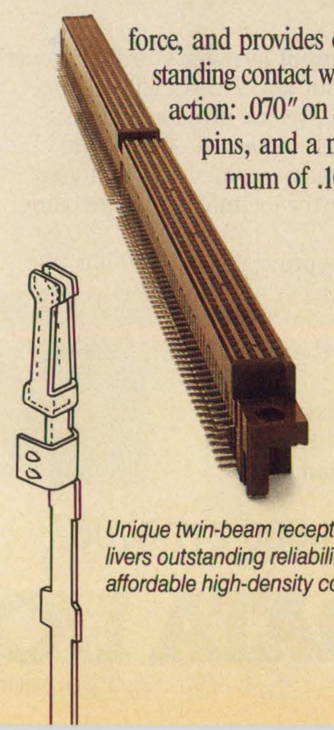
There's more here than economy, though. Tightly controlled, short point-of-contact geometry allows two levels of mating for make-first break-last sequencing of power and ground pins. The same design reduces insertion





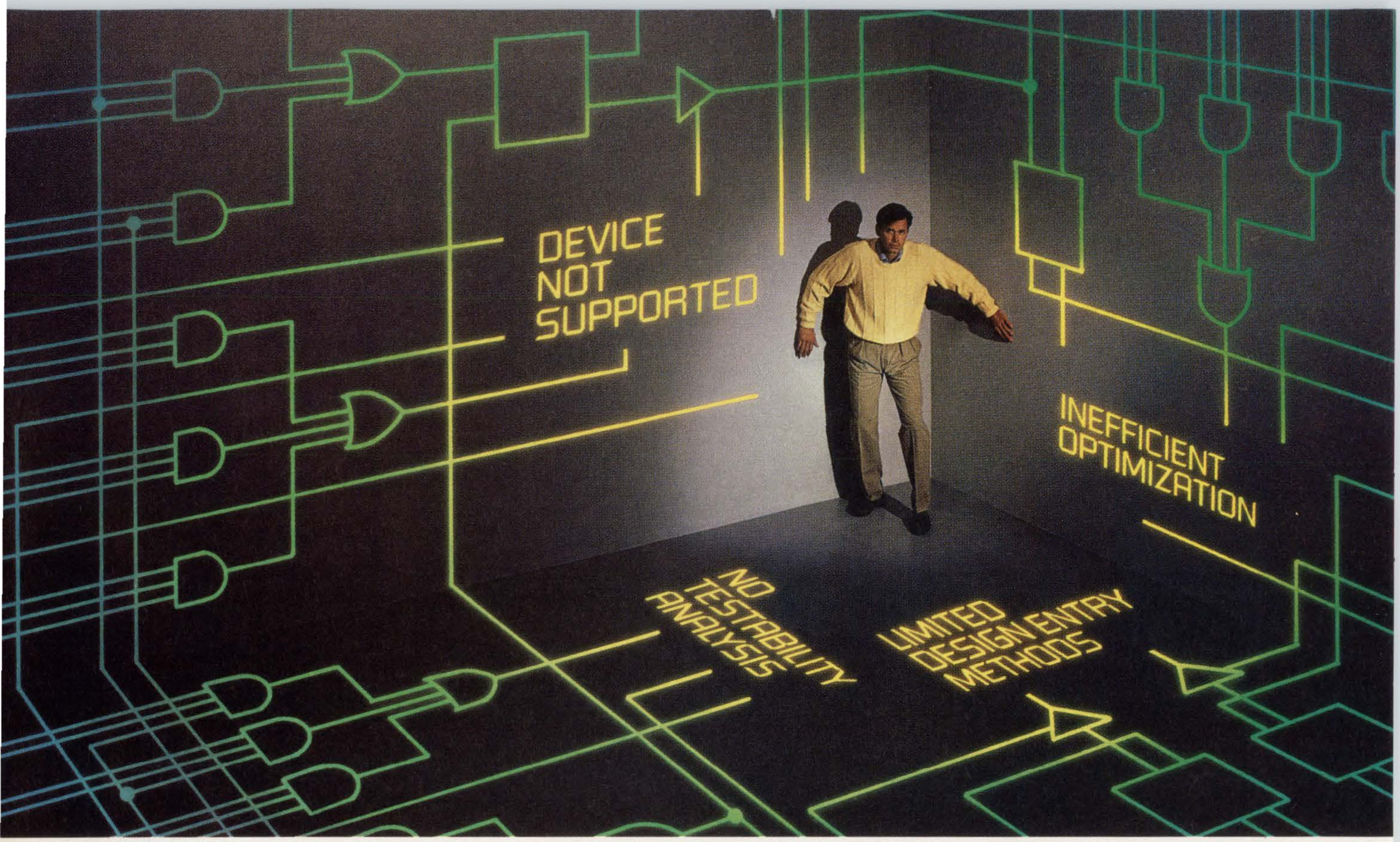
Two levels of sequenced mating allow "hot" connect/disconnect. Compliant pin option for solderless pcb insertion.





Unique twin-beam receptacle delivers outstanding reliability in an affordable high-density connector.

CIRCLE 99



Don't get cornered by limited PLD design software.

A close look at most PLD design software reveals disturbing dead-ends. Unsupported devices, limited design entry methods, inefficient optimization, and lack of testability analysis can stop the design process cold.

Data I/O® gives you powerful PLD design software that outperforms the competition in every category. And we can prove it.

Data I/O supports more computing platforms including 286- and 386-based PCs, Sun & Apollo workstations, VAXs and Apples.

More devices supported. Data I/O supports more PROMs, traditional PLDs, complex PLDs, and FPGAs. Our device coverage includes every semiconductor manufacturer on the market and more than 200 different device architectures.

More design entry methods. Enter your design using any combination of high-level logic equations, truth tables, state machines, or schematics. Only Data I/O offers true high-level design entry.

More levels of verification. Behavioral verification checks the circuit's function as you design. After synthesis, partitioning and PLD selection, structural verification provides full debugging of every fuse, node and pin.

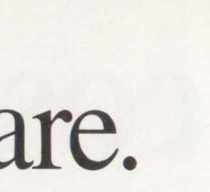
More efficient optimization. Produce more compact, efficient designs with multiple levels of reduction—optimized for each device architecture—and automatic factoring.

Full testability analysis. Using fault grading techniques, our tools analyze the testability of your circuit and identify untestable portions. They also automatically generate test vectors to provide the best fault coverage possible.

More output formats. Our tools generate output for PROMs, PLDs, and FPGAs. We can provide pinlists, netlists, Berkeley PLA files, and schematics—whatever output you need for the technology you're using.

Make us prove it. Data I/O has the world's most powerful PLD design tools. Ask for the proof.

Call today for a FREE PLD design evaluation kit.



1-800-247-5700

DATA I/O
Corporation

Data I/O Corporation 10525 Willows Road N.E., P.O. Box 97046, Redmond, WA 98073-9746, U.S.A. 1-800-247-5700/Telex 15-2167
Data I/O Canada 6725 Airport Road, Suite 302, Mississauga, Ontario L4V 1V2 (416) 678-0761
Data I/O Europe World Trade Center, Strawinskylaan 633, 1077 XX Amsterdam, The Netherlands +31 (0)20-6622866/Telex 16616 DATIO NL
Data I/O Instrumatic Electronic Systems Vertriebs GmbH Lochhamer Schlag 5A, 8032 Frafelfing, W. Germany, 089-85-85-80
Data I/O Japan Sumitomoseimei Higashishinbashi Bldg., 8F, 2-1-7, Higashi-Shinbashi, Minato-Ku, Tokyo 105, Japan (03) 432-6991/Telex 2522685 DATAIO J

AUTOMOTIVE ELECTRONICS

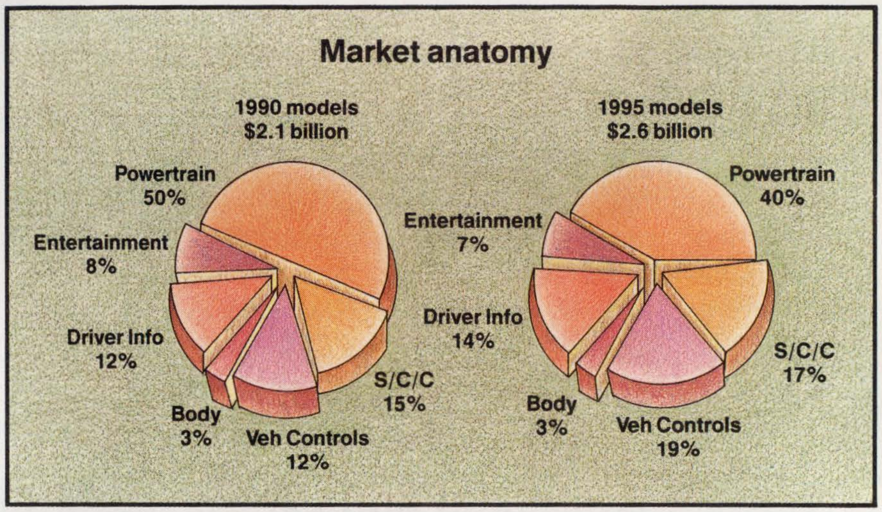
EDITORIAL FEATURE

Autos Spur the 90s

Transportation emerges as the next catalyst for electronic component technology.

JOHN GYORKI AND MILT LEONARD

THE ELECTRONICS industry is undergoing a fundamental change, spurred on by new applications in vehicles. Automakers in the 1990s will increasingly depend on electronics to meet ever more strict safety and emissions standards. Moreover, manufacturers now see auto electronics technology as a means of getting a competitive edge. The result: Innovative applications in ride control, entertainment, and driving aids have already been developed, and indications are that the best is yet to come. The next phase of automobile development will treat the auto as a total integrated system which will rely on substantially higher levels of computer speed and memory.



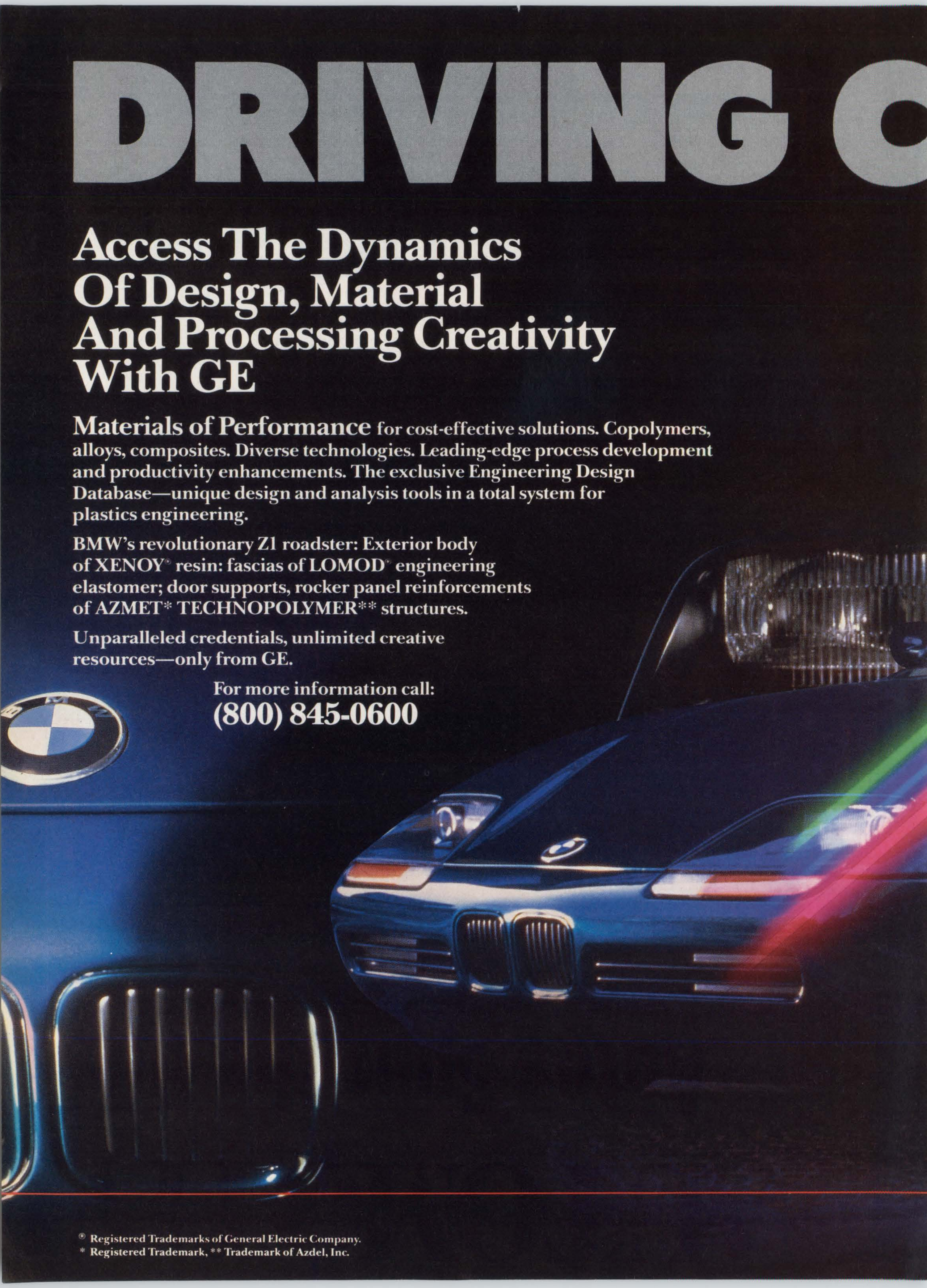
ELECTRONIC CONTROLS for the power train of American cars are expected to account for the lion's share of the auto electronics market, according to Dataquest. Electronics for vehicular controls will experience the largest growth, while other market segments undergo little change.

Experts feel that automotive applications may stimulate the demand for electronics in the 1990s as the PC did in the early 1980s. Electronics companies that supply European and Japanese automakers may benefit in particular. The reason is that these car builders tend to buy electronic components from outside suppliers. The Big Three automakers in Detroit, on the other hand, tend to obtain most of their electronics from internal divisions.

TRENDS AND PROJECTIONS

According to Roger Grace Associates, a San Francisco-based consulting firm, automakers' increasing dependence on electronic solutions (along with a growing automotive market) will boost the worldwide automotive electronics market from an estimated $12.5 billion in 1987 to $35 billion by 1995. Growth for North American auto electronics is equally dramatic. Where a 1970 model car from Ford Motor Co. contained about $25 worth of electronics, the electronic content per vehicle of 1984 models averaged $585. Projections for 1995 indicate a jump to $1,500 per vehicle, and to $2,000 by the end of the decade. Similarly, Chrysler Corp. estimates a jump from an average $350 for a 1988 model to about $1,400 for a 1992 model. The increased emphasis on automotive electronics is also reflected in a study conducted by The University of Michigan at Ann Arbor. The Delphi V study reports that electronics will represent 20% of a car's total value by the year 2000.

Another study by Dataquest Inc., a San Jose-based market research and consulting firm, divides an estimated $2.6 billion electronics market for the North American passenger-car industry into application areas. Most expenditures (40%) will go toward power-train controls such as ignition systems, emission control, and engine and transmission control. Vehicle controls will comprise another 19%, followed closely by the safety, comfort, and convenience (SCC) aspects of automotive design, which will consume 17% of the market. Currently the fastest growing segment of the automotive market, SCC includes keyless entry, automatic climate control, memory seats, and antiskid


DRIVING C
Access The Dynamics Of Design, Material And Processing Creativity With GE
Materials of Performance for cost-effective solutions. Copolymers, alloys, composites. Diverse technologies. Leading-edge process development and productivity enhancements. The exclusive Engineering Design Database—unique design and analysis tools in a total system for plastics engineering.
BMW's revolutionary Z1 roadster: Exterior body of XENOY® resin: fascias of LOMOD® engineering elastomer; door supports, rocker panel reinforcements of AZMET* TECHNOPOLYMER** structures.
Unparalleled credentials, unlimited creative resources—only from GE.
For more information call:
(800) 845-0600
® Registered Trademarks of General Electric Company.
* Registered Trademark, ** Trademark of Azdel, Inc.


HANGE
GE Plastics
CIRCLE 122

ELECTRONIC FUEL INJECTION

ELECTRONIC FUEL-INJECTION (EFI) computers basically control engine air-fuel (A/F) ratios to handle changing conditions. For example, a ratio of 14.7/1 is optimal for cruise conditions, but a richer mixture is needed for cold start and wide open throttle (WOT). Similarly, a leaner mixture is required for decelerations; sometimes the fuel is totally cutoff on deceleration.

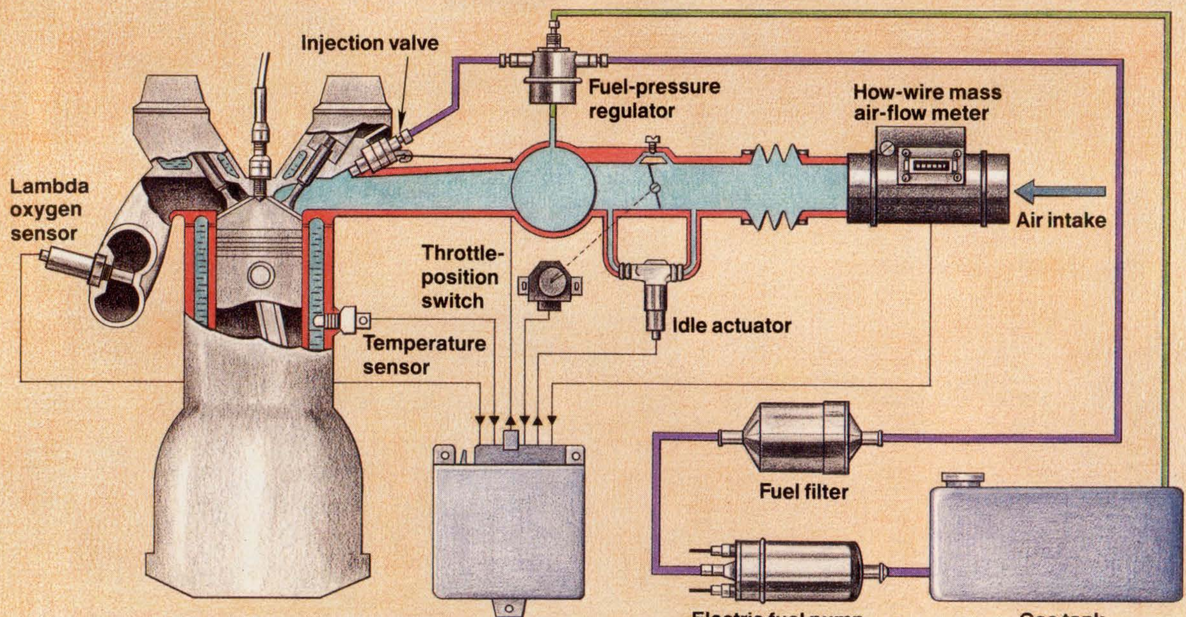
Sensors give the EFI controller information about the volume of air inducted so it can calculate the precise amount of fuel to be injected. Direct-measuring mass airflow sensors were not readily available for use in early EFI systems. Rather, a so-called speed density system was employed that measured engine speed, manifold vacuum, and inducted air temperature. Mass air intake could only be interpolated from these secondary measurements. Inaccuracies resulted and had to be corrected.

However, Bosch of Germany recently developed an advanced mass airflow sensor that overcomes such drawbacks. The air meters use either a hot wire or hot film as the sensing element. Inducted air tends to cool the heated resistance element as it passes. The idea is to adjust current through the element to keep it at a constant temperature. The amount of current flow is proportional to airflow and, thus, serves as a measure of inducted air mass.

Exhaust emission and fuel economy requirements have forced engine designers to constantly improve fuel-management techniques. For example, systems are being designed to learn and adapt to changing driving conditions and engine parameters. New solutions to internal-combustion engine-management problems include injection valves with split spray jets for engines containing four valves per cylinder, hot wire mass airflow meters, and highly integrated electronic ignition systems.

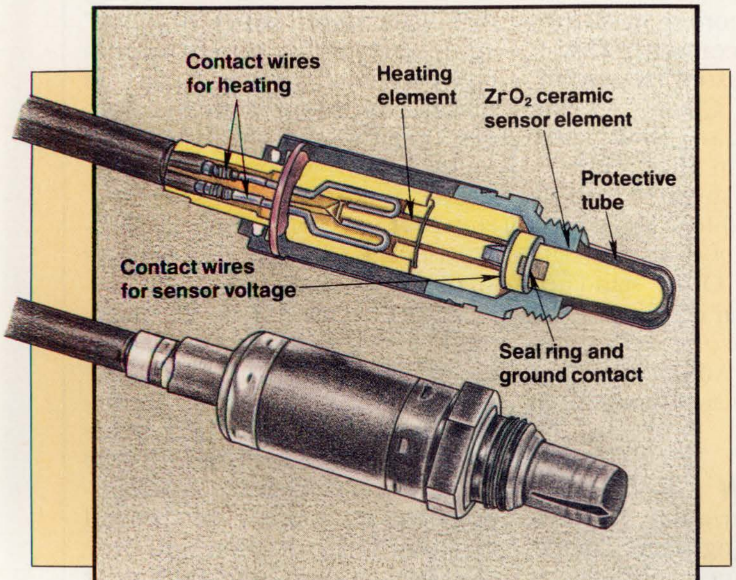
Two basic types of EFI systems are widely used. The first is called multiport injection where each cylinder has a separate fuel injector. The other is single-point injection where one main injector sits in the throttle body.

The Mono-Jetronic system by Bosch uses a simple single-point, throttlebody injection system (TBI). Gasoline is injected through a single solenoid-operated valve located above the throttle valve. This thoroughly atomizes fuel at the point of maximum air velocity.



THE LH-JETRONICS system with hot-wire airflow sensor is one of the most advanced EFI systems available for passenger cars. Earlier systems, such as the L-Jetronic, contained a moving vane (pushed by the airflow) connected to a position-sensing potentiometer.

Like most other EFI systems, the LH-Jetronic fuel system is controlled by solenoid-operated injector valves. The pressure drop at the injector nozzle (metering point) is held constant with a pressure regulator. Thus, the injected volume of fuel depends solely on the opening period of the injector valves as calculated by the electronic control unit.



THE LAMBDA sensor developed by Bosch in the early 1970s is used in many European and U.S. vehicles today. Placed in the exhaust stream, the sensor constantly monitors the residual exhaust gas oxygen content and helps regulate it via the ECU. The downstream catalytic converter both chemically oxidizes and reduces the three principle toxic constituents — CO, HC, and NO_x.

The TBI system consists of a throttle valve, injection valve, pressure regulator, throttle valve potentiometer, temperature sensor, and throttle valve servomotor. Because of the compact and low-profile design, the throttle body can mount directly on the intake manifold.

Fuel-injection control and exhaust gas optimization is handled by an intelligent system, called Alpha-n control. This is a self-adaptive controller that monitors the exhaust gas (Lambda) sensor, throttle valve angle, and engine speed. These inputs determine the fuel-control schedule, also known as the engine map.

The computer monitors exhaust gas composition and stores the data in memory. Next, it calculates an optimum operating point, outputs a new fuel-injection signal, then rechecks the exhaust gas. The intelligent system takes into consideration warm-up characteristics, differences in temperature, air pressure, and the engine condition.

The exhaust gas Lambda sensor developed by Bosch has been in production since 1976. It is used in the U.S., Japan, and Europe on more than 10 million vehicles.

The Lambda sensor sit in the exhaust gas stream, typically in the exhaust pipe ahead of the catalytic converter. The external surface of a Z_rO_2 ceramic sensing element protrudes into the exhaust gas flow and the inner surface is exposed to outside air. The Z_rO_2 electrodes generate a small voltage that is proportional to the ratio of residual oxygen in the exhaust gas to oxygen in ambient air. When the ratio changes, the output voltage also changes.

The electronic control unit uses the Lambda output voltage as a factor in adjusting the air-fuel ratio. The exhaust gas composition is kept at a level that is optimum for treatment by the catalyst.

The Lambda sensor can only operate when the exhaust gas and manifold exceed 900°C. On some engines, the time for Lambda sensor warm-up is prohibitive so a self-heating sensor was developed. This permits closed-loop control within 30 s of starting and during idle.

braking. Driver information systems, such as digital gages, service reminders, trip and navigation computers, and CRT and head-up displays, will account for another 14%, and entertainment and body systems, such as multiplexing and lighting will comprise the rest.

NEAR-TERM BENEFITS

New car models showcase advanced electronic control systems from the power train throughout the chassis. For example, General Motors Corp. plans to equip all luxury and full-size 1991 cars with ABS (antilock braking systems), which will become standard on all models by 1994. A typical ABS combines wheel-speed sensors, microcontrollers, and brake-pressure modulators to apply pulsed brake pressure at each wheel without brake lockup.

Using many of the same components as ABS, traction control minimizes wheel slippage during vehicle acceleration. The front-wheel drive of the 1990 Cadillac Allante has a 2-stage antislip system made by Robert Bosch GmbH of Stuttgart, West Germany. The system combines front-axle traction control with Bosch's four-wheel ABS. Cadillac's 1992 Eldorado and Seville are expected to be similarly equipped. Other U.S. cars expected to have traction control next year are the Lincoln Town Car from Ford Motor Co. and the New Yorker Fifth Avenue and Imperial from Chrysler Corp.

Active suspension improves vehicular handling and safety by changing the damping force of shock absorbers according to driving conditions. European and Japanese auto suppliers are leading the technology with systems that respond to such variables as road surface, axle load, wheel turning angle, and even side loads caused by wind.

The list goes on with antitheft and security systems. GM's PASS-Key (personalized automotive security system) has an ignition key with an embedded resistor code which is read by electronic sensors in the ignition lock cylinder. If an improper key is inserted, the system disables the starting and fuel systems. In a more aggressive system by Ford, opening the door turns on the horn, blinks the lights, and disables the starter coil when the dome light is lit by opening the door.

With the number of in-vehicle control modules doubling to over 60 during the past ten years, the size and weight of wire harnesses that interconnect these functions has increased dramatically. To reduce the complexity of such links, U.S. carmakers are turning to multiplexed designs. These use a microprocessor to send pulse-width-modulated commands over a single wire to distributed output devices.

For example, an integrated system on the Buick Electra controls exterior mirrors, window motors, and door locks, and provides keyless entry, antitheft, and illuminated entry functions. Multiplexing reduced the number of wires passing through the door on the driver's side from 56 to 20. Multiplexing is also being used in the Cadillac Allante to power interior lighting modules and in Chrysler's collision-detection system to allow an engine-control module, body computer, and trip-fuel consumption computer to share data from various sensors.

The deployment of multiplexing technology in automotive applications has been delayed by a lack of international standards. In pursuit of a common approach to system protocol, standards committees in the U.S., Japan, and Europe have devised three classes of multiplexed systems as a starting point: Class A for low-speed body wiring and control functions, Class B for medium-speed data communications, and Class C for high-speed, real-time control. Furthermore, the Society of Automotive Engineering (SAE) is expected to complete its recommended practice (J1850) for Class B applications late this year.

Networking schemes will also show up in automotive applications. Bosch has developed a technique called the automotive serial controller area network (CAN). Its protocol is supported in silicon from both Microcontroller Div. of Motorola Inc. (Austin, TX) and Intel Corp. (Santa Clara, CA) The network topology is a multimaster bus configuration that operates over either two shielded copper wires or fiber cable with a maximum bus length of 40 m and a data rate of 1M bit/s. Other standards vying for universal acceptance are the CarLink protocol from Detroit's Big Three, and Automobile Bus and VAN (vehicle area network) in Europe.

ON THE HORIZON

Even more intriguing features are in the planning stage. Digital signal-processing (DSP) techniques for speech synthesis and speech recognition will enable cellular telephones to be controlled by voice and talk to the driver. Cellular users can already use a system from L.A. Cellular in Los Angeles to receive traffic updates, vehicle location, and recommendations for hotels, restaurants, and trip designations.

For truck drivers, an emerging satellite technology called radio determination satellite service (RDSS) beams messages to areas not serviced by traditional communications systems. A terminal mounted in the cab displays the message on a screen, prints out a hardcopy, or delivers the message with a speech-synthesis system developed by Berkeley Speech Technologies of Berkeley, CA.

DSP technology is also behind an active noise-cancellation system being developed by Lotus Engineering in the United Kingdom. Aimed at reducing interior car noise, the system effectively "fingerprints" the sound picked up by several microphones distributed throughout the car, generates out-of-phase noise signals, and broadcasts this sound through the car's stereo speakers to cancel the noise. The system is expected to be offered to auto manufacturers within two years.

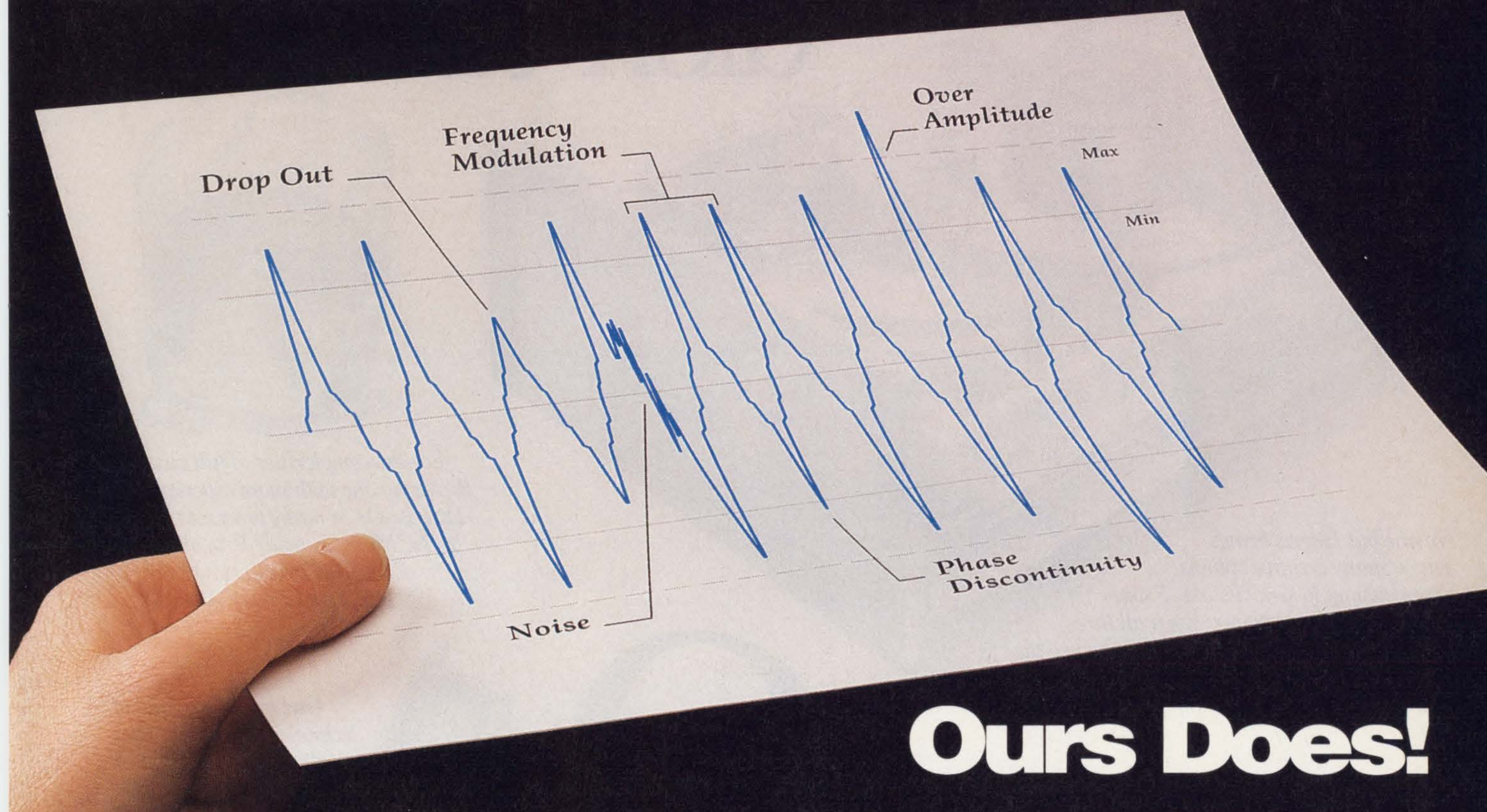
Although market growth beyond the mid-1990s is difficult to predict, driver information systems that work with "smart highway" equipment are expected to help fuel continued growth. Japan and Europe are far and away the leaders in this and related technologies such as sophisticated vehicular navigation systems. However, an experimental program in the U.S. may spur interest among domestic carmakers.

In part because of its legendary traffic jams, California is experimenting with a smart highway program which could lead to a commercial system by the mid-nineties. Jointly conducted by the California Department of Transportation (Caltrans), the Federal Highway Administration, and General Motors Corp., the Pathfinder program was initiated in 1988 to relieve traffic tie-ups by integrating traffic information with a vehicle navigation system.

The $1.6 million experiment uses 25 Oldsmobile Delta 88 sedans equipped with electronic navigation systems from Etak of Menlo Park, CA. The navigation system consists of a trunk-mounted communications console and a display screen fitted on the dashboard. The two-way communications system is linked to other test vehicles and to the Caltrans traffic operations Center in Los Angeles. Drivers receive traffic information visually on the display screen or by computer-synthesized voice. The screen shows area street maps, tracks the vehicle's position, and gives alternate routes for avoiding traffic.

The ultimate solution for smart highways will need to include sensors along the highway for gaging traffic density and speed. A traffic control center will retransmit this information to properly equipped vehicles. The scheme might even be used to regulate vehicle speed automatically. Though the prospects for smart highway technology are dramatic, several major hurdles remain, such as high installation cost, software development, and the need for communications protocols.

Does Your Signal Generator Simulate The Real World?



Ours Does!

The LeCroy Arbitrary Function Generators

The ideal signal source for testing duplicates any worst case signal that a DUT can encounter including variations in shape, frequency, duty cycle, amplitude, phase, and even noise.

Now there is such a source, the LeCroy Arbitrary Function Generator. You can create signals of any shape and vary all the parameters singly or simultaneously, separately or interactively. And the generation of test waveforms is not a problem. LeCroy's EASYWAVE® software is a complete toolkit for making test waveforms from scratch. Whether you choose to create waveforms by using equations, select elements from our library of simple elements, or even by acquiring real world signals with a digital oscilloscope! In minutes you will be building your signal; in an hour you'll be an expert.

Three models offer a choice of single, dual, or both analog and digital outputs. All have 100 MHz bandwidth (200 MHz clock), ± 10 V p-p swing, 5 ns risetime, and other characteristics optimized for high speed, high fidelity applications.

Call the technical information hotline **1-800-5-LECROY** for product information including the tutorial, " The Hows and Whys of AFG's", a demonstration version of EASYWAVE, or for application assistance.

CIRCLE 133 FOR INFORMATION
CIRCLE 134 FOR DEMONSTRATION

700 Chestnut Ridge Rd, Chestnut Ridge, NY 10977-6499 USA

LeCroy

Innovators in Instrumentation

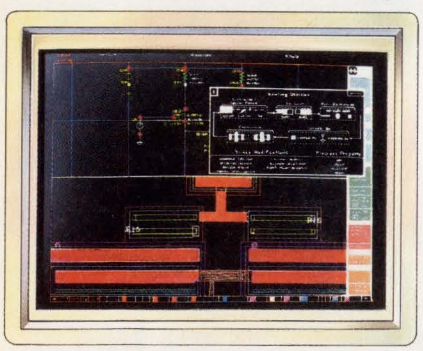
Harris ASICs are disk drives to

For the complexities of full custom, there's no one with more experience than Harris. Or so many processes: CMOS to BiCMOS. Bipolar JI to bipolar DI. Even BiCMOS/DMOS for Intelligent Power ASICs.

No one but Harris brings you so many creative options. From custom to semicustom. From digital to analog to power. Even all three combined. Our custom capability spawned the creation of two sophisticated ASICs which control the motor and disk head position in this Seagate disk drive.

Our broad portfolio of technologies and libraries allows for smooth integration of digital, analog and power—on a single chip. As in the mixed-signal subscriber line interface circuits we supply to major companies in the telecommunications industry.

Your success is ensured because Harris is committed to total customer satisfaction. We're the number one supplier of ASICs to the U.S. military, a responsibility which sets precedents for the levels of quality, reliability and service you require.



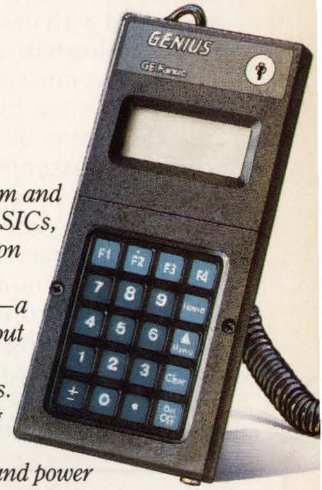
Our FASTRACK™ Design System, built on the Cadence Framework, offers you open architecture, exceptional design flexibility, easy upgrades and a standard user interface.*

Your ASIC possibilities are enriched through our strategic alliances. Advancell®, the international agreement of Siemens, Toshiba and Harris, offers you a cell-based design library with over 400 functions, including RAM, PLA and analog. Our gate arrays include 13 sizes with up to 110,000 equivalent gates.

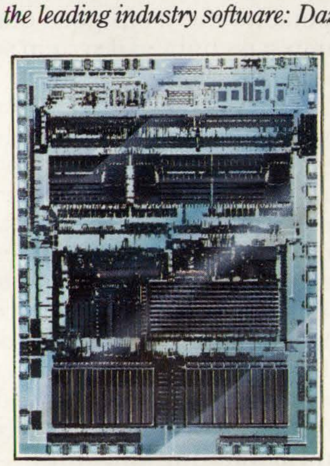
Harris is an unmatched source for a broad range of ASICs, including digital, analog, power, 6805 and RTX microcontrollers, and application-specific standard products. Last year alone, Harris introduced hundreds of complex new designs, now in operation in a wide variety of applications. For more information on how we can deliver your ASICs on

in everything from Sunday drives.

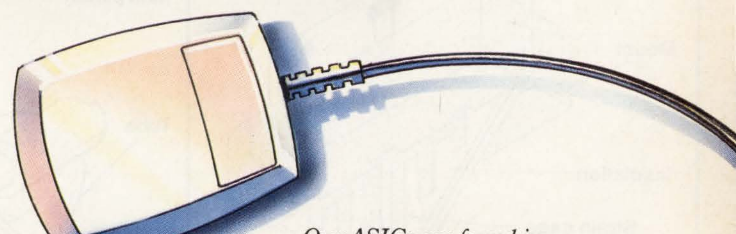
Our own ASIC design system — FASTRACK™ — isn't the only track; Harris also supports the leading industry software: Dazix, Mentor*, Valid* and OrCAD*.*



With the help of custom and off-the-shelf Harris ASICs, GE Fanuc Automation produced its unique Genius I/O System—a distributed input/output system with extensive diagnostic capabilities. Harris' wide-ranging capability lets you marry logic, analog and power for factory automation and other intelligent motor control applications.*

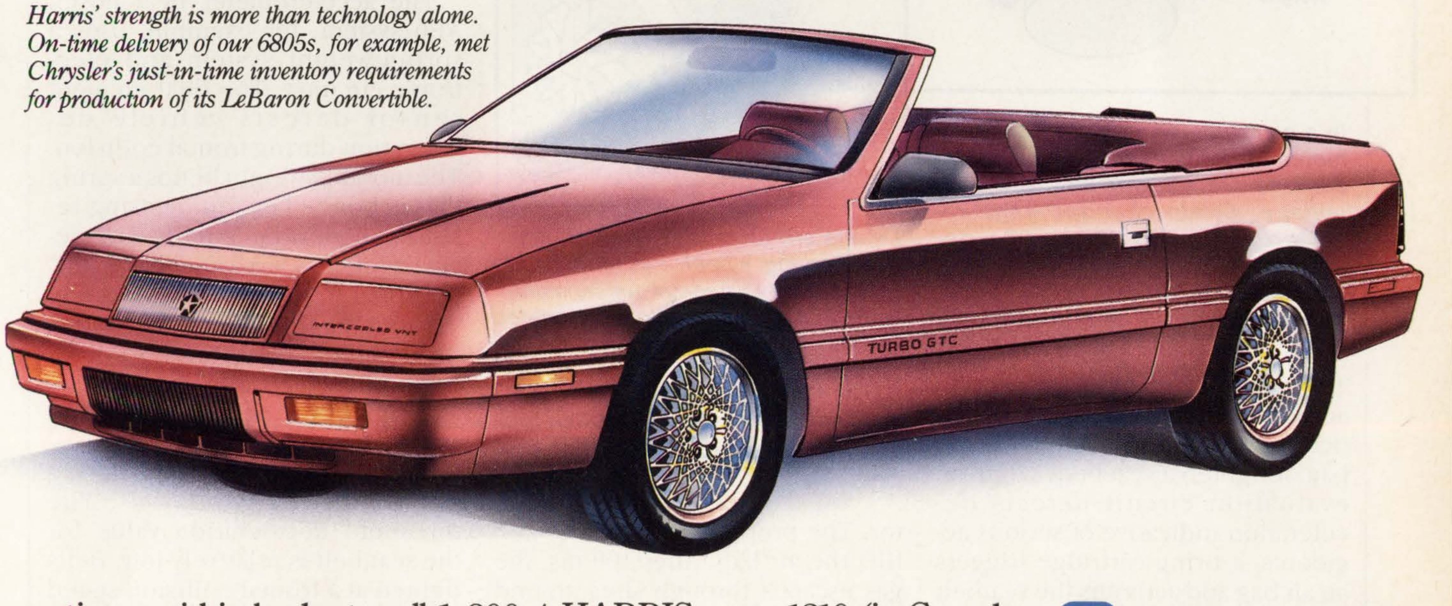


In core-based design, we support several industry standards including the 6805 and our RTX™ microcontrollers.



Our ASICs are found in many leading PCs. Some of the world's top creative designers—with small time-to-market windows—find our expertise can open doors.

Harris' strength is more than technology alone. On-time delivery of our 6805s, for example, met Chrysler's just-in-time inventory requirements for production of its LeBaron Convertible.



time, within budget, call 1-800-4-HARRIS, ext. 1210 (in Canada, 1-800-344-2444, ext. 1210). Or call your local sales office. Harris Semiconductor. What your vision of the future demands. Today.

HARRIS SEMICONDUCTOR
HARRIS · RCA · GE · INTERSIL

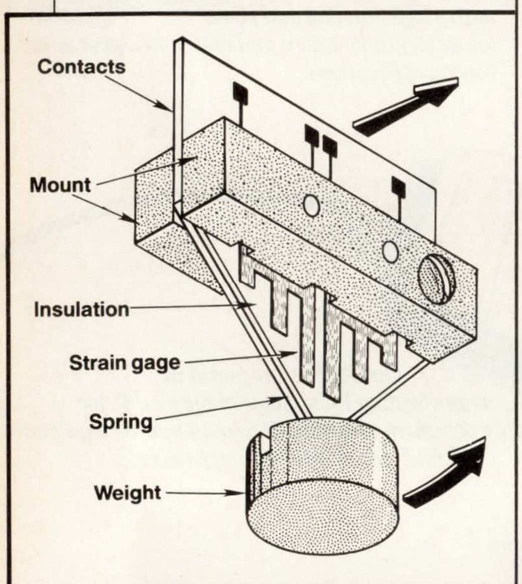
**Trademark of a company other than Harris Corporation.*

CIRCLE 144

PASSENGER RESTRAINT SYSTEMS

Seat belts have been widely used on American vehicles since the early 1960s. But recently, lawmakers have dictated that cars be equipped with passive restraints.

Beginning with model year 1990, all U.S. cars must provide a passive-restraint system for the driver, and in 1994 it must be available for the front seat passenger as well. Safety legislation places unusual demands on designers to provide air-bag systems that are reliable, do not deploy during minor fender-benders, can remain unused without degradation for long periods, and can survive a crash but still deploy. Key to such a system is a trigger unit that senses the magnitude of the crash.

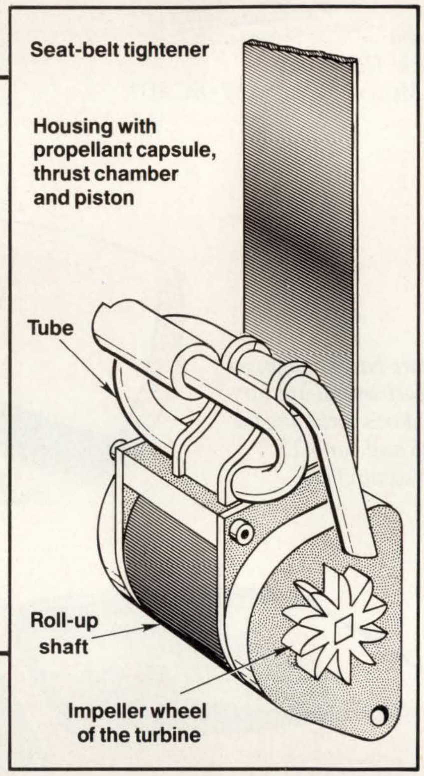


In a collision, a weight bends beam-mounted strain gages. The gages are a bridge circuit driven by a reference voltage. Strain changes gage resistance that is related to deceleration, unbalances the bridge, and signals the ECU. The ECU determines when the airbag should deploy.

The trigger unit must contain an acceleration sensor that accurately determines when to blow the air bag or tighten a seat belt. When an evaluation circuit detects deceleration indicative of serious accidents, a firing cartridge triggers an air bag and activates the seatbelt tensioner. In a frontal collision at 30 mph (18 km/h) — the velocity needed to trigger the air bag — the calculation is so fast that the cartridge fires within only 10 ms.

At the same time, the system must be sensitive enough to discern minor bumps that must not deploy the air bag. To prevent such problems, the device checks itself against data from test crashes to implement filtering action. For further reliability, a diagnostic program continuously checks the integrity of the entire electrical system, including the controller, cable and plug, and trigger unit.

At specified deceleration, the trigger sends an electrical pulse to a detonator located in a gas genera-



Drivers are protected by an airbag in the steering wheel. Passengers are restrained by a special belt tensioner. Upon impact, a capsule is detonated by an electrical signal, and the resulting high pressure expels a fluid against turbine blades. The turbine turns the shaft, reverses the roll-up mechanism, and tightens the seat belt.

tor. The propellent detonates and fills the air bag. After 100 ms, the gas escapes through slots around the edge of the bag and collapses to absorb the kinetic energy of the driver's body.

The seat-belt tensioner for the front seat passenger operates from the same trigger unit as the air bag. Propellent forces fluid against impeller blades of a turbine. Turbine wheel rotation forces a roll-up shaft to tighten the belt.

If the vehicle battery is disabled during an accident, a large capacitor gives enough backup power to operate the restraint system. A voltage converter assures that the full operating voltage is available for the trigger unit even if the battery drops as low as 4 Vdc.

A check lamp monitors the electrical system. The lamp illuminates when the ignition switch is on and remains lighted for about 10 s during a test cycle. If the system is operable, the lamp goes out. The lamp stays lighted if system service is needed.

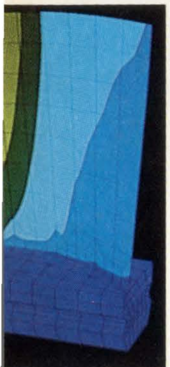
Older restraint systems were primarily mechanical, employing several sensors that can monitor only two or three parameters. Acceleration in these devices contained mechanical switches that tended to cause inadvertent bag deployment. In contrast, newer electronic units contain more sophisticated acceleration sensors, with microprocessor and digital signal-processing ICs for control and monitoring functions.

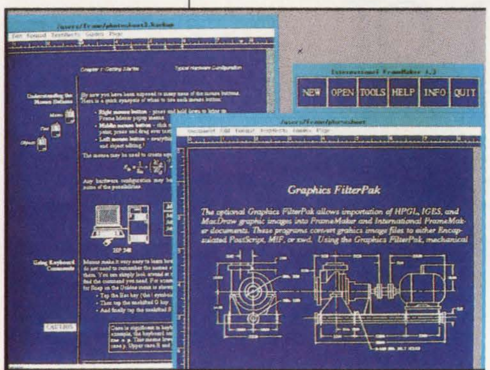
The accelerometer in a Bosch AB6 system, for example, uses a spring-weight system and electronic circuitry. The dual element sensor detects vehicle deceleration during frontal collision. The movable weight bends a spring that is bonded to four sensing resistors in a bridge circuit. The device generates a voltage that is proportional to the deceleration. The voltage is fed to an amplifier through a highpass filter.

A limiter stage follows that filters out high-frequency vibrations and subtracts signals less than 4 g — accelerations encountered during normal driving conditions. The threshold deceleration value for the seat belt is relatively low. Belts tighten at a frontal collision speed of only 25 mph (15 km/h). But the threshold level for the air bag is approximately 42 mph (25 km/h).

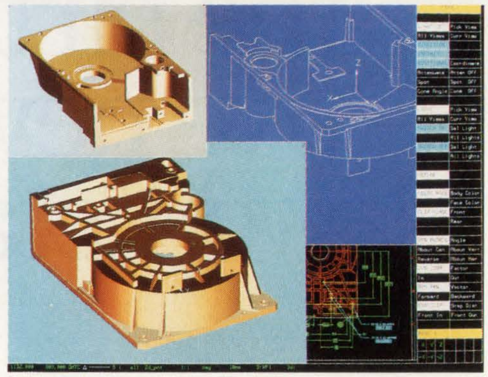
HP and Apollo proudly announce the birth of five new workstations.

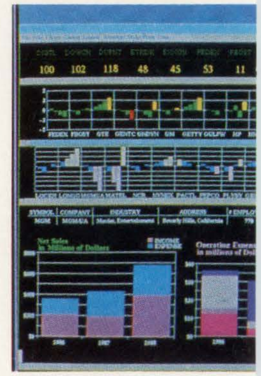
As you'd expect, compatibility runs in

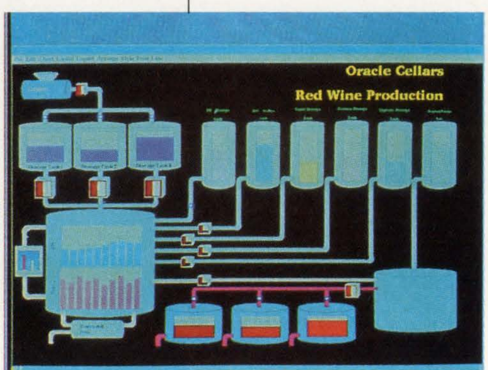




Documentation

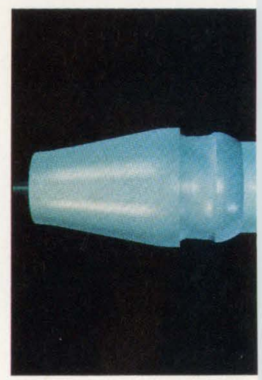

Solid modeling for mechanical engineering

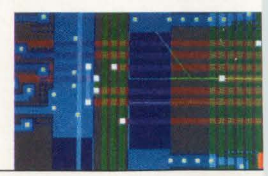

Graphic informa

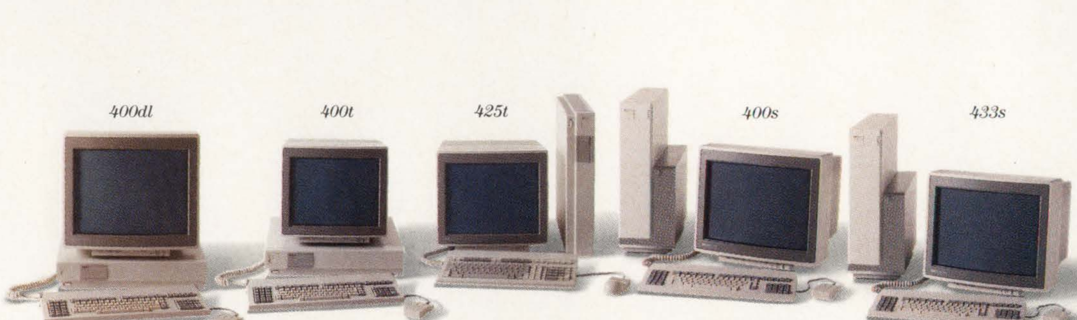


Graphic information system


Advanced 3D graphics

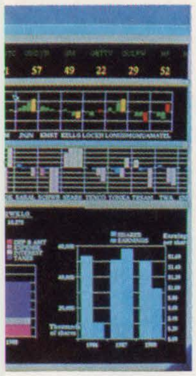

Mechanical computer-



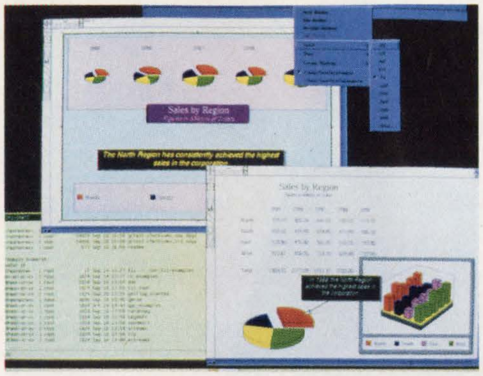


The HP Apollo 9000 Series 400.

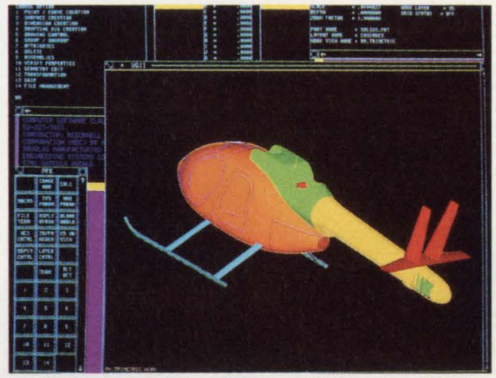
the family.



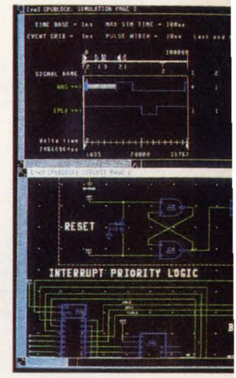
tion system

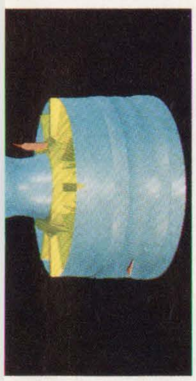


Presentation spreadsheet



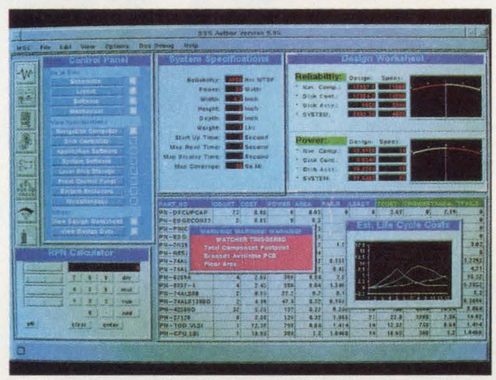
Mechanical CAD and manufacturing



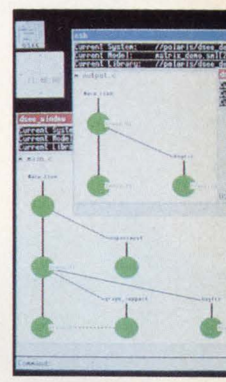


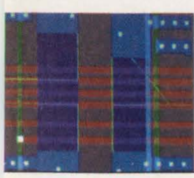
aided engineering

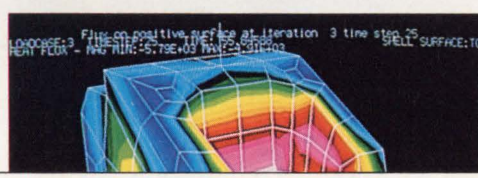
CASE configuration management

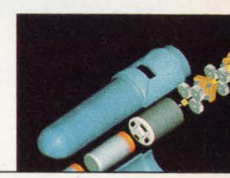


Electronic design automation









You're ready for more powerful workstations. But you want them at a reasonable price. And you don't want to sacrifice your software investment to get them.

Hewlett-Packard has a better way.

The new Hewlett-Packard Apollo 9000 Series 400 workstations. Based on the latest Motorola technology, they give you astonishingly fast performance at a very low price. As well as the capability to handle over 3200 applications, the broadest and best set of applications available.

At the entry level, there's the very powerful 400dl with 12 MIPS for under \$5,000.* The 425t with 20 MIPS and 3.5 MFLOPS is priced under \$9,000.* And, there's the affordable 433s, with 26 MIPS and 4.5 MFLOPS for under \$16,000.*

Our new VRX graphics options offer you excellent performance for 2D graphics with X Windows. Or add the unparalleled power of our advanced 3D graphics for the best rendering technology in the industry.

The affordable, compatible new generation of Hewlett-Packard Apollo workstations. Just the kind of innovation you'd expect from HP Apollo. For more information, call **1-800-752-0900, Ext. 1540.**

There is a better way.

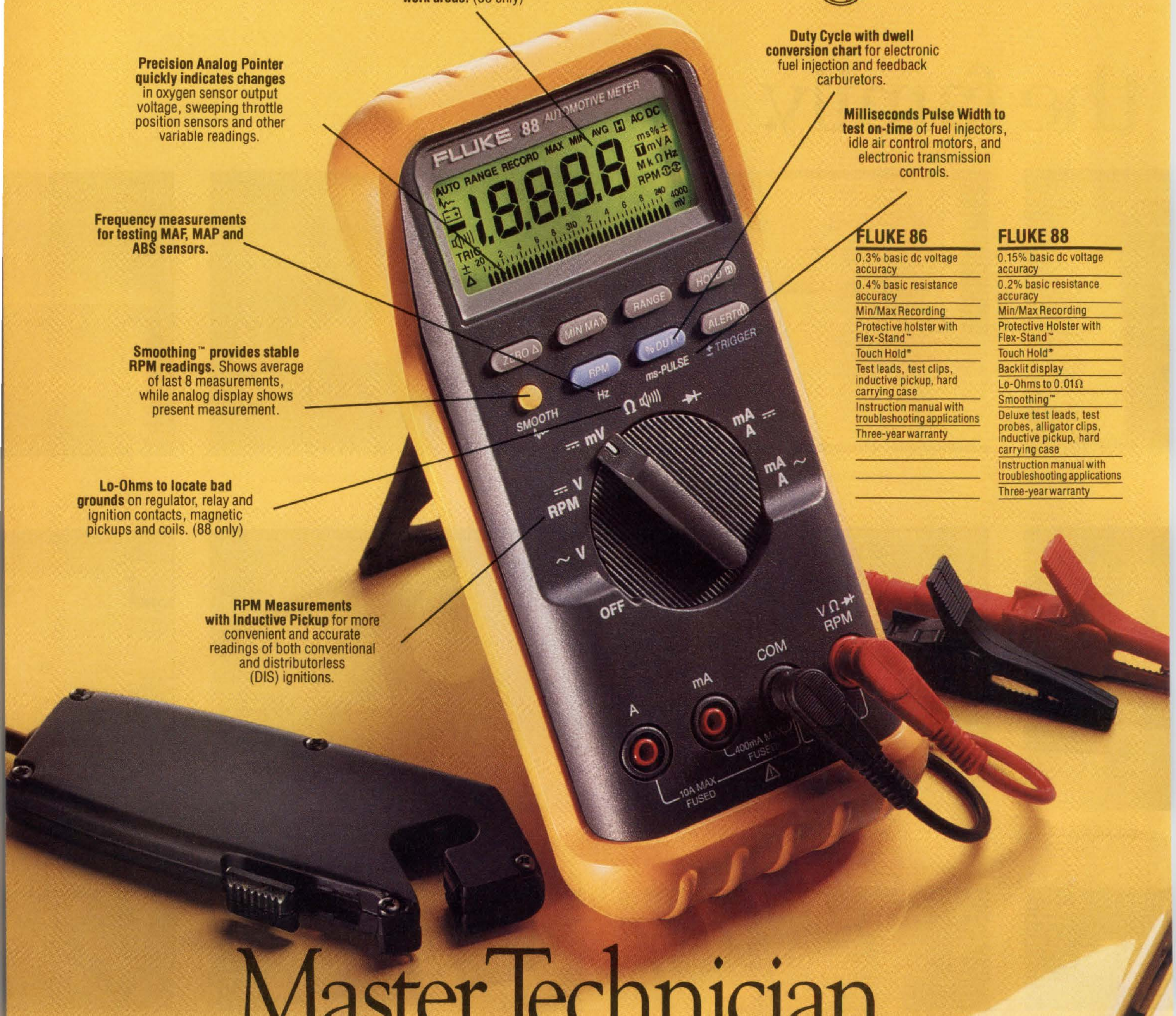
HEWLETT PACKARD

*U.S. list price.

CIRCLE 119

FLUKE AND PHILIPS – THE GLOBAL ALLIANCE IN TEST & MEASUREMENT

FLUKE® PHILIPS PHILIPS



FLUKE 86	FLUKE 88
0.3% basic dc voltage accuracy	0.15% basic dc voltage accuracy
0.4% basic resistance accuracy	0.2% basic resistance accuracy
Min/Max Recording	Min/Max Recording
Protective holster with Flex-Stand™	Protective Holster with Flex-Stand™
Touch Hold®	Touch Hold®
Test leads, test clips, inductive pickup, hard carrying case	Backlit display
Instruction manual with troubleshooting applications	Lo-Ohms to 0.01Ω
Three-year warranty	Smoothing™
	Deluxe test leads, test probes, alligator clips, inductive pickup, hard carrying case
	Instruction manual with troubleshooting applications
	Three-year warranty

Master Technician

Introducing the Fluke 86 and 88. Dedicated automotive multimeters. More Capable. More Profitable.

The new Fluke 86 and 88 Automotive Meters have all the right features to test electronic engine control components. To test every part of the electrical system and to zero in on the problem fast. To hunt down even the trickiest driveability problems. Quickly. And profitably.

They are the first to deliver Fluke's superior digital multimeter performance in a totally automotive-specific package. Providing full DMM capabilities *plus* pulse width, duty cycle, frequency measurements, and RPM measurements with an inductive pickup. The Fluke 88 adds Smoothing,™ Lo-Ohms, deluxe test leads and a backlit display.

Yet with all this high-tech performance, Fluke meters are tough enough to stand up to dust, dirt, grease, moisture, and all the abuse you can dish out. And a full three-year warranty to back them up.

Demand the best—Fluke. To get the job done right, the first time, for a long time to come. Fluke 86 and 88 Automotive Meters are available from leading automotive tool suppliers nationwide. Or call **1-800-44-FLUKE, ext. 11,** for more product information.

Everett, WA 98206. U.S.: (206) 356-5400. Canada: (416) 890-7600.

Ad No. 0601-F86

CIRCLE 97

FLUKE®

Newly Developed ICs Driving Auto Electronics

Early automotive electronics had to make do with older semiconductors, but specially designed ICs are opening up a wide range of new applications.

RANDY FRANK AUTOMOTIVE SEGMENT,
MOTOROLA DISCRETE AND SPECIAL TECHNOLOGIES GROUP, PHOENIX, ARIZONA

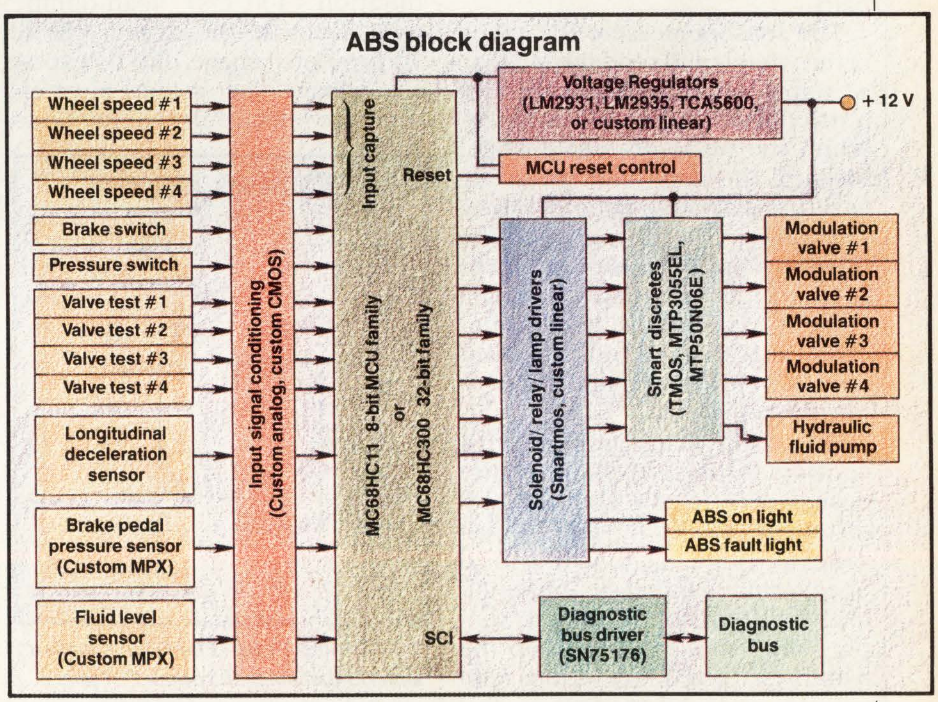
CARBURETORS and points have gone the way of horseshoes and saddles in the area of personal transportation. Just as the automobile replaced the horse, increasingly sophisticated electronic control systems have made formerly essential components of the auto obsolete. The new systems improve performance, safety, convenience, communications, and manufacturability, and reduce emissions. In addition, they offer superior system diagnostics for improved serviceability, and system integration for increased reliability.

Although the microcontroller unit (MCU) is the critical control element in many current systems (12 applications depend on MCU technology), other semiconductor technologies will also play a key role in achieving high-volume production. Applications will include transient suppression, load controls that need more rugged and smarter power devices, and sensing of numerous vehicle inputs. In addition to supplying more precise control, the automotive semiconductors used in these applications must cope with one of the harsher environments for electronic components.

A good example of an automotive electronic control system is an antilock braking system (ABS). Virtually every auto manufacturer offers some sort of ABS on selected models. The typical ABS uses an MCU, several sensors, semiconductor power devices, and hydraulic components to automatically pump the brakes rapidly and repeatedly. As a result, the driver can maintain steering ability and vehicle stability under difficult road surfaces, such as ice or wet asphalt and under hard braking conditions.

Functions performed by a typical ABS controller include actuation of solenoids, motors, and indicator lamps. A simplified model of a generic ABS system starts with inputs from either vehicle sensors (or switches) or driver-actuated switches (Fig. 1). These inputs are converted to a form that can be employed by the MCU. For simple switched inputs, the interface requirements are minimal or nonexistent, but many sensing inputs require amplification, buffering, temperature compensation, or analog-to-digital conversion.

If designers develop custom ICs



***1. DESIGNERS CAN REDUCE** the complexity and component count in an antilock braking system controller by developing custom ICs to link the sensors to the microcontroller unit. That interface circuitry is represented by the input-signal conditioning block in this simplified model.*

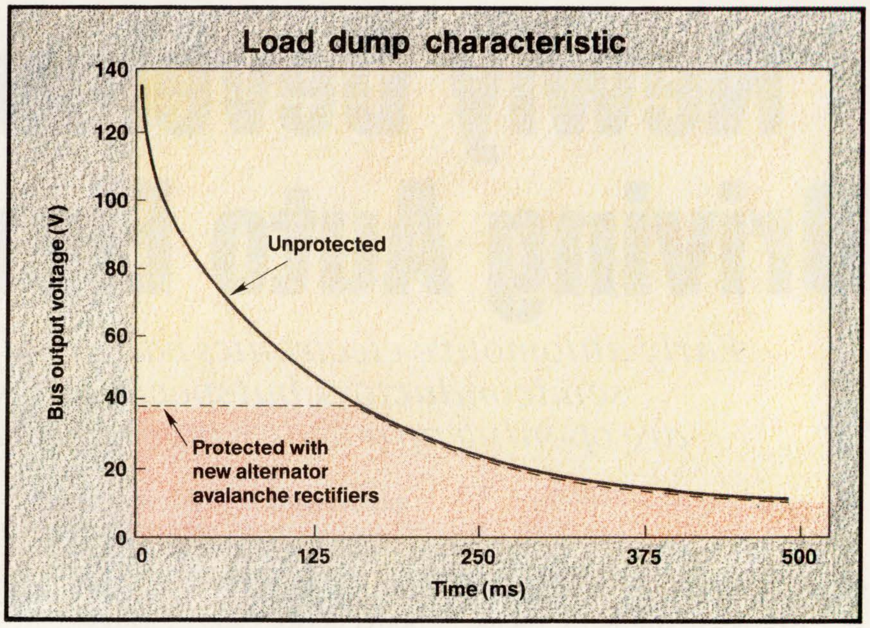
to link the sensors to the MCU, the ABS controller's complexity and component count can be considerably reduced. For instance, combining signal conditioning with the sensing elements to allow bidirectional communication with the MCU creates a "smart sensor." Smart sensors are typically monolithic semiconductor devices that offer fewer components, improved reliability, and reduced system cost.

The MCU's low-current, digital output must be amplified before it can control the power semiconductor or relay that will ultimately actuate the desired solenoid, motor, lamp, or display. As in the smart sensor, output signal conditioning and power semiconductor devices can be combined into smart-power ICs.

Besides easing the interface task, smart I/O devices also protect the system and supply fault-detection or diagnostic capabilities. With increased vehicle-system complexity, circuit protection and diagnostics are viewed as mandatory for improving manufacturability, safety, and first-time success for repairs.

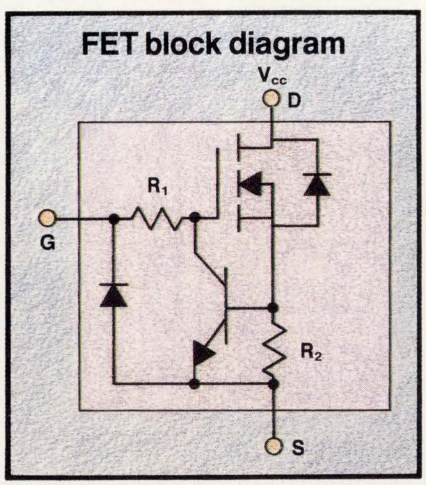
The sensors measure the speed of the wheels and send the MCU an ac signal whose frequency is proportional to the wheel's speed. When the MCU detects a wheel lock-up, the controller drives relays that activate solenoid valves. The valves control the hydraulic pressure applied to each wheel to keep it in an optimum slip range. Present systems use electromechanical relays and bipolar power transistors or power FETs to activate the solenoids.

One of the many problems that confronts automotive-electronics designers is that the nominal 12-V system in passenger cars is just about anything but 12 V. In typical operations, charging systems regulate the alternator's output to supply sufficient voltage to keep the battery charged under various temperature and load conditions. This voltage can range from over 15 V at 0°F to about 12 V at maximum under-hood temperatures.



2. AN ALTERNATOR PROTECTED with new avalanche rectifiers generates a much smaller voltage transient when it's disconnected from the charging circuit (dashed line). The vehicle's electronics can then use less expensive power FETs with lower breakdown voltages.

Moreover, electronic assemblies on cars must withstand reverse battery conditions to −13 V, jump starts from tow trucks (24 V), short-duration voltage transients that can easily exceed ±100 V, and long-duration (400 ms) "load-dump" transients that can exceed +80 V. To prevent damage due to excessive voltage, the systems must either use electronic components with a breakdown voltage that can withstand the various automotive voltages, or they must include protective circuits.



3. A CURRENT-LIMITED FET is actually a small IC that holds the power FET plus a small-signal npn and related components. As the npn unit turns on, gate drive is taken away from the FET, limiting its maximum current.

The load-dump effect is a good example of the varying-voltage problem and how it can be remedied. To the voltage-regulated alternator, a properly connected battery appears as a large capacitor, maintaining a low and constant bus voltage. However, when it's disconnected, the alternator suddenly generates a high (by automotive standards) voltage transient lasting several hundred milliseconds (Fig. 2). This transient can cause catastrophic damage to voltage-sensitive electronics.

A common and relatively inexpensive way to suppress these transients is to place a short voltage clipper—such as a Zener diode or surge supressor—across the input of the electronics. The suppressors, which for automotive applications are in the 24-V to 32-V range, must withstand the energy of the transient. This energy level is defined by many automotive specifications, the most common being 60-V or 100-V peak transients decaying exponentially to a 14-V battery level in a time constant of 0.115 seconds.

SIEMENS

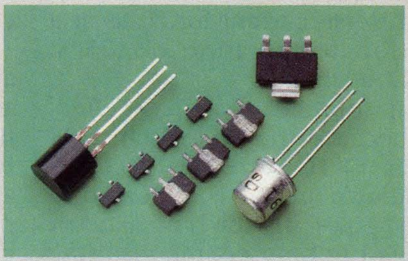
If you think you have no choice when it comes to MOSFETs... think again.

Tired of losing in a shell game with manufacturers who offer a limited selection of small signal MOSFETs? Then take a look at Siemens SIPMOS® FETs, and choose from an unequalled number of types and packages.

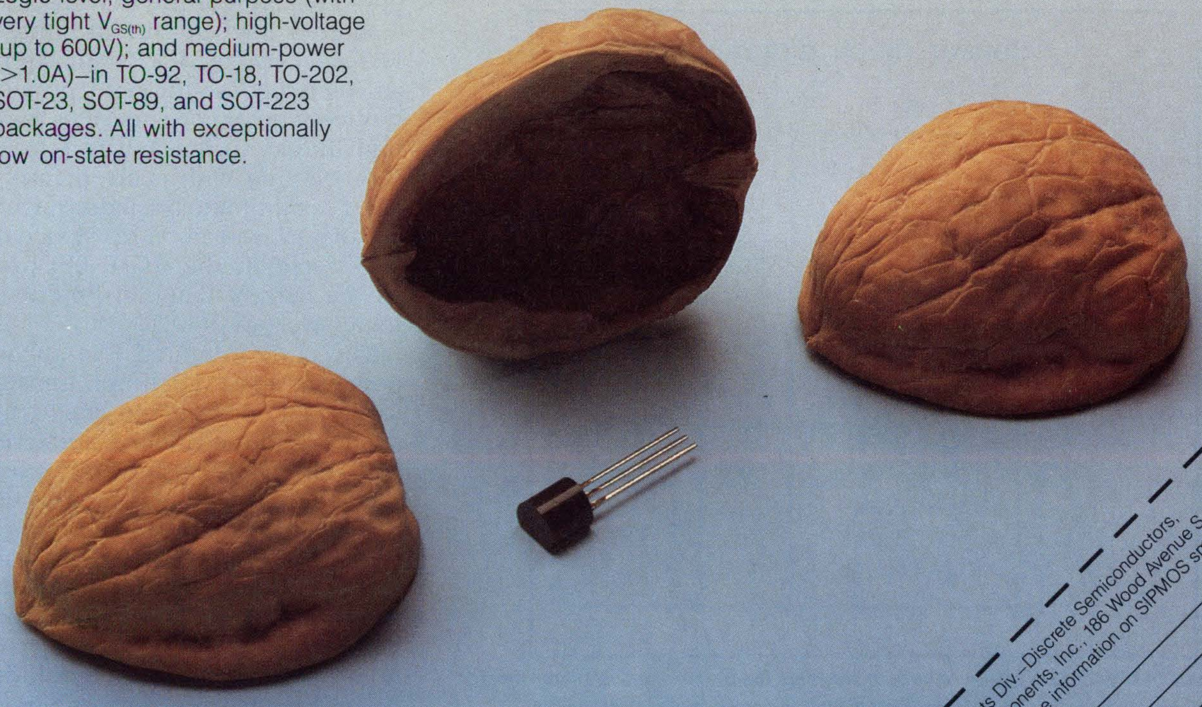
That's right. Siemens small signal SIPMOS FETs are the answer for your circuit when high performance can't be compromised. With Siemens SIPMOS FETs, you can choose between a wide range of N- and P-channel enhancement mode and N-channel depletion mode devices with the largest surface mount selection available anywhere:

- **N-Channel Enhancement**–Logic-level; general-purpose (with very tight $V_{GS(th)}$ range); high-voltage (up to 600V); and medium-power (>1.0A)–in TO-92, TO-18, TO-202, SOT-23, SOT-89, and SOT-223 packages. All with exceptionally low on-state resistance.
- **N-Channel Depletion**–General purpose and high-voltage types in TO-92, SOT-23, and SOT-223 packages.
- **P-Channel Enhancement**–Complements to the N-channel devices with breakdown voltages up to 240V in TO-92, SOT-23, SOT-89, and SOT-223 packages.

So why gamble with other suppliers when you can win with Siemens? Select SIPMOS small signal FETs for a real choice in MOSFET devices. Return the coupon for a data kit including our handy Product Selector Guide. Or call **1 (800) 888-7730** today.



Select Siemens SIPMOS... for a real choice in small signal MOSFETs.



Special Products Div.–Discrete Semiconductors,
Siemens Components, Inc., 186 Wood Avenue S., Iselin, NJ 08830.
Please send me information on SIPMOS small signal MOSFETs.

Name

Firm

Street

City

State

Zip

Phone

SCI-1000

CIRCLE 140

E.D. 8/9/90

Therefore, for five time constants (0.575 seconds), the suppressor must sustain this source or compliance voltage through a specified limiting resistance. The general range of resistor values produces surge currents in the 0.5-A to 10-A range. In addition, the specifications usually require that the device withstand 10 transient pulses, one every 30 seconds.

The duration of the load-dump transient will cause excessive junction temperatures even in many ruggedized power MOSFETs. However, using avalanche rectifiers (such as Motorola's MR2535L) in the alternator can limit the maximum voltage to 40 V, even with 90 A of reverse current for 80 µs at a junction temperature of 175°C (Fig. 2, again).

This solution is very cost-effective because the on-resistance of power FETs increases as their breakdown voltage is increased to the 2.2 power. If a lower breakdown voltage can be used, the resulting reduction in on-resistance will reduce the cost of the power FETs, assuming that die size remains constant. Even if only a few power FETs are used, the savings can easily offset the cost of the avalanche rectifiers.

The spectrum of new automotive systems is pushing the development of power electronic components (including smart power ICs), which will ease system design and lower costs. The devices must control lighting, solenoid (inductive), and motor loads; illuminate displays; and perform dc-dc power conversion for 12-to-15-V, 12-to-24-V, and 12-to-48-V systems (see the table). Many of these loads require relatively high in-rush and/or high steady-state currents, so to minimize power dissipation or heatsinking requirements large output devices are used. Power FETs are the most frequently used semiconductor device in these cost-sensitive applications.

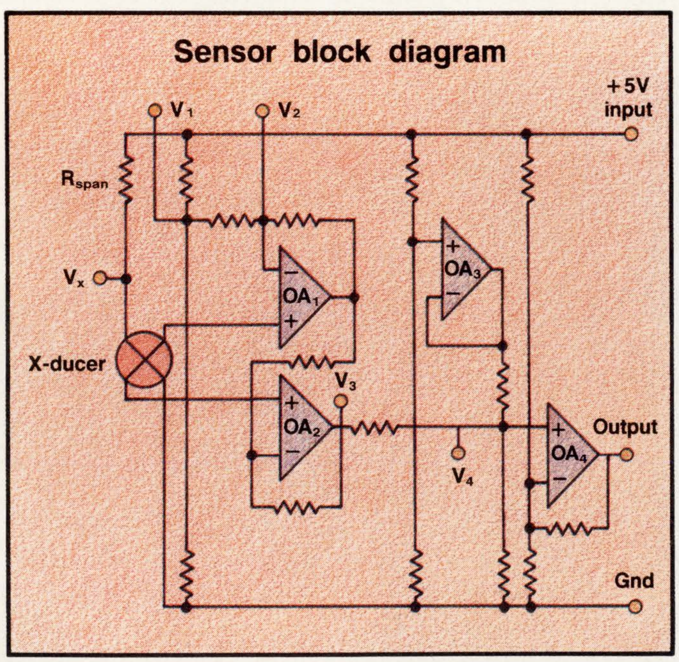
A critical factor in under-hood automotive applications is a high ambient temperature. As a result, the auto industry has pushed for higher maximum junction temperatures for power devices. By using plastic packaging materials with a glass transition temperature approaching 200°C makes it possible for 175°C ratings for the newest, energy-rated power FETs, such as Motorola's E-FET power MOSFETs.

Another class of devices, ruggedized FETs like the Motorola TMOS series, are designer-friendly components that offer opportunities to reduce the number of circuit components because they're easier to interface and they perform special functions. For example, using tighter processing controls and techniques developed for fabricating MCU and memory chips has substantially improved the typical gate-rupture capability of the MTP50N06E (a 60-V, 50-A, 0.028-Ω power FET) from approximately 40 V to over 90 V. In many applications, this improvement can eliminate the need for an external Zener diode on the gate.

The procedures used to qualify new power devices are also being beefed up. Standard practice is to use 80% of the breakdown rating during reliability tests. For all power FETs, this has been increased to 100% of the maximum data-sheet rating to ensure that devices are stressed to the combined maximum temperature and voltage. For example, high-temperature gate bias tests are conducted at 100% V_{GS} and 150°C, and high-temperature reverse bias testing is done at 100% V_{DS} and 150°C. Devices that can operate at 175°C are being qualified at the higher temperature as well.

Another important feature of power ICs is the ability to withstand a shorted load. A current-limited FET, such as the MLP1N08L, offers an integrated solution to protect semiconductor power devices from high in-rush current as well as from short circuits. With a current rating of 1.1 A, minimum breakdown voltage of 80 V, and an on-resistance of 0.75 Ω at 25°C, the MLP1N08L limits the current that can flow in a logic-level power FET.

The current-limited FET incorporates a small-signal npn transistor and a diode from the gate to the source of an n-channel, logic-level FET (Fig. 3). Because it's designed for medium-speed switching applications that require rfi and emi to be minimized, the device has an integral resistor, R_1, that limits the gate charge and discharge rate. R_2 is the sensing resistor that determines the maximum current level for forward biasing of the npn tran-



4. A FULLY INTEGRATED pressure sensor contains the piezoresistive silicon sensor element and all of the necessary signal conditioning circuitry in the same die.

SIEMENS

Soturation!

With more new U.S. Industry types and our extensive European line-up, we're "soturating" the market.

"Soturation"—simply, it means that we're putting together an enormous family of quality SOTs for you to choose from. And since we're constantly expanding our product line, finding the perfect SOT for your design will be easy.

But that's only part of our successful SOT story.

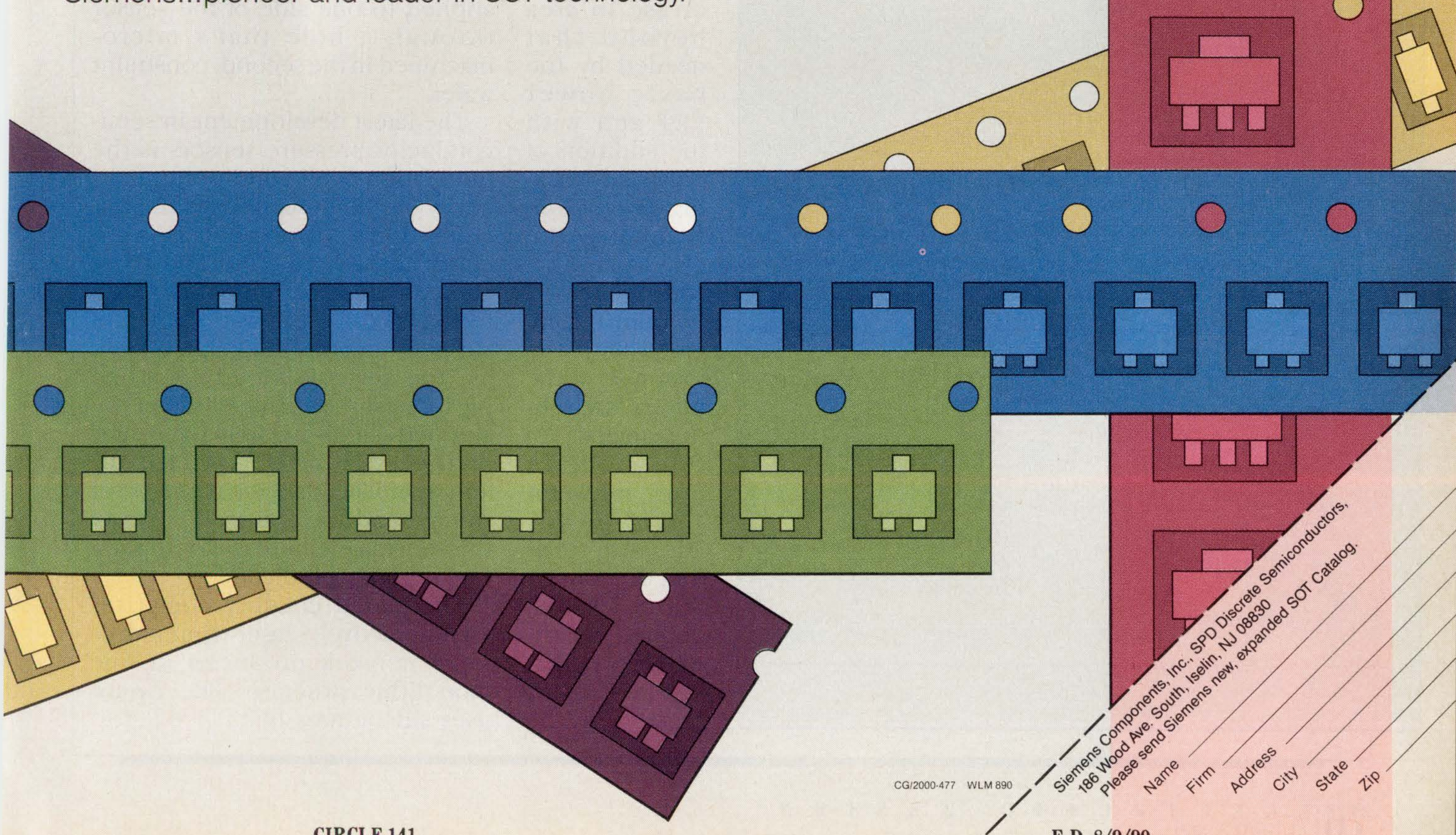
That's because each SOT is built with Siemens unsurpassed quality and long term reliability. And every one of them is produced using Statistical Process Control (SPC), a data-driven method that manages the manufacturing operation, providing a quality level of ≤5 DPM.

Result: Performance that's second to none. Which is what your boards require to withstand the punishing environment of surface mount assembly, plus whatever your application demands.

Whether the need is for automotive, computers, communications, telecommunications, instrumentation, tuners, or factory automation; you're assured of the highest quality SOT for your applications.

Discrete Surface Mount Semiconductors from Siemens. The definition of superior quality. Check it out yourself. Write or call...today! Siemens extensive line-up of quality SOTs are in stock now at Advacom, Advent, Hall-Mark and Marshall. Or clip the coupon for our new expanded SOT catalog. Siemens Components, Inc. (800) 222-2203.

Siemens...pioneer and leader in SOT technology.



CG/2000-477 WLM 890

CIRCLE 141

sistor. As the npn transistor turns on, gate drive is taken away from the power FET, limiting the current. The current limit is temperature dependent and decreases with increasing temperature, from 2.3 A at 25°C to 1.1 A at 150°C. The MLP1N08L withstands over 8 kV in electrostatic discharge tests conducted with the human-body-model test circuit.

Because the MLP1N08L conducts current and dissipates power even during a short circuit, a heatsink is needed to keep the junction temperature below the maximum of 150°C. To simplify the user's assembly process, therefore, the current-limited FET will also be offered in a fully isolated package whose thermal performance is similar to schemes that use additional hardware, such as mica washers or commercially available isolation pads. Both versions of the FET are suitable for low-cost applications. Two ideal automotive uses are in incandescent-lamp operation and in injector drivers.

A standard, logic-level power FET process produces the current-limited FET. The process, which can create small-signal devices as well as power ICs, enables designers to boost integration levels with only a small increase in area beyond that needed by the basic power FET and with the addition of only one masking layer. Consequently, the cost of the added circuitry is minimal compared with the total cost of the power switching device. An intermediate level between smart-power ICs and standard power MOSFETs, dubbed Smartdiscretes, differs from an IC process by the lack of isolation between circuit elements (except for the oxide-isolated diodes). Eliminating the isolation keeps the cost down but also limits the circuits that can be obtained. Moreover, parasitic elements that can occur must be accounted for in each design.

Devices made possible by the Smartdiscrete process also help fill another need in automotive electronics: diagnostic signals. The process permits a simple open-drain diagnostic scheme that can indicate the presence of an open or short fault by sending a flag to an MCU. The diagnostic uses information supplied by either the current-limit or thermal-sensing circuits.

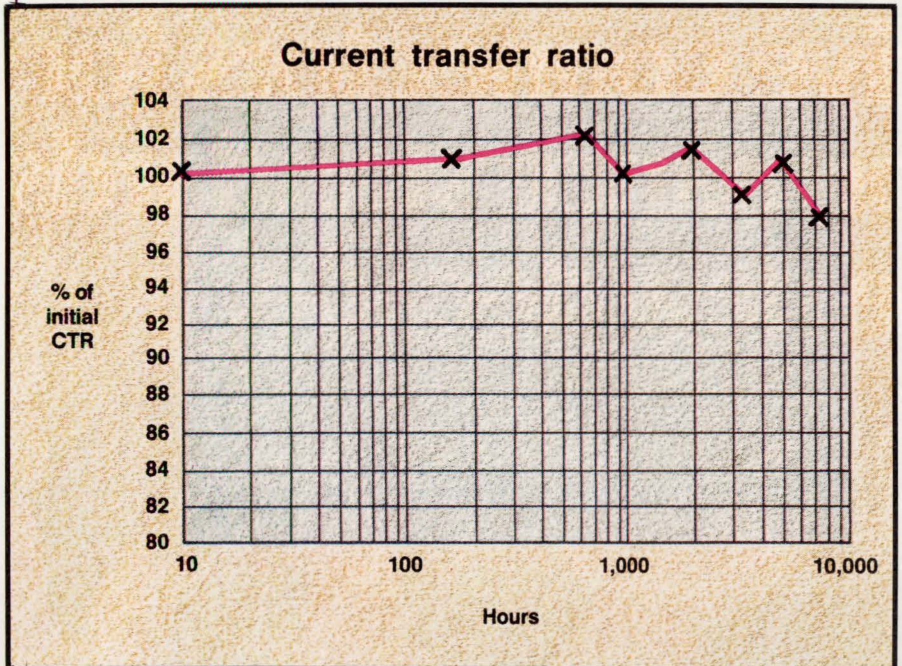
Electronic engine control systems have used semiconductors for sensing manifold absolute pressure (MAP) for over seven years. Most frequently, a MAP sensor uses two silicon wafers to produce a piezoresistive silicon pressure sensor. The top wafer is etched until a thin, square diaphragm (approximately 1 mil thick) is created. The square area is extremely reproducible, as is the 54.7° angle of the cavity wall. In addition to absolute pressure measurements, atmospheric pressure or a reference pressure can be applied to one side of the sensor through a hole that's micromachined in the second, constraint wafer.

The latest development in semiconductor pressure sensors is the integration of all conditioning circuitry on the same chip as the micromachined diaphragm. This circuitry adjusts the offset and span, compensates for temperature effects on both offset and span, and supplies an amplified signal (Fig. 4). The device is based upon one piezoresistive sensing element positioned at a 45° angle in the center of the edge of the square diaphragm. The variation of the offset voltage and the full-scale span of this sensing element with temperature is highly predictable.

The added circuitry comprises an interactively laser-trimmed 4-stage network produced in one monolithic structure. The circuit uses silicon area that's needed to

Automotive systems and their loads

Engine control:	Display
Fuel injection	Solenoid
Canister purge	Solenoid
EGR Valve	Solenoid
Ignition	Coil
Engine cooling fan	Motor
Load control	Solenoids/display
Anti-skid brakes	Solenoids
Audio system	Speaker coil
Climate control	Motor + solenoids/display
Anti-theft	Solenoids/alarm/light/flasher
Power seats	Motors
Power windows	Motors
Remote control mirrors	Motors
Heated key	Resistor
Trunk release	Solenoid/display
Trunk closing device	Motor
Door lock systems	Solenoids
Door closing device	Motors
Power antenna	Motor
MPG/trip computer	Display
Retractable headlamp doors	Motors
Headlamp wiper motors	Motor
Windshield wiper motor	Motor
Rear window wiper motor	Motor
Horns	Inductors
Heated backlite	Resistor
Electronic transmission	Solenoids
Electronic power steering	Motor
Diagnostic	All
Four-wheel drive control	Solenoids/display
Electro-hydraulic suspension	Solenoids/display
Electronic heater	Resistor/display
Heated windshield	Resistor/display
24 V or 48 V power	Inductor/dc-dc
Traction control	Solenoids/display
Collision avoidance	Solenoids/display
Multiplex wiring	Lamps/motors/solenoids/display



5. PROCESSING REVISIONS and improvements in process control have yielded LEDs whose current transfer ratio (a measure of the diode's light output) remained at 98% of its initial level even after 7,500 hours.

mechanically support the diaphragm, so the die size for the fully signal-conditioned unit is 145 by 130 mils, compared to 120 by 120 mils for the uncompensated element.

The laser trim procedure yields a device (the MPX5100D) with a zero-pressure offset voltage of 0.5-V nominal and a full-scale output voltage of 4.5 V when connected to a 5.0-V supply. Therefore, the output dynamic range caused by an input pressure swing of 0-15 psi is 4.0 V. The output depends on the supply voltage, which can be a maximum of 10 V.

To measure pressures or levels of vehicle fluids, semiconductor sensors must be exposed to one or more liquids (oil, fuel, coolant) detrimental to the semiconductor circuit's operation. Each application must be addressed separately, but cost limits generally prohibit the use of stainless steel isolation. Instead, more cost-effective protective polymers and chemically tolerant plastic and rubber materials are needed. Recently developed materials have made possible a 100-psi sensor, the MPX700, that can measure oil pressure. A custom version of this unit has withstood over 1 million pressure cycles at high temperature.

Several manufacturers have adapted the techniques used for making piezoresistive pressure sensors to develop piezoresistive accelerometers. The piezoresistive accelerometer, however, with its beams and suspended mass, is considerably more complex than the simple diaphragm used in most pressure sensors. A three-layer structure is needed to supply overrange stops, a bending beam, and air damping.

Optical sensing techniques using infrared emitters and detectors have been used successfully for several years in rather benign environments to accurately sense rotational and linear motion. But their extension into automotive electronics has been delayed due to temperature sensitivity and stability problems with the emitters. With recent improvements, however, optical sensors can work at temperatures to 150°C.

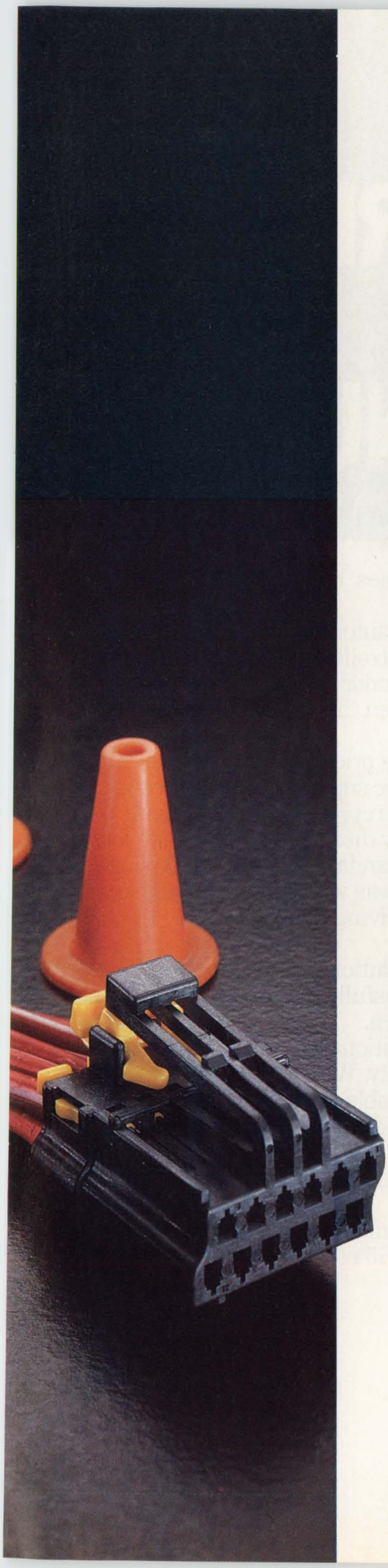
Detailed studies of LEDs from U.S. and non-U.S. sources showed that under accelerated conditions it's common for the diode to degrade 15% to 20% after 1000 hours of testing. Processing revisions and improvements in process control implemented by Motorola have greatly increased long-term reliability. The tests used the current transfer ratio (CTR)—the ratio of transistor collector current to forward current—as a measure the LED's light output. After 7500 hours, the average CTR of the improved LEDs was still almost 98% of their initial value (Fig. 5). This testing was performed at room temperature but tests are in progress to evaluate their operation at 85°C, 105°C, and 125°C.

Several custom optical sensors have already been developed for automotive use. Two pairs of optical emitters and detectors were mounted at the end of the steering column to measure steering wheel turn angle direction and speed as part of a ride-control system. Multiple slots in a shutter interrupt the light path of the two pairs of emitters and detectors to provide the quadrature signal.

The MCU in the ride-control system uses an algorithm that determines the straight-ahead wheel position and then calculates the lateral acceleration that will result from the turn angle. If this lateral acceleration is above a programmed level, the shock absorber damping is switched to firm. The optical steering sensor also sends the MCU information that enables it to determine the rate at which the steering wheel is turning. If this rate is too high, the damping is switched to firm to supply more maneuverability.

Perhaps the most significant aspect of semiconductors is the fabrication process, which offers the ability to integrate functions while aggressively reducing cost, especially in the volumes represented by automotive applications. In the 10 years since the first use of microprocessors in vehicles, prices have dropped by more than an order of magnitude, while features and computing capability increased significantly. Continuing development ensures that new devices will be available for cost-effective performance in future automotive systems.

Automotive connectors for new performance standards in the new decade.



Every new idea in automotive electronics must meet high quality standards in a tight economy.

To provide advanced connectors that live up to those requirements, we work under a formal, corporate-wide quality program, starting from an established technological 'platform' and developing products that enhance the manufacturing process.

Our latest — the AMPSEAL underhood connector and the POSI-MATE instrument panel connector — typify the philosophy. Both employ proven contact technology, a design platform that offers easy reliability projections and cuts development and testing time significantly.

Yet both still allow application-specific versions, particularly the high-density POSI-MATE connector, which can be implemented in many configurations.

Crimp contacts allow automated termination, and the clean (lanceless) design uncomplicates handling. Terminal position assurance is provided by the housings. Our IP connector goes a step further with connector position assurance: for protection against under-dash tugs, the latch can also be locked.

Both assemble quickly, but our AMPSEAL high-temp submersible connector is unique — it literally goes together in seconds.

The housing comes preassembled, seals in place, with the front partially extended. In a simple, two-stage loading sequence, terminals are first inserted through the rear seal area and held firmly in the positioning stage. When the front is pushed into place, the contacts are locked.

Both connectors provide an inherent quality control check as well — the housings won't assemble if a contact is in wrong. Ideas like this have helped us meet tough quality/manufacturability requirements in the global automotive arena for decades, and in every related industry as well. We'd like to help you.

For more information or to arrange for an AMP Automotive Sales Engineer to visit at your convenience, call 1-800-522-6752 Ext. 7302. AMP Incorporated, Harrisburg, PA 17105-3608.

Quick-assembly AMPSEAL submersible connectors seal both wiring and interface. True-position assurance within housing, no backout.

POSI-MATE high-density connectors stagger contacts on a 3 mm x 1.5 mm interface. Instrument panel security: secondary locking prevents separation of mated housing.

THIS IS AMP TODAY. AMP

CIRCLE 153

THIS LITTLE HYBRID DROVE D CENSORED Y NUTS.

We'd like to name names, but the story is still unfolding.

One of the Big Three automobile manufacturers had been buying custom controllers for instrumentation lighting from an off-shore vendor—we're talking about a million pieces annually—when the dollar suddenly took a downturn.

Faced with continuing price increases, they went looking for a reliable domestic supplier. "All we need is a simple form, fit and function replacement," they said.

Not so simple. As they discovered, other suppliers either wanted to sell them standard parts or an expensive ASIC. Furthermore, no one was willing to make the effort to supply an IC and hybrid and make it cost competitive. It was driving them nuts.

Then in marched the General.

Because we're set up to provide custom hybrid power IC solutions, we routinely dedicate a program manager to the project. In this case, he not only successfully engineered exactly the part they wanted, he also pioneered a few improvements of his own.

He designed the heat sink right onto the package at no additional expense. This reduced parts count, saved labor costs and significantly increased reliability. What's more, because of his growing intimacy with the customer's design process, he was able to identify and implement a new consumer feature that was also incorporated onto the hybrid—a circuit that activates a courtesy light for 30 seconds after you close the car door.

The auto manufacturer was thrilled. Not only did we give them another competitive advantage, we've shipped them nearly a million parts.

That's our business: solving problems by going that extra mile. If you need a custom power IC or hybrid solution, contact Silicon General, 11861 Western Avenue, Garden Grove, CA 94641. TWX: 910-596-1804. FAX: 714-893-2570. Phone: 714-898-8121.

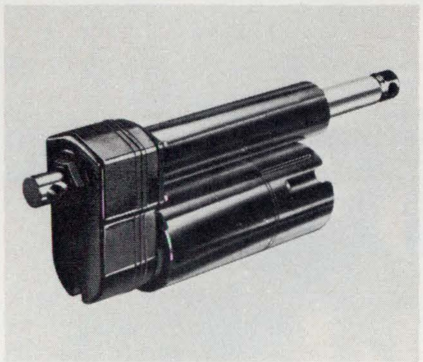
SILICON GENERAL

Solutions...
that's the general idea.

CIRCLE 145

ACTUATORS PROVIDE MOTION CONTROL

A NEW LINE OF ELECTRIC linear actuators are designed to provide remote and automatic motion control in large vehicles such as buses, vans, and trucks. Applications include door opening and closing; transmission "shift by wire" in trucks and off-highway equipment; and wheelchair lifting, positioning, and locking. Using motor voltages of 12, 24, 36 or 90 VDC, the actuators can operate at stroke lengths up to 24 in., speeds to 2 in./s and with loads up to 1,500 lb.



The weatherproof actuators, which consist of a motor, gearbox, and leadscrew, are simple to install because complex wiring is not needed. *Warner Electric/Dana Corp., 449 Gardner St., S. Beloit, IL 61080; (815)389-3771.*

CIRCLE 343

COMPARATOR IC TESTS CIRCUITS

THE AD22001 IS A five-channel comparator IC which tests the series circuit leading to a lamp to determine if a circuit is intact and a functional lamp is in the socket. This IC continually monitors the status of up to five bulbs. It features a wide temperature range (−40 to 125°C) and low voltage drop (nominal 1.75 mV at 22°C).

The comparators, which can be connected to a car battery, are designed to check the amount of voltage applied to automotive lamps. The AD22001 generates a digital display to show whether the amount of voltage is correct. In addition, the AD22001 is designed to provide an output to supply 15-V CMOS interface circuits. *Analog Devices Inc., One Technology Way, P.O. Box 9106, Norwood, MA 02062: (617)329-4700.*

CIRCLE 344

HALL SENSOR ACTIVATES LAMPS

THE UGQ5140K IS AN IC Hall sensor that can activate incandescent lamps, relays, and solenoids. The IC is equipped with an internal protection system. A voltage regulator on the chip allows use of the device to be used with supply voltages of 4.5 V to 28 V.

The UGQ5140K features a high-current sink capability (300-mA continuous; 900-mA peak current limit), an automotive temperature range (−40 to 85°C), and a low-profile 4-pin Mini-SIP package. *Sprague Electric, 70 Pembroke Rd., Concord, NH 03301; (603)224-1961.*

CIRCLE 345

METERS AID IN TROUBLESHOOTING

IN ADDITION TO MEASURING basic quantities such as DC and AC voltage, current, and resistance, two handheld meters, the Fluke 86 and 88, also have the ability to measure revolutions-per-minute, frequency, duty cycle, and pulse rate. Both models can record minimum and maximum readings and can average the readings in a given time period. These capabilities make it possible to check current draw and voltage drops in automotive starting and charging circuits.

Built according to military standards, the 86 meter includes probes and alligator clips. The 88 includes heat probes, needle point probes, and alligator clips. Both meters have safety features which warn users when leads are connected to the current jack

while the meter is selected for voltage or resistance. An added feature for the 88 meter is smoothing, which displays the average of eight measurements and provides a stable display for fluctuating signals. U.S. list prices are $459 for the 88 and $399 for the 86. *John Fluke Mfg. Co. Inc., P.O. Box 9090, Everett, WA 98026; (206)881-6966.*

CIRCLE 346

SURGE SUPPRESSORS CHALLENGE ZENER DIODES

THE V24ML FAMILY of surge suppressors are designed as alternatives to Zener diodes for automotive applications. The devices are rated for peak currents of up to 2,000 A (8/20-μs current wave), have a jump-start overvoltage capability of 24.5 V for five minutes and can operate at a wide temperature range (-55 to 125°C) to handle the harsh environment of the automotive industry.

The devices are supplied in leadless chip form for surface mounting. These devices can also distribute heat evenly because their semiconducting ceramic structure, unlike that of Zeners, contains thousands of *p-n* junctions at their conductive-grain boundaries. The result is low peak temperatures, which makes the device more reliable.

Production quantities of the V24ML1210 are now available at $.46 each. The V24ML1206, 2820 and 2220 will be available at the end of this year. *Harris Semiconductor, P.O. Box 883, Melbourne, FL 32901: 1-800-4-Harris, ext. 1066.*

CIRCLE 347

IC REGULATOR OFFERS ACTIVE RESET

THE CS-403 IS A LINEAR postregulator IC for switching power supplies. It features low drift and noise immunity and is the first regulator IC to provide an active reset. The reset functions at voltages as low as 3 V. The CS-403 also offers low quiescent current (for example, 3 mA for 0-mA load; 5 mA for 500-mA load) and low dropout (1V typically). Other features include 500-mA output current, short-circuit protection, and high efficiency.

Microprocessor-based systems can also use the CS-403 for filtering. Unit price is $.95 in high volumes. Product is available from stock. *Cherry Semiconductor Corp. 2000 S. County Trail, E. Greenwich, RI 02818; Call Robert LeFort (401)823-3959.*

CIRCLE 348

1M-BIT DRAM FOR HOSTILE TEMPERATURES

A NEW 1M-BIT DRAM chip is designed to function in a temperature range of -40 to 125°C for automotive applications. The extended-temperature memory chip can also be used in robotics, testing and measuring equipment, and industrial PCs. The DRAM is available in standard ZIP, DIP, and SOJ packages in 1M bit × 1 and 256k × 4 configurations. *Micron Technology Inc., 2805 E. Columbia Rd., Boise, ID 83706; Call Sharon Bittick (208)383-4000.*

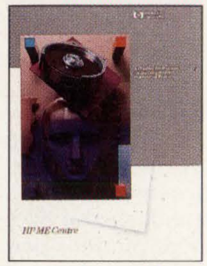
CIRCLE 349

AUTOMOTIVE ELECTRONICS RESOURCE FILE

These brochures, catalogs and technical bulletins are available to you.

To order copies, circle the appropriate numbers on the information Center Card.

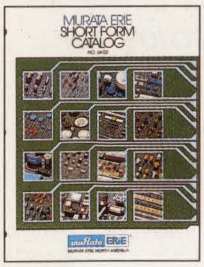
HP ME CAD/CAM



Hewlett-Packard's Mechanical Engineering Program promotes the capabilities of HP's CORE products as well as complementary and supplementary VAB products to cover the full spectrum of needs within the ME environment.

Hewlett-Packard, Ft. Collins, CO
CIRCLE 201

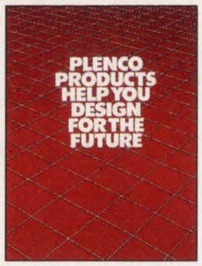
ELECTRONIC COMPONENTS CATALOG



98 pgs. of charts and diagrams covers complete line of products. Includes info. about ceramic capacitators, chip inductors, potentiometers and piezo alarms and other electronic components.

Murata Erie North America, Inc. Symrna, GA
CIRCLE 202

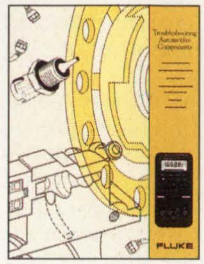
MOLDING COMPOUNDS



Plastics engineering company offers a reference file for manufacturing and design engineers. The detailed listing of phenolic, melamine-phenolic and polyester molding compounds shows properties and test values for stock compounds.

Plastics Engineering Co., Sheboygan, WI
CIRCLE 203

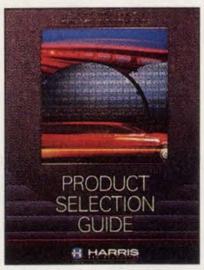
FREE AUTOMOTIVE ELECTRONICS POSTER



Now available from Fluke; an illustrated guide to troubleshooting 10 of the most common electronic control components found in today's high tech automobiles. This attractive poster is approximately 2 × 3 ft. 1-(800) 44-Fluke

John Fluke Mfg.
CIRCLE 204

POWER IC DRIVERS



Descriptive data on power ICs designed for automotive application such as lamp, solenoid and motor drivers. Key features, spec sheets, environmental stress data, and a handy product/application selection guide are included in this reference folder.

Harris Semiconductor, Melbourne, FL
CIRCLE 205

NICKEL CADMIUM BATTERIES

Literature from Sanyo provides electrical specifications for seven families of nickel cadmium batteries. They all exhibit excellent charge/discharge and thermal characteristics. Applications include high-capacity, fast charge, high temperature, heat resistance and memory backup.

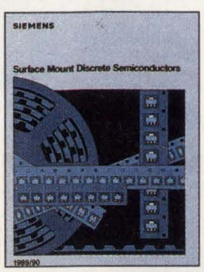
SANYO Electric Co. Ltd. San Diego, CA
CIRCLE 206

DIGITAL SCOPES

Catalog includes DSO's and signal sources and is a reference guide to digital waveform instruments. Contains substantial educational material on related concepts.

LeCroy Corporation, Chestnut Ridge, NY
CIRCLE 207

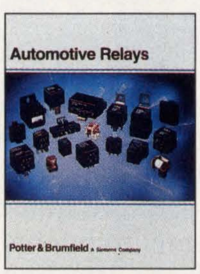
FREE MOSFET DATA KIT



This handy kit is packed with data sheets about the full Siemens line of small signal SIPMOS® FETs . . . high voltage types . . . low threshold . . . depletion mode . . . medium power . . . and the most surface mount types in the industry! 1 (800) 888-7730

Siemens Components, Iselin, NJ
CIRCLE 208

POTTER & BRUMFIELD AUTOMOTIVE RELAYS



This 32-page catalog lists relays designed for automotive applications. Plug-in, bracket mount and PC board relays have contact ratings through 70 amps. A selector guide helps determine applications. Fax: (812) 386-2335. Phone: (812) 386-2311.

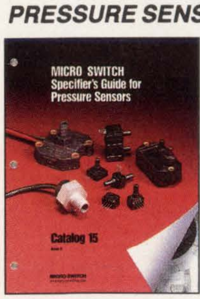
Potter & Brumfield, Princeton, IN
CIRCLE 209

SURFACE MOUNT SHORT FORM

A handy short form catalog featuring the widest selection of surface mount discrete semiconductors in the industry . . . Microwave, RF and Tuner . . . General Purpose, Switching, High Voltage . . . Lower power MOSFETs . . . and sensors!

Siemens Components, Iseline, NJ
CIRCLE 210

PRESSURE SENSORS



An updated guide has been issued by Honeywell's Micro Switch Div. Gage, differential, absolute, vacuum gage, low pressure, high pressure, heavy-duty, pressure-to-current, adjustable gage & digital set-point pressure sensors are included in catalog.

Micro Switch, A Honeywell Div., Freeport, IL
CIRCLE 211

FEA FOR DESKTOP COMPUTERS

FEA 3D modeling & analysis system for 286/386/486 PC's perform linear & nonlinear stress, dynamic, heat transfer, piping & electrostatic analysis. Model with included CAD package or interface to others. Phone: 412-967-2700 FAX 967-2781

Algor Interactive Systems, Inc., Pittsburgh, PA
CIRCLE 212

PRESSURE TRANSDUCERS

Full-line catalog provides pressure transducer, instrumentation and load cell information. Application and selection guides provided to determine the type of transducer you need. New product data sheets available for low cost high pressure/high volume OEM users. 1-800-333-DATA

Data Instruments, Acton, MA
CIRCLE 213

Careful Designing Is Needed To Meet Today's Stringent Timing Requirements And To Supply Clean Clock Signals.

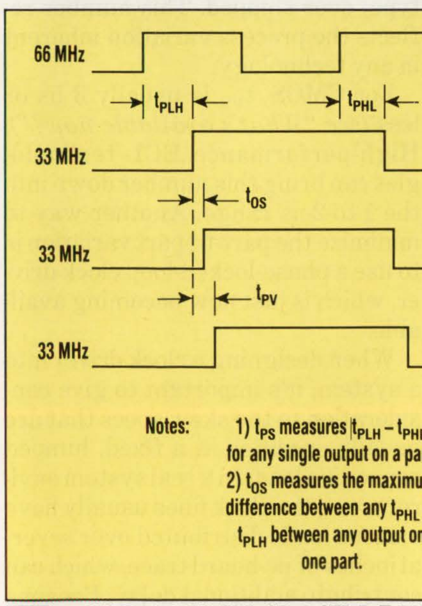
Low-Skew Clock Drivers Maximize MPU Systems

CHRIS HANKE AND GARY THARALSON
Motorola Inc.,
Semiconductor Products Sector,
3102 North 56th St., Phoenix, AZ
85018-6606; (602) 952-3000.

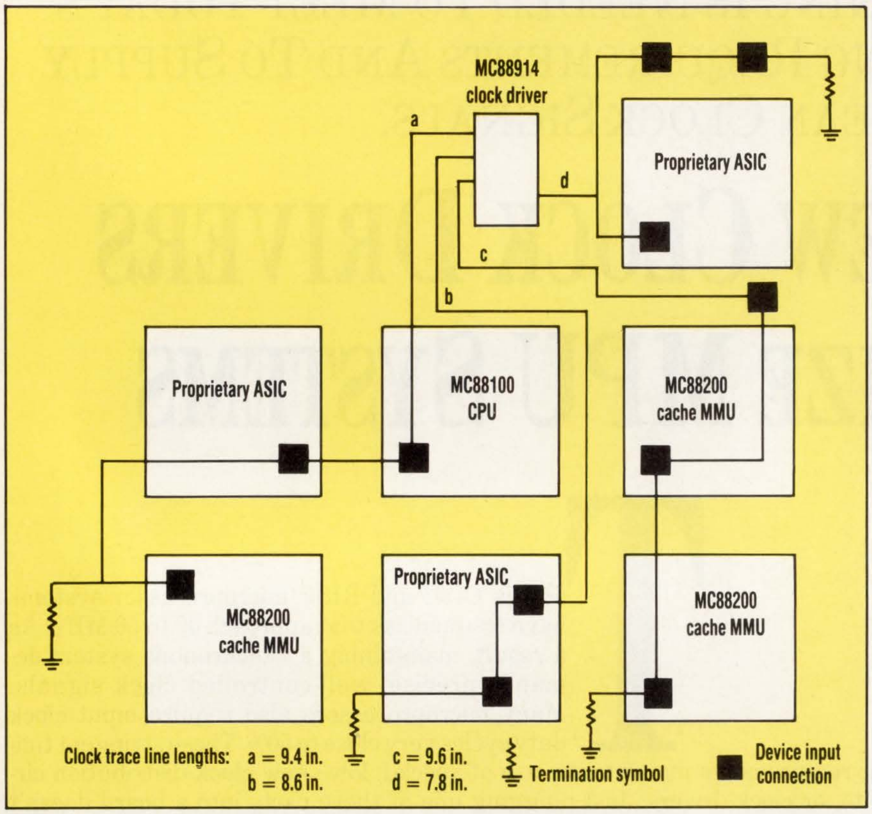
Today's CISC and RISC microprocessor systems have frequencies that approach 40 to 50 MHz. As a result, maintaining a synchronous system demands precise, well-controlled clock signals. Many microprocessors also require input clock duty cycles very close to 50%. These stringent timing requirements mandate the use of special, low-skew clock distribution circuits, or clock drivers. Just plugging one of these parts into a board doesn't ensure a trouble-free system, however. Meeting system timing requirements and providing clean clock signals call for careful design techniques for systems and pc boards.

Designers of microprocessor systems want to use as much of a clock cycle as possible without adding unnecessary timing guardbands. Unfortunately, propagation delays of peripheral logic don't scale with frequency. Therefore, as the clock period decreases, system designers have less time but the same logic delays to accomplish the function. How do designers gain more time? One option is to use a special clock source that minimizes clock "uncertainty."

A simple example illustrates this concept. At 33 MHz, $T_{cycle} = 30$ ns. An FCT240A octal inverter buffer, for example, has a high-low uncertainty of the min/max spread of t_{PLH} to t_{PHL} of about 3.3 ns. If 1.7 ns of pin-to-pin skew due to the actual part and pc-board trace delays is also considered, then only 25 ns of the clock period is still available. The worst-case t_P of clock-to-data valid on the 88200 M-bus is 12 ns, which leaves only 13 ns to accomplish other functions. In this case, 17% of a cycle is required for clock distribution or clock "uncertainty." From a system designer's point of view, this percentage is an unacceptable penalty. At 50 MHz,



1. IN DEFINING CLOCK-DRIVER skew, T_{OS} measures the difference between the fastest and slowest propagation delays between the outputs of one part. T_{PS} measures the difference between the high-to-low and low-to-high transition for one output (pin). T_{PV} measures the maximum propagation-delay delta between any pin on any part.



2. A SCALE REPLICATION of a RISC 88000 system board-layout section includes an MC88100 CPU, MC88200 cache MMU devices, and MC88914 CMOS clock driver. The only pc-board traces shown are the clock-output traces from the MC88914 to the various loads. For this clock driver, the output-to-output skew (t_{OS}) is guaranteed to be less than 1 ns at any given temperature, supply voltage, and fixed load up to 50 pF.

the penalty balloons to 25%.

A maximum of 10% of the period allotted for clock distribution is an acceptable standard. If multiple levels of clock distribution (one clock driver's output feeding the inputs of several other clock drivers) are necessary owing to large clock fan-outs, the additional part-to-part skew variations add even more to the clock uncertainty. Standard logic has always been specified with a large (and conservative) delta between the minimum and maximum propagation delays. This delta creates excessive clock uncertainty, which system designers have been forced to design into their systems, even though it's unrealistic.

When system frequencies were below 16 MHz, this large clock penalty could be tolerated. As the preceding example points out, that's not the case today. A clock driver's specifications guarantee this min/max delta to be a specific, small value. To reduce the clock overhead to manageable levels, a clock driver with minimal variation (less than 5%) from a 50% duty cycle and guaranteed low output-to-output and part-to-part skew must be used.

Clock-Skew Definitions

A typical clock driver has one input, which is usually driven by a crystal oscillator. The clock driver can have any number of outputs, which have a certain frequency relationship to the clock input. And clock-driver skew is typically defined by three different specifications *(Fig. 1)*.

The first specification, t_{OS}, measures the difference between the fastest and slowest propagation delays (any transition) between the outputs of one part. Note that this number must be 1 ns or less for high-end systems.

The second specification, t_{PS}, measures the difference between the high-to-low and low-to-high transition for one output (pin). It defines how close to a 50% duty cycle the clock driver's outputs will be. For example, if this specification is 1 ns ($\pm$0.5 ns), the output duty cycle at 33 MHz is 50% ($\pm$3.5%). A clock driver, which buffers only the crystal input, creates a 1:1 input to output frequency relationship. This can be a problem if a very tight tolerance to a 50% duty cycle is required.

Output Duty Cycle

In this case, the output duty cycle depends on the input duty cycle, which isn't well-controlled in most crystal oscillators. The clock driver's outputs switching at half the input frequency ($\div$2) is a common relationship. This means that the outputs switch on only one edge of the oscillator. As a result, the output doesn't depend on the duty cycle of the input (crystal oscillator frequency is very stable).

The third specification, t_{PV}, measures the maximum propagation-delay delta between any given pin on any part. This specification defines the part-to-part variation between any clock driver (of the same device type) ever shipped. This number reflects the process variation inherent in any technology.

For CMOS, t_{PV} is usually 3 ns or less *(see "What's available now?")*. High-performance ECL technologies can bring this number down into the 1-to-2-ns range. Another way to minimize the part-to-part variation is to use a phase-locked-loop clock driver, which is just now becoming available.

When designing a clock driver into a system, it's important to give consideration to the skew specs that are usually specified at a fixed, lumped capacitive load. In a real system environment, the clock lines usually have various loads distributed over several inches of pc-board trace, which can contribute additional delay. Because the clock lines sometimes act as transmission lines, the system designer must use careful board-layout techniques to minimize the total

LOW-SKEW CLOCK DRIVERS

system skew. In other words, just plugging a low-skew clock driver into a board won't solve all timing problems.

Consider a scale replication of a section of an RISC 88000 system board layout *(Fig. 2)*. The board section includes the MC88100 CPU, the MC88200 cache MMU devices, and the MC88914 CMOS clock driver. The only pc-board traces shown are the clock-output traces from the MC88914 to the various loads. For this clock driver, the output-to-output skew (t_{OS}) is guaranteed to be less than 1 ns at any given temperature, supply voltage, and fixed load up to 50 pF.

MINIMIZE CLOCK SKEW

To calculate the total system skew, the difference in clock pc-board trace length and loading must be taken into account. For an unloaded pc-board trace, the signal delay per unit length, t_{pd}, depends only on the dielectric constant, e_r, of the board material. The characteristic impedance, Z_o, of the line depends upon e_r and the trace's geometry. These relationships are depicted for a microstrip line *(Fig. 3)*. The formulas for t_{pd} and Z_o are slightly different for other types of strip lines. For simplicity, all calculations in this article assume a microstrip line.

The equations are valid only for an unloaded trace. Loading down a line increases its delay and lowers its impedance. The signal-propagation delay (t_{pd}') and characteristic impedance (Z_o') due to a loaded trace are calculated by the formulas:

$$t_{pd}' = t_{pd}\sqrt{1 + C_d/C_o}$$
$$Z_o' = Z_o/\sqrt{1 + C_d/C_o}$$

C_d is the distributed load capacitance-per-unit length, which is the total input capacitance of the receiving devices, divided by the length of the trace. C_o is the intrinsic capacitance of the trace, which is defined as:

$$C_o = t_{pd}/Z_G$$

Assuming typical microstrip dimensions and characteristics as w = 0.01 in., t = 0.002 in., h = 0.012 in., and $e_r = 4.7$, the equations yield $Z_o = 69.4\ \Omega$ and t_{pd} = 0.144 ns/in. *(Fig. 3, again)*. C_o is then calculated as 2.075 pF/in. If it's assumed that an MC88100 or 88200 clock input load is 15 pF and that two of these loads, along with a 7-pF FAST TTL load, are distributed along a 9.6-in. clock trace, C_d = 37 pF/9.6 in. = 3.85 pF/in. The loaded trace propagation delay and characteristic impedance are then calculated as t_{pd}' = 0.243 ns/in. and $Z_o' = 41\ \Omega$.

In terms of trace c, the two MC88200s are about 3 in. apart *(Fig. 2, again)*. Using the calculated value of t_{pd}', the clock-signal skew due to the trace is about 0.7 ns. Because these two devices are on the same trace, this is the total clock skew between these devices. Careful inspection of all the clock traces shows that clock-signal skew was accounted for and minimized on the board layout. The longest distance between any 88000 devices on one clock trace is

WHAT'S AVAILABLE NOW?

Low-skew clock drivers come in several technologies *(see "How is a low-skew clock-driver chip achieved?", p. 96)*. There are big differences among clock drivers in operating frequencies, voltage levels, power consumption, and packaging *(see the table)*. Some drivers have features like power-on reset and external reset, which enables multiple clock-driver devices to be synchronized.

One clock driver design that can be helpful in large applications is the MC88915 phase-locked loop. Using an internal V_{CO} and phase/frequency detector, the PLL forces the driver output always to be in phase with the input signal. Thus, a system clock, which feeds several boards and may be of lower frequency, can be regenerated after crossing a backplane to ensure that each board is synchronous with the others.

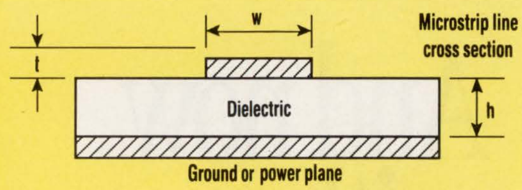
TYPICAL CHARACTERISTICS

Parameter	CMOS[4]	TTL[5]	ECL[6]	ECL/TTL[7]
Max. input clock frequency (min.)(MHz)	110	70	1000	135
Output characteristics				
Number	4Q+2Q′	4Q′	9Q+9Q′	80Q–1:1
Levels: (V)				
V_{oh}	V_{CC}	2.5	-1.0	2.5
V_{ol}	GND	0.5	-1.6	0.5
Timing (50-pF load; maximum values):				
t_{OS}-propagation delay skew[1] (ns)	1	1	0.15	1
t_{PS}-output-to-output skew[2] (ns)	1	1.5	0.05	0.5
t_{PV}-part-to-part skew[3] (ns)	3	3	0.15	1
Rise/fall times (ns)	3/3′	3/3	0.5/0.5	1.7/1.6
Drive sink/source current (mA)	24/24	20/24	50 Ω	24/15
Input requirements:				
V_{ih} (V)	2.0	2.0	-0.7	PECL/TTL
V_{il} (V)	0.8	0.8	-1.4	PECL/TTL
Pulse width (minimum) (ns)	3	6	0.1	3.5
Power:				
Supply voltage (V)	+4.5 to +5.5	+4.5 to +5.5	–5.0 to –5.4	+4.75 to 5.25
I_{CC} (quiescent) (mA)	1.5	70	60	70
Packaging:	14-pin DIP 14-pin SOIC	14-pin DIP 14-pin SOIC	28-pin PLCC	28-pin PLCC

NOTES:
1 It $_{PHL}$ actual-t $_{PLH}$ actuall
2 Any two outputs from a given input clock
3 For a given set of conditions (that is, capacitive load, temperature, and V_{CC}) at each device
4 Reference data sheet MC74F803
5 Reference data sheets MC88913, 88914, 88915
6 Reference data sheets MC10E111, 100E111
7 Reference data sheets MC10H, 100H640, 641, 642, 643

about 4.5 in., which translates to about 1.1 ns of skew.

The two 88000 devices farthest from the clock driver (traces a and c) are at about the same distance along their respective traces. This makes the clock skew between them the 1 ns guaranteed from output to output of the clock driver. As a result, the worst-case clock skew between any two devices on this board is about 2.1 ns, which at 33 MHz is 7% of the period. Unless a designer pays careful attention to matching the clock traces on the board, this number could easily exceed 3 ns and the 10% cut-off point, even if a low-skew clock driver is used.



$$Z_o = \frac{87}{\sqrt{e_r + 1.41}} \ln\left(\frac{5.98h}{0.8w + t}\right)$$

$$t_{pd} = 1.017\sqrt{0.475 e_r + 0.67} \text{ ns/ft}$$

Where: e_r = relative dielectric constant of the board material

w, h, t = dimensions indicated in microstrip diagram

3. IN CALCULATING SYSTEM **skew, the difference in clock pc-board trace length and loading must be taken into account. For an unloaded pc-board trace, the signal delay per unit length, t_{pd}, depends only on the dielectric constant, e_r, of the board material. These relationships are depicted for a microstrip line.**

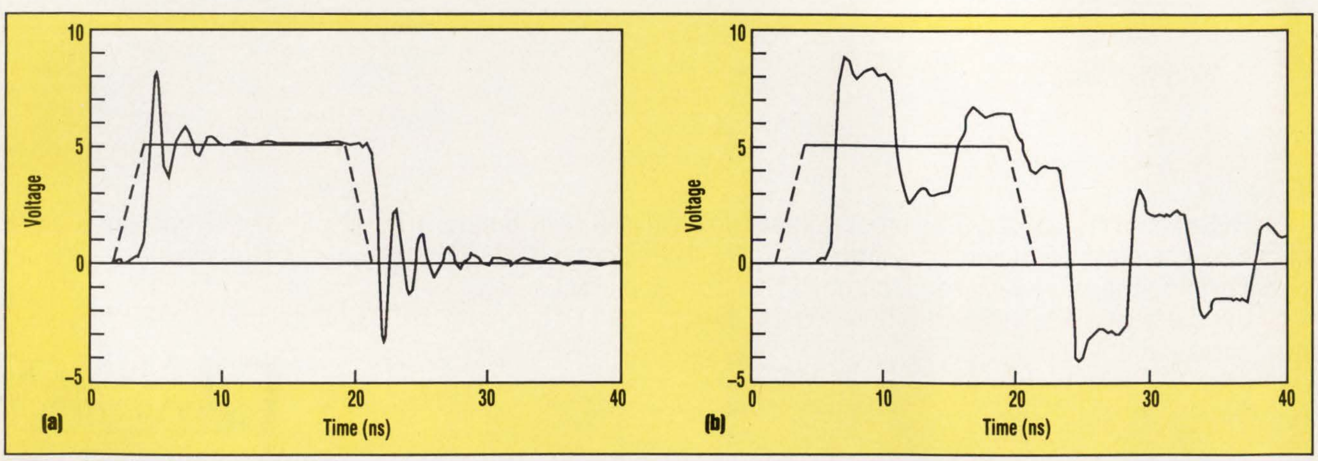
Transmission-line effects occur when a large mismatch is present between the characteristic impedance of the line and the input or output impedances of the receiving or driving device. The basic guideline to determine if a pc-board trace needs to be examined for transmission-line effects is as follows: If the smaller of the driving device's rise or fall time is less than three times the propagation delay of a switching wave through a trace, transmission-line effects will be present. This relationship can be stated as an equation:

$$3 \times t_{pd}' \times \text{trace length} \leq t_{rise} \text{ or } t_{fall}$$

For the MC88914 CMOS clock driver described previously, rise and fall times are typically 1.5 ns or less (from 20% to 80% of V_{CC}). Analyzing the clock-trace characteristics presented earlier for transmission line effects means that 3×0.243 ns/in. $\times$ trace length $\leq$ 1.0 ns (1 ns is used as "fastest" rise or fall time). Therefore, the trace length must be less than 1.5 in. for the transmission-line effects to be masked by the rise and fall times.

Consider then a clock-signal waveform seen at the receiver end of an unterminated 0.5-in. trace and an unterminated 9-in. trace *(Fig. 4)*. These results, which were obtained using Spice simulations, may not be exact but are adequate to predict trends and for comparison purposes. The 9-in. trace, well beyond the 1.5-in. limit where transmission-line effects come into play, exhibits its unacceptable switching characteristics caused by reflections shuttling along the trace. Even the 0.5-in. line exhibits substantial overshoot and undershoot. At these edge rates, any unterminated line shows some overshoot and undershoot.

Clock lines shorter than 1.0 to 1.5 in. are unrealistic on a practical board layout. As a result, CMOS clock lines should be terminated if the driver has 1- to 2-ns edge rates. Termination, which closely matches the line to the load or source impedances, has been a reality in the ECL world for many years. But, CMOS and TTL devices have only recently reached the speeds and edge rates that require termination. CMOS outputs further complicate the issue by driving from rail to rail (5 V), with slew rates exceeding those of high-



4. SPICE SIMULATIONS, **run with parameters of 25° and V_{CC} of 5 V, were done for an unterminated, 0.5-in., 41-Ω transmission line (a) and an unterminated, 9-in., 41-Ω transmission line (b). The 9-in. trace shows unacceptable switching characteristics caused by reflections moving back and forth along the trace. Even the 0.5-in. line shows a great deal of overshoot and undershoot.**

When it comes to affordable DSP, no one has it down like Analog Devices.

- At 10 MIPS, the ADSP-2105 is the fastest DSP in its price category, and it's even faster than many other DSPs costing a lot more. Plus the price is the same whether you buy 100 or 100,000.
- The ADSP-2105 builds on the high performance ADSP-2100 family architecture, so it's code compatible. You can quickly port ADSP-2100 or ADSP-2101 code to the ADSP-2105. Or use our C Compiler for a fast start.
- Not only is the ADSP-2105 code compatible, it's also pin compatible with the ADSP-2101. So it provides a complete upgrade path to higher performance.
- The ADSP-2105 packs plenty onto one chip, including 1024 words of program RAM, 512 words of data RAM, full serial port, hardware companding, timer and more.
- It's easy to get the ADSP-2105 up and running with our inexpensive EZ-KIT, a complete software and hardware design package.

Introducing the ADSP-2105 at only $9.90 each.

Introducing a DSP that could only come from Analog Devices, the ADSP-2105. An exclusive because it combines the high performance of our ADSP-2100 family with an unprecedented price in DSP – just $9.90 each. So now you can consider the power of DSP in a host of new applications.

ADSP-2100

ADSP-2101

Just how well does the ADSP-2105 combine low price with high performance? Find out for yourself by ordering our EZ-KIT from your local Analog Devices sales office today. Or call DSP Marketing at (617) 461-3771.

ANALOG DEVICES

CIRCLE 118

performance ECL devices.

Because clock lines are driven only from one location, they lend themselves to termination more easily than bus lines, which are commonly driven from multiple locations. Digital systems use various types of termination techniques *(Fig. 5)*. Because no single termination scheme is optimal in all cases, the trade-offs in the use of each needs to be discussed and recommendations made specific to clock drivers.

The driving device in the Spice simulations of various termination schemes was the MC88914 output buffer. In all simulations, it drove a 9-in., 41-Ω transmission line. The simulations were run using model parameters at 25°C and V_{CC} of 5.0 V.

Series Termination

Series termination is recommended if the load is lumped at the end of the trace and the output impedance of the driving device is less than the loaded characteristic impedance of the trace. It's also recommended when a minimum number of components is required. The problem with series termination arises when the driving device has different output impedance values in the low and high states, which occurs in TTL and some CMOS devices. A well-designed CMOS clock driver should have nearly equal output impedances in the high and low states, avoiding this problem. An additional advantage is that series termination doesn't create a dc current path.

As a result, the V_{OL} and V_{OH} levels aren't degraded. The Spice-generated waveforms of series termination show that this termination effectively masks transmission-line effects.

If each clock output is driving only one device, series termination is recommended. Because this isn't realistic in most systems, series termination isn't generally advised for clock-line termination.

Parallel termination uses one resistor tied to ground or V_{CC}, whose value is equal to the line's characteristic impedance. Its major disadvantage is the dc current path it creates when the driver is in the high state (if the resistor is tied to ground). This

HOW IS A LOW-SKEW CLOCK DRIVER CHIP ACHIEVED?

Designing and manufacturing a low-skew clock-driver chip calls for many of the same factors in system design, but obviously on a much smaller scale. Careful circuit design, symmetrical layout techniques, and good control of the fabrication process are needed for low output-to-output and part-to-part skew characteristics. First, using circuit design methods, the high-to-low and low-to-high transitions from the clock input to the distributed outputs must be as close as possible to each other. Then the rise and fall times of a signal out of the output buffers (drivers) must be evenly matched. This is done by matching the output impedances of the pull-up and pull-down transistors. Satisfying these two requirements results in a 50% duty cycle.

The design-related methods depend on computer simulations and the accuracy of the simulator models. But when the circuit is implemented in silicon, layout parasitics can adversely affect circuit performance. Chip-level parasitics are similar to the pc-board trace parasitics that must be accounted for when calculating signal delays on the board level. However, one advantage at the chip level, due to the short length of signal lines, is that transmission-line effects are negligible. A clock-distribution part has several outputs, usually at least four, whose propagation delay skews must be matched within a given tight specification (for example, less than 1 ns). If the path to one output has more layout-induced parasitic resistance and/or capacitance than the other outputs, then its propagation delay might be slower than the others by more than the specified limit.

Layout parasitics are always present, therefore the trick is to match the parasitics of each output as closely as possible. This means that the layout must be symmetrical, with the path from clock input to each output looking almost identical. As such, the length and parasitic resistance and capacitance of each signal path must be equal. ECL's extremely high switching speeds also demand that the characteristic impedance of the paths be tailored to avoid reflections at the branching points.

Packaging effects must also be considered to minimize skew. The leads of a standard DIP package have large and variable inductive parasitics. As a result, the outputs must be connected to package leads that have matched inductances—that is, symmetrical pins on opposite sides of the package. Again, for ECL, the high speeds demand a package such as a plastic leaded chip carrier, which minimizes the inductive and capacitive effects of the pins. External impedance matching of clock lines is also important.

Within a part, the circuit design, layout, and packaging techniques that are described guarantee that one part will have low output skew. However, in a synchronous system using more than one clock driver device, the part-to-part output skew must be within a reasonable tolerance (two to three times the output-to-output skew). Achieving this goal requires tight control over the fabrication process. CMOS particularly doesn't have ECL's temperature and voltage compensation features. How well critical process parameters, such as channel length and threshold voltage, are held within a small tolerance determines how small the part-to-part variation will be.

References

1. "A Clock Distribution Circuit with a 100-ps Skew Window" by Rajnish Maini, James McDonald, and Lou Spangler, IEEE 1987 BTCM.
2. *MECL System Design Handbook* HB295/D, Motorola.

causes excessive power dissipation and V_{OH} level degradation. Because a clock driver output is always switching, the dc-current-draw argument loses some credibility at higher frequencies. For one thing, the ac switching current becomes a major component of the overall current. Therefore, the key consideration in parallel termination is how much V_{OH} degradation can be tolerated by the receiving devices. This termination technique is effective in minimizing switching noise. Nonetheless, Thevenin termination has some advantages compared with parallel termination.

Thevenin termination uses one resistor tied to ground and a second tied to V_{CC}. When designers use this type of termination, it's important that they consider the choice of resistor values to avoid settling of the voltage between the high and low logic levels of the receiving device. TTL designers commonly use a 220/330 resistor value ratio, but CMOS is somewhat tricky because the switch point is at $V_{CC}/2$. With a 1:1 resistor ratio, a failure at the driver output would cause the line to settle at 2.5 V. Besides causing system-debugging problems, this could lead to potential damage to the receiving devices.

THEVENIN AND AC TERMINATION ARE THE RECOMMENDED SCHEMES FOR CLOCK LINES, BUT IT DEPENDS ON THE CLOCK'S FREQUENCY.

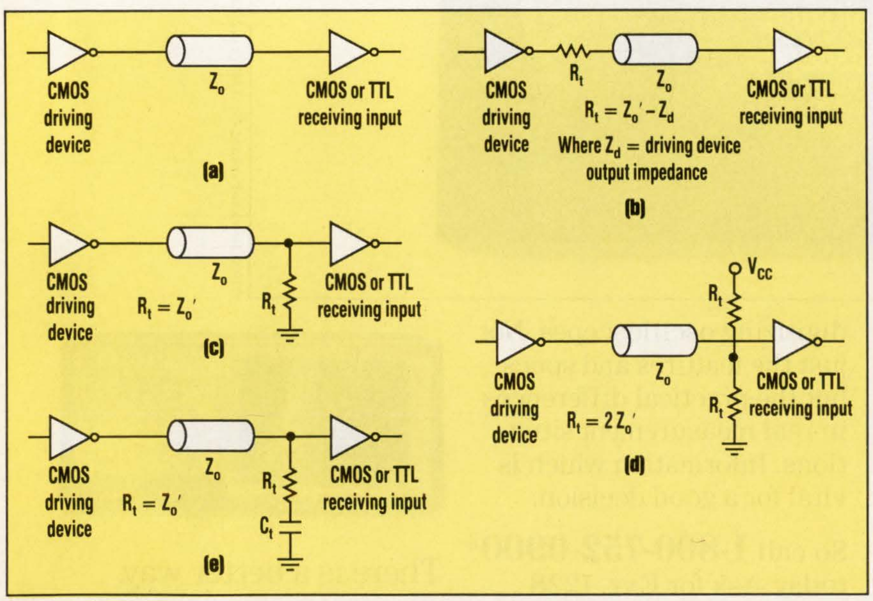
In Thevenin termination, the parallel equivalent value of the two resistors should equal the line's characteristic impedance. A dc path does exist in both the high and low states. However, it's better than parallel termination because the resistance in the Thevenin dc path is at least two times greater.

The Thevenin termination waveforms exhibit characteristics similar to those for parallel termination but with less V_{OH} degradation *(Fig. 6)*. The only real advantage of parallel over Thevenin is fewer resistors (half as many), resulting in more available board space. If space isn't a factor, Thevenin termination is recommended over parallel.

Ac termination typically uses a resistor and capacitor in series to ground. The capacitor blocks dc current flow but allows the ac signal to flow to ground during switching. The time constant of the resistor and capacitor must be greater than twice the loaded line delay. Ac termination is recommended because of its low power dissipation and the availability of the resistor and capacitor in single-in-line packages (SIP). A pull-up resistor to V_{CC} is sometimes added to set the dc level at a certain point because of the failure condition described in regard to Thevenin termination. As noted earlier, the argument of lower dc current is less convincing at high frequencies. The ac-terminated waveform walks out slightly toward the end of a high-to-low or low-to-high transition, making it somewhat less desirable than Thevenin termination at higher frequencies.

Thevenin and ac termination are the two recommended termination schemes for clock lines, but it depends on the clock's frequency. It's safe to assume that ac is the best choice at frequencies of 25 MHz and below. If the system frequency could reach 40 MHz and beyond, Thevenin becomes the better choice.

The results presented might imply that terminating the clock lines completely solves noise problems, but termination can cause secondary problems with some logic devices. Termination acts to reduce the noise seen at the receiver, but that noise actually appears as additional current and noise at the driving device's output. If the internal and input logic on the source device isn't sufficiently decoupled on chip from the high-current outputs, internal threshold problems can occur. This phenomenon is commonly known as "dynamic threshold." It's usually evidenced by glitches appearing on the outputs of a fast, high-current drive logic device as it switches high or low. This is most severe on "ACT" devices,



5. COMMON TERMINATION TECHNIQUES, represented schematically, are a transmission line with no termination (a); a transmission line with series termination (b); a transmission line with parallel termination (c); a transmission line with Thevenin termination (d); and a transmission line with ac termination (e).

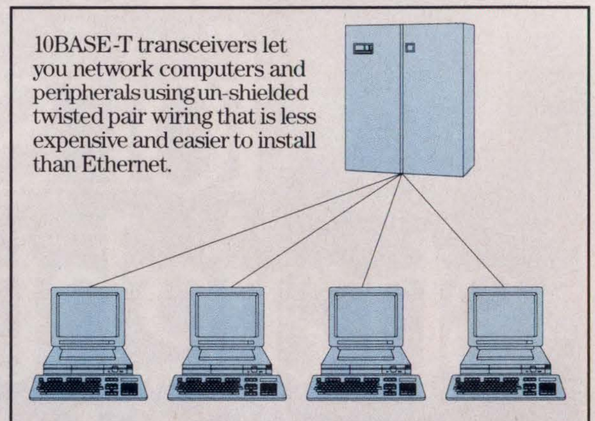
Looking for some straight answers on twisted pair?

The newest tw

Finally, a plug and play 10BASE-T network.

With our new ML4650 family of Single Chip 10BASE-T transceivers, you're covered all across the LAN. Because we have single chip twisted pair solutions for both ends, hub to node. Available now. In quantity. Giving you a fast, no hassle 10BASE-T solution.

On the PC side, the ML4651 and ML4652 transceivers incorporate AUI interfaces designed for both Ethernet adapter cards and external MAUs. On the hub side, the ML4654 is tailor-made for a hub design with TTL or ECL outputs. All are highly integrated single chip solutions, minimizing the number of external components required. So your design-in process is much easier. And faster.



10BASE-T transceivers let you network computers and peripherals using un-shielded twisted pair wiring that is less expensive and easier to install than Ethernet.

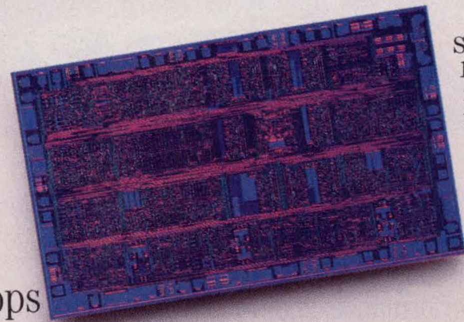
On-chip current driven transmitters are less sensitive to noise and power supply variations. So you get superior jitter performance and low noise outputs that help you easily pass FCC requirements. And the receiver includes an intelligent squelch that rejects cross-talk noise commonly found coupling from the phone wires into the LAN. There's no external crystal oscillator required either, and devices use 5 volts only power supplies.

Parts are available in 20- and

Micro Linear 10BASE-T products are available in both adapter card and external MAU configurations.

ist in 10BASE-T.

24-pin skinny DIPs and 28-pin PLCCs. There's even an ML4621 Fiber Optic Inter-Repeater Link (FOIRL) receiver available to satisfy 10 Mbps fiber optic Ethernet requirements.



Semi-standard options of the standard 10BASE-T circuits are possible simply by modifying the metal mask on the FB3651 tile array.

And, unlike much of the technology you've been hearing about, these are products of experience. We've been shipping twisted pair transceivers since 1987, as part of Synoptics' LattisNet network.

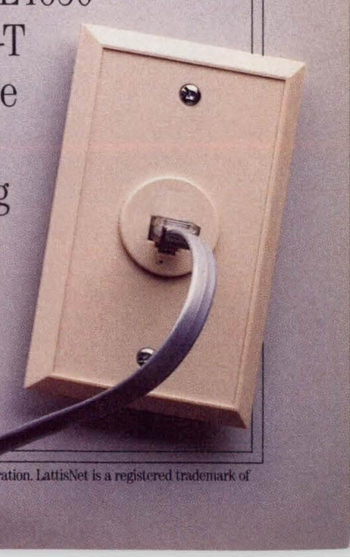
Semi-standard options.

We're one of the first to market for one simple reason. Our 10BASE-T family is based on our standard FB3651 bipolar tile array. So we were able to quickly modify our "standard" product to satisfy the rapidly-emerging IEEE 802 standards.

And, for the same reason, they can be easily modified with semi-standard capability to give you proprietary product advantages. Like functional or performance modifications. Or special screening packaging or reliability levels to meet your specific network requirements. Whether it's an on-board AUI device. Or a multi-port repeater (MPR) designed to achieve that critical time-to-market advantage you've been looking for.

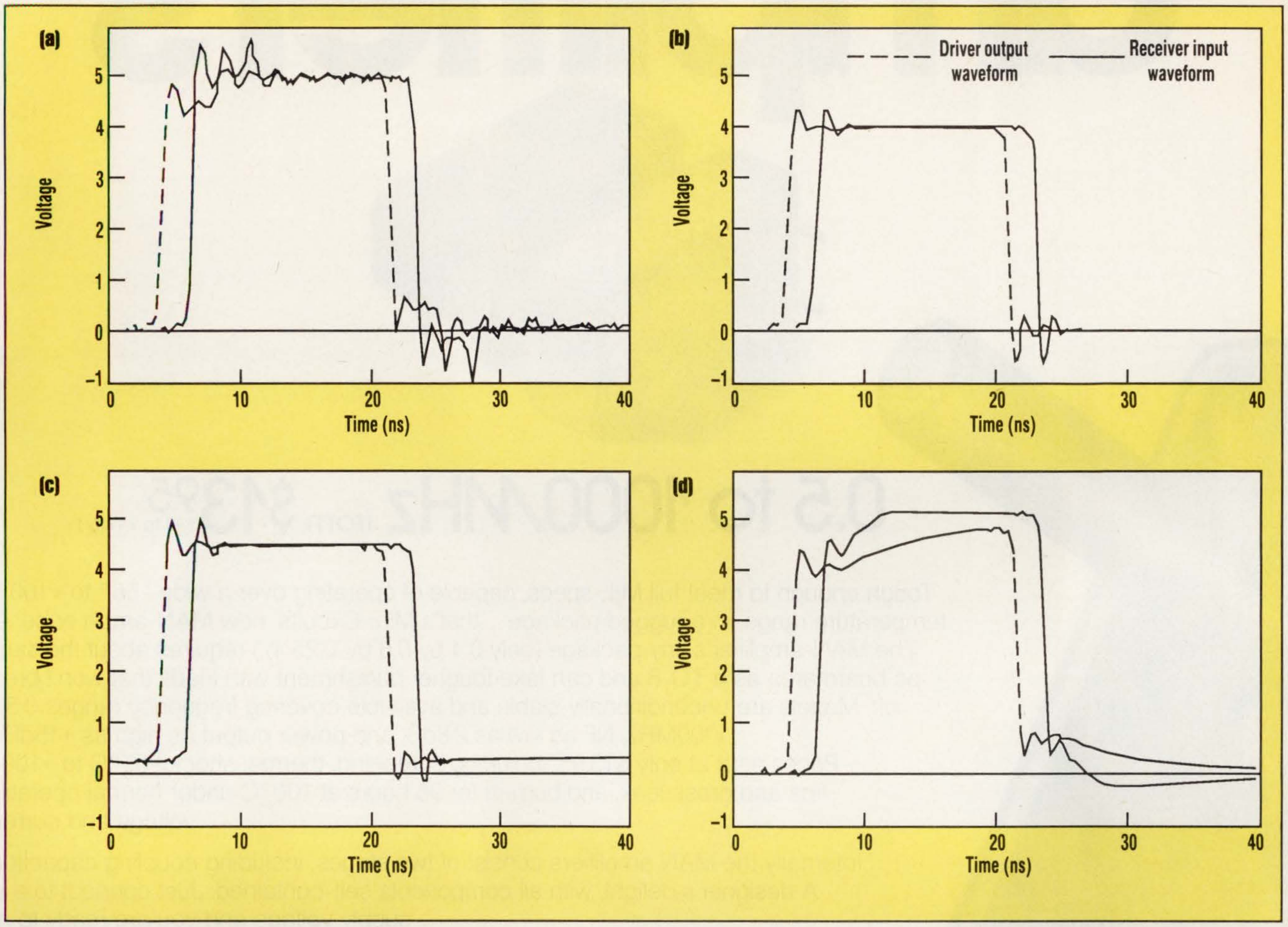
Call us on it.

If you'd like to turn your 10BASE-T idea into a deliverable product, just call Charles Yager today at (408) 433-5200 and ask him for the complete story on our ML4650 family of single chip 10BASE-T transceivers. Or ask for a free sample. It could add a whole new twist to your networking scheme.



Micro Linear, 2092 Concourse Drive,
San Jose, CA 95131

Micro Linear



6. SPICE SIMULATIONS, run with parameters of 25° and V_{CC} of 5 V, were done for various terminations of a 9-in., 41-Ω transmission line. Simulation results are for series termination (a); parallel termination (b); Thevenin termination (c); and ac termination (d). The waveforms for Thevenin termination show similar characteristics to those of the waveforms for parallel termination, but there is less V_{OH} degradation.

which have high current and high slew-rate CMOS outputs, along with TTL inputs, which have low noise immunity. This problem can be minimized by decoupling the internal ground and V_{CC} supplies on-chip and in the package.

This decoupling is accomplished by having separate "quiet" ground and V_{CC} pads on-chip, which supply the input circuitry's ground and V_{CC} references. These pads are then tied to extra "quiet" ground and "quiet" V_{CC} pins on the package or to special "split leads." These resemble a tuning fork and use the leadframe inductance to accomplish the decoupling. When choosing a clock source, designers should note that the part must have one of these decoupling schemes.

A reliable, high-frequency microprocessor system requires a low-skew clock driver, along with special attention to the board layout of clock traces. The line lengths and loading must be matched to avoid excessive signal skew between CPUs, cache MMUs, and other critical peripheral devices.

To ensure a clean clock signal throughout the system, clock traces must also be terminated in some fashion. Carefully addressing these issues early in the design cycle helps designers to guarantee optimal system performance.☐

References

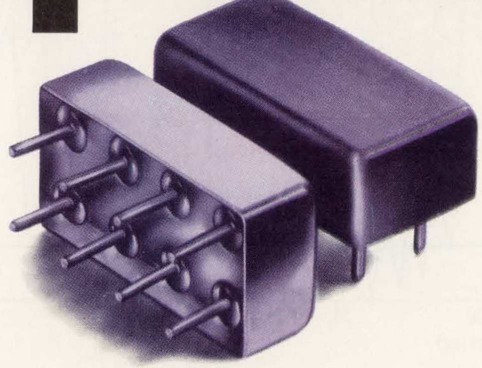
1. Blood, William R., *MECL System Design Handbook*, Motorola Inc., 1983.
2. Application Note AN1051, *Transmission Line Effects in PCB Applications*, Motorola Inc., 1990.
3. *Motorola FACT Data*, Motorola Inc., 1990.

Chris Hanke, a CMOS design engineer in Motorola's Logic IC Division, received BSChemEng and MSEE degrees from Rensselaer Polytechnic Institute, Troy, N. Y.

Gary C. Tharalson, a new product planner in Motorola's Logic IC Division, Mesa, Ariz., received a BSEE from the University of Minnesota and an MBA from Arizona State University.

HOW VALUABLE?	CIRCLE
HIGHLY	541
MODERATELY	542
SLIGHTLY	543

rugged plug-in amplifiers



0.5 to 1000MHz from $13.95 (10 to 24 qty)

Tough enough to meet full MIL-specs, capable of operating over a wide -55° to +100°C temperature range, in a rugged package...that's Mini-Circuits' new MAN-amplifier series. The MAN-amplifier's tiny package (only 0.4 by 0.8 by 0.25 in.) requires about the same pc board area as a TO-8 and can take tougher punishment with leads that won't break off. Models are unconditionally stable and available covering frequency ranges 0.5 to 1000MHz, NF as low as 2.8dB, and power output as high as +15dBm.

Prices start at only $13.95, *including* screening, thermal shock -55°C to +100C, fine and gross leak, and burn-in for 96 hours at 100°C under normal operating voltage and current.

Internally the MAN amplifiers consist of two stages, including coupling capacitors. A designer's delight, with all components self-contained. Just connect to a dc supply voltage and you are ready to go.

The new MAN-amplifiers series...
another Mini-Circuits' price/performance breakthrough.

MODEL	FREQ. RANGE (MHz) f_L to f_u	GAIN dB min	GAIN dB flatness††	MAX. OUT/PWR† dBm	NF dB (typ)	DC PWR 12V, mA	PRICE $ ea. (10-24)
MAN-1	0.5-500	28	1.0	8	4.5	60	13.95
MAN-2	0.5-1000	19	1.5	7	6.0	85	15.95
MAN-1LN	0.5-500	28	1.0	8	2.8	60	15.95
◇MAN-1HLN	10-500	10	0.8	15	3.7	70	15.95
*MAN-1AD	5.500	16	0.5	6	7.2	85	24.95

††Midband $10f_L$ to $f_{u/2}$, ±0.5dB †ldB Gain Compression ◇Case Height 0.3 In.

Max input power (no damage) +15dBm; VSWR in/out 1.8:1 max.

*Active Directivity (difference between reverse and forward gain) 30 dB typ.

finding new ways...
setting higher standards

Mini-Circuits

A Division of Scientific Components Corporation
P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500
Fax (718) 332-4661 Domestic and International Telexes: 6852844 or 620156

CIRCLE 105

C118 REV. E

CIRCLE 521

TEST GANGED POT TRACKING

M. S. NAGARAJ
Isro Satellite Centre, Digital Systems Div., Airport Rd., Vimanapura P.O., Bangalore 560 017, India.

Ganged potentiometers are widely used in audio stereo systems and in many instrumentation circuits. Often, the performance deficiencies in this type of equipment can be traced back to the ganged potentiometers, which have two resistance tracks that are out of step. Here, a circuit is developed to rapidly test the ganged-potentiometer tracking. The tracking error can be measured with an accuracy of better than 1% at all shaft-slider positions in the entire electrical travel of the potentiometer.

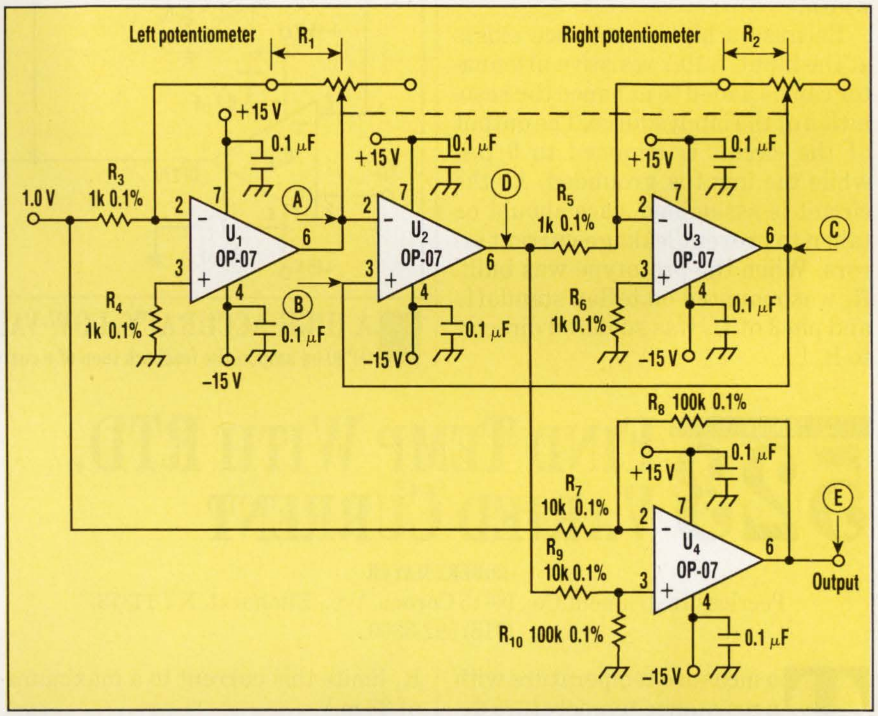
The circuit uses ultra low-offset-voltage op amps, eliminating the need for offset nulling *(see the figure).* The inverting amp built around op amps U_1 and U_3 uses the potentiometers under test as feedback resistors.

At any given shaft-slider position, let $R_1/R_2 = n$ volts at point A. As a result, $V_A = 1\ V \times (R_1\ k\Omega/1\ k\Omega) = R_1 = nR_2$.

The voltage at point D, $V_D = V_C/$ gain of $U_3 = nR_2/(R_2/1) = n$, and at point E, $V_E = 10 \times (n-1)$.

These relationships show that V_E is positive when $R_1 > R_2$, zero when $R_1 = R_2$, and negative when $R_1 < R_2$. One volt at the circuit's output corresponds to a tracking error of 10%.

The values shown in the circuit are for 10-kΩ ganged potentiometers. For other values, let resistors R_{3-6} equal a potentiometer value of 0.1 to restrict the maximum output voltages of U_1 and U_3 to within 80% of the supply voltages.□



THIS CIRCUIT MEASURES THE TRACKING ERROR of ganged potentiometers. Less than 1% accuracy can be achieved at all shaft-slider positions of the potentiometer.

IFD WINNERS

IFD Winner for April 26, 1990
Kerry Lacanette, National Semiconductor, 2900 Semiconductor Dr., P.O. Box 58090, Santa Clara, CA 95052; His idea: *"Create an Accurate Noise Generator."*

IFD Winner for May 10, 1990
Gary Multer, Sen Majumdar, and Raj Pisupati, Digital Equipment Corp., 20 Hampden St., Boston, MA 02119; His idea: *"Drive Stepper Motor, Cut Cost."*

CIRCLE 522

BUILD A PRECISE, LOW-CURRENT SOURCE

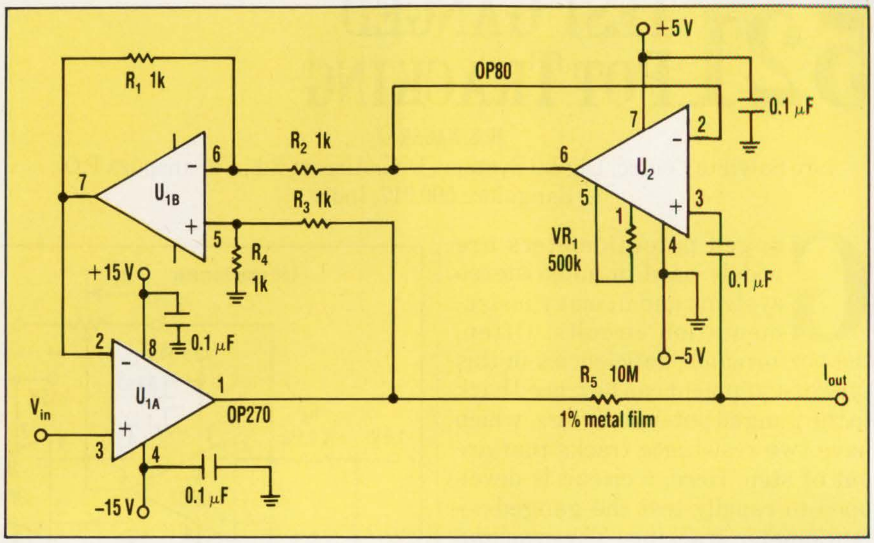
JOHN GUY
Precision Monolithics Inc., 1500 Space Park Dr., P.O. Box 58020, Santa Clara, CA 95052; (408) 727-9222.

A current source that attains a resolution as low as 10 pA is useful in applications where a precise, low-value current is needed. When the circuit forces current into ground, the output remains within 2% of the ideal current over the ±100-nA range. Over the −4 to +3.5-V compliance range, the error that appears is less than 5%. This accuracy results from using an OP80 op amp from Precision Monolithics in the feedback loop *(see the figure, p. 106, top).* The OP80 has an I_B of 200 fA typical.

For a given voltage (V_{in}), amp U_{1A} generates an output voltage so that the current through R_5 equals V_{in} divided by R_5 (10 MΩ). This current causes a voltage drop across R_5, which is sensed by the unity-gain-differential amp consisting of U_{1B} and U_2. That amp's output is connected to the inverting input of U_{1A}, completing the feedback loop.

The noise in the circuit is of particular concern, especially that produced by resistor R_5. The circuit is limited to low-frequency and dc applications due to its 400-nV/$\sqrt{Hz}$ noise. For applications that don't require the circuit's 10-pA output, lower values of R_5 can be substituted. This will cause an increase in bandwidth.

Because a high impedance exists at the input, a 10:1 resistive attenuator can be added to enhance the resolution of the input source. The output of the circuit is trimmed to 0 pA, while the input is grounded. As the circuit is assembled, care should be taken to prevent leakage-current errors. When the prototype was built, R_5 was mounted on teflon standoffs and pin 3 of U_2 was soldered directly to R_5.□



A HIGH-ACCURACY, LOW-VALUE CIRCUIT can be achieved by using an OP80 op amp in the feedback loop of a current-source circuit.

CIRCLE 523

FIND TEMP WITH RTD, VARIED CURRENT

ROBERT MAYER

Peerless Instrument Co., 90-15 Corona Ave., Elmhurst, NY 11373; (718) 592-3300.

To measure temperature with a resistance-temperature detector (RTD), a known current is passed through the RTD as the voltage across it is measured. By applying Ohm's law, the RTD's resistance is calculated as V/I. This resistance then corresponds to a one-to-one function of the RTD's temperature.

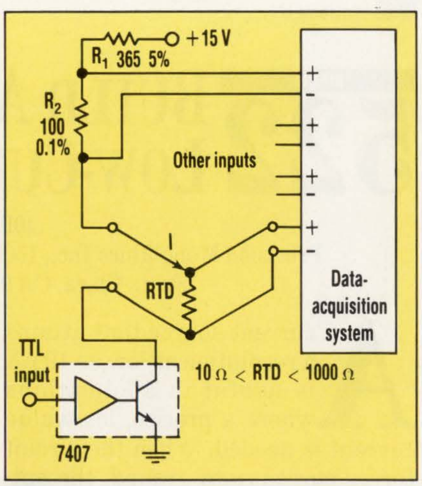
The RTD's resistance can also be found by determining the current and voltage separately *(see the figure)*. When the 7407 open-collector output transistor is on, current I flows through R_1, R_2, and the RTD. R_1 limits this current to a maximum of 33 mA.

A data-acquisition system measures the voltage across R_2 and across the RTD. The circuit's microprocessor (not shown in the figure) divides V_{R2} by R_2 to find I, then divides V_{RTD} by I to find the RTD resistance. When these steps are followed, I drops out of the equation leaving:

RTD resistance $= R_2 \times V_{RTD}/V_{R2}$.

This approach offers four advantages over conventional methods that employ a constant-current source to supply the known current. First, the signal-to-noise ratio (SNR) is excellent because a large RTD voltage is induced by a large current. Second, only one precision component (R_2) is required to supply a high-accuracy result. A constant-current source with the same accuracy and SNR would need additional high-precision components.

The third advantage of this method is that the current can be switched on and off by a TTL signal. Errors caused by selfheating of the RTD can be can be reduced by turning the current off between measurements. Finally, the RTD resistance can vary over a large range. The constant-current-source method has a much smaller range because it can't supply the required current when the RTD resistance exceeds the quotient of $V_{supply}/I_{constant}$.□



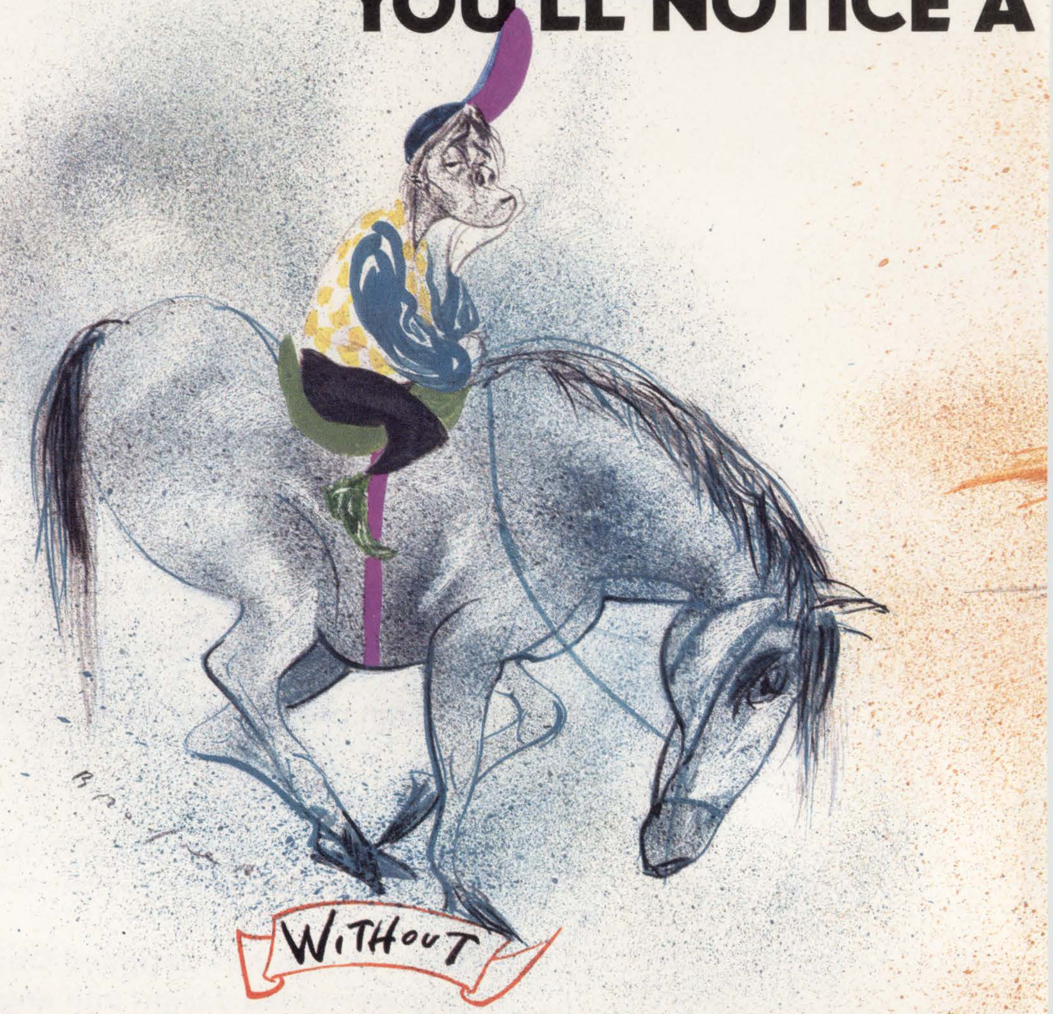
TEMPERATURE CAN BE measured with an RTD by taking two voltage measurements—one across R_2 and the other across the RTD. The current and then the RTD resistance are then calculated. The temperature is then a function of the resistance.

VOTE!

Read all the Ideas for Design in this issue, select your favorite, and circle the appropriate number on the Reader Service Card. The winner receives a $150 Best-of-Issue award and becomes eligible for a $1,500 Idea-of-the-Year award.

SAMSUNG NOW

68040 SYSTEMS EQUIPPED YOU'LL NOTICE A



Systems utilizing the new Samsung 84C31 take off. They run like Triple Crown-winning thoroughbreds. They blaze, scorch, and leave others in their dust.

In a word, they are fast.

And they make even speedy 68040 systems that *don't* use the 84C31, look like they're not in motion.

The 84C31 was designed with the close cooperation of Motorola. It is the *only* DRAM controller designed specifically for Motorola's powerful 68040 and 68030 microprocessors.

SAMSUNG'S DRAM CONTROLLER FOR THE 68040 AND 68030

Part Number	*RAMs Supported*	*Package*
KS84C31-33CL	256K, 1Mb	68-pin PLCC
KS84C32-33CL	256K, 1Mb, 4Mb	84-pin PLCC

Samples and production available now.

Like the extremely successful earlier-generation Samsung System Accelerators,™ the part is highly integrated and inherently fast. And as the cutting edge in memory control, it can help you simply and economically enhance even 68040 performance.

The 84C31 supports both the burst and non-burst modes of the 68040. It also provides a direct interface

WITH OUR DRAM CONTROLLER: CERTAIN IMPROVEMENT.

to the microprocessor. Which saves you dollars, board real estate, and

68030 PERFORMANCE SUMMARY

Access Clocks	*DRAM Speed*	*Frequency (Mhz)*
4-2-2-2	70 ns	20
5-2-2-2	120 ns	20
5-2-2-2	80 ns	25
6-2-2-2	120 ns	25
6-2-2-2	80 ns	33
7-2-2-2	100 ns	33

68040 PERFORMANCE SUMMARY

Access Clocks	*DRAM Speed*	*Frequency (Mhz)*
3-2-2-2	80 ns	25
5-2-2-2	100 ns	25
6-2-2-2	120 ns	25
5-2-2-2	80 ns	33
6-2-2-2	100 ns	33

design time, since it means you don't need additional glue logic.

Ease of design is another advantage. As a glance at our System Design Guides will show, it's an unusually simple chip to design in.

All in all, we believe the 84C31 is the best memory controller solution available today.

For details on using it to make *your* designs take off, contact DRAM Controller Marketing, Samsung Semiconductor, 3725 No. First St., San Jose, CA 95134. Or call 1-800-669-5400, or 408-954-7229.

SAMSUNG
Semiconductor

CIRCLE 143

Workstations And HDTV Get Triple 10-Bit 80- MHz DAC ICs

Frank Goodenough

For the first time, designers of high-resolution computer graphics systems can get 10-bit video digital-to-analog converter (DAC) ICs. Moreover, they can get three of these 80-MHz DACs on a single chip for under $20. The ADV7121/22 triple DACs from Analog Devices can resolve over one billion colors at any given time, a capability that's well beyond that of the human eye. Such capability is needed by sophisticated color graphics systems such as HDTV and workstations, to linearize the transfer-function curve of drive current to light output (also known as a Gamma curve) of the display system *(see the figure)*.

The DACS are aimed at any high-resolution color graphics application employing a true-color system or a special lookup table. These include workstations, medical imaging, and even high-end PCs.

With the higher 10-bit resolution (instead of the more common 6 or 8 bits), calculations for the required color shadings become simpler. For the graphic designer in need of a color with half the intensity, it's much easier to call out a digital half-code than to calculate which code associated with the given display system will produce the desired color.

This feature is in such high demand that NHK (the Japanese equivalent of the FCC) designed the 7121 into the prototype system they use for receiving their MUSE HDTV standard. Other HDTV development teams in both the U.S. and Europe are already using these DACs for their prototype systems. The DACs also comply with the Society for Motion Pictures and Television Engineering (SMPTE) 240, a proposed U.S. production HDTV standard.

At the heart of each ADV7121 and ADV7122 lie three RGB, 10-bit 30-, 50- or 80-MHz DACs, each with its own TTL-compatible latched pixel input port. An additional input is provided for the pixel clock which strobes the latches to refresh the DAC outputs. A reference amplifier converts an external 1.235-V reference to a 17.7-to-18.5-mA fullscale current source for each DAC. A variable resistor connected to the amplifier sets the exact fullscale current—the white level for all three DACs. The current sources are compliant from -1.4 to +1 V. Thus, each DAC can develop 0.5 V at the end of a doubly terminated 75-Ω line.

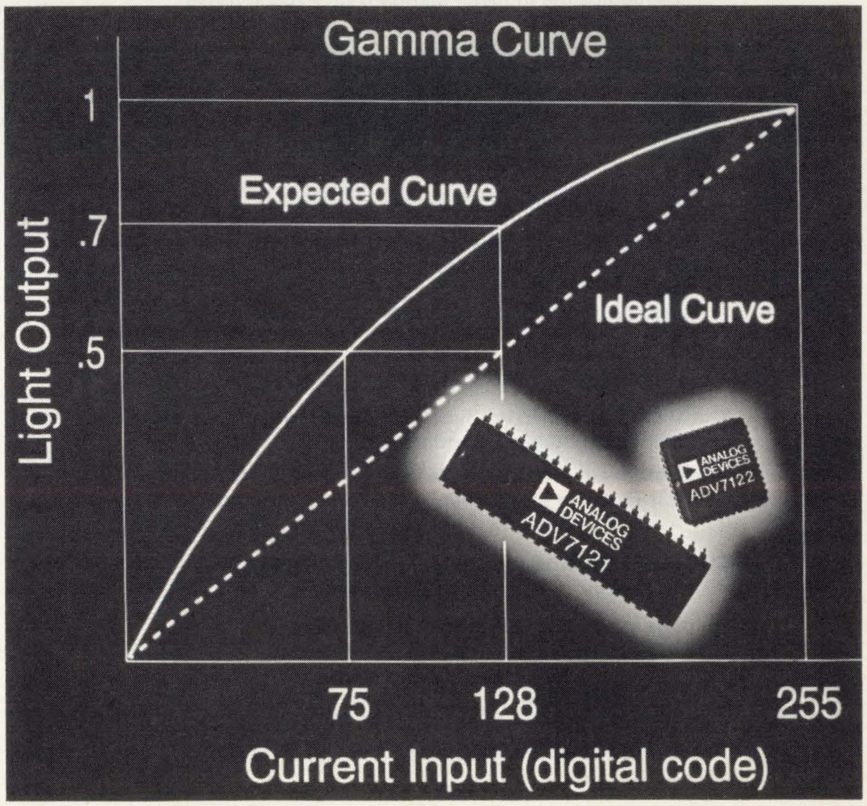
Identical Devices

The two devices are identical (the same chip) except that the 7121 lacks the SYNC and BLANK inputs due to its 40-pin double-width DIP package (the 7122 is in a 44-pin PLCC). In addition to the three speed-versions and two packages types, there are two performance grades. Integral and differential nonlinearity (INL and DNL) of the J-grade device run ±3 and -1 LSB maximum, respectively, over the temperature range of 0 to 70°C. Under similar conditions, INL and DNL of the K-grade units run ±2 and ±1 LSB, respectively. All are guaranteed to be monotonic over temperature.

The availability of three speed versions permit system designers to choose the most economical device as a function of CRT resolution. For example, at a refresh rate of 60 Hz, the 80-MHz converters are required for the latest 1024-by-1024-pixel CRT displays. Maximum current consumption from a 5-V power-supply rail for these CMOS chips is just 125 mA for the 80-MHz units and 100 mA for the others.

In quantities of 1000, pricing ranges from $18.35 each for the 30-MHz, J-grade ADV7121 to $35.30 each for the 80-MHz, K-grade ADV7122. Small quantities are in stock.

Analog Devices Inc., 804 Woburn St., Wilmington, MA 01887; Chris Hyde, (617) 937-1422 **CIRCLE 301**

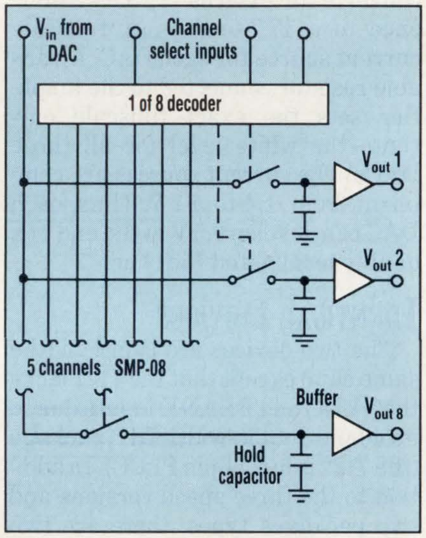


Multiplexed Sampling Amplifier Deletes Costly DACs

While the cost of 12-bit IC d-a converters (DACs) has dropped, if you need a lot of them, total system cost can climb—and they not only take space, but the input digital lines to them do as well. Another approach, somewhat analogous to dynamic vs static RAMs, uses a single DAC and multiple sample-and-hold amplifiers which are continuously refreshed. To fill that need, Precision Monolithics has announced the SMP-08. It has eight, voltage-output, sample-and-hold amplifiers any one of which can have its held voltage uniquely updated, at any time, from a single DAC. A 3-bit input word selects the channel. An update to 8-bit accuracy for 0 and 10 V typically takes 1 µs. Droop rate is 0.25 mV/ms. And that's with on-chip capacitors. Absolute accuracy is 8-bits, linearity 12-bits. Unit price in lots of 100 runs $6.25.

***Precision Monolithics Inc. P.O. Box** 58020, Santa Clara, CA 95052-8020; Walt Heinzer (408) 562-7254.* **CIRCLE 302**

■ *FRANK GOODENOUGH*



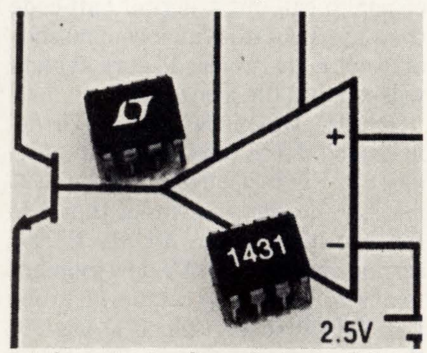
Sample To 16-Bit Accuracy In 250 ns

With the SP9760 sample-and-hold amplifier, you can grab a 10-V signal to 16-bit accuracy in just 250 ns, typical, and a 20-V signal to the same accuracy in typically 350 ns, or 500-ns maximum. This hybrid, whose speed comes from a pair of custom dielectrically-isolated ICs, is the fastest 16-bit accurate sampling amp available. Other critical specifications for the 0-70 °C model include an aperture uncertainity of 75 ps rms and a full-power bandwidth of 2 and 4 MHz respectively for 20- and 10-V output swings. Slew rate is a minimum of 75 V/µs. Total harmonic distortion at 100 kHz for 5 Vp-p output is typically -90 dB; at 10 kHz for a 20 Vp-p signal, it is -88 dB. Applications include CAT scanners, magnetic resonance imaging, and high-performance automatic test equipment. In its 24-pin double width DIP the commercial grade SP9760 runs $199 each in hundreds. The mil-grade unit $90 more.

Sipex Corp. 6 Fortune Dr., Billerica, MA 01821; Jack Worthen (508) 663-9691. **CIRCLE 303**

Shunt Reference In TO-92 Sinks 100 MA

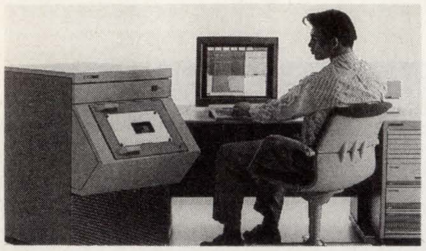
An adjustable shunt-type linear reference/regulator, the LT1431, comes in a 3-pin TO-92 as well as 8-pin DIPs and SOICs. It contains a 2.5-V band-gap reference, its output transistor sinks 100 mA, and, with just a single external resistor, can be connected to deliver 2.5 or 5 V out with 1% accuracy. Two resistors



set the output voltage between 2.5 and 36 V. It can also provide the reference and isolated negative feedback in a 5-V switching regulator by connecting a resistor to the regulator's output and driving the LED in an opto-isolator with the IC's open-collector npn. The LT1431 (TO-92) goes for just $0.92 each in hundreds.

Linear Technology Corp., 1630 McCarthy Blvd., Milpitas, CA 95035-7487; Bob Scott, (408) 432-1900. **CIRCLE 304**

IC EVALUATION SYSTEM FEATURES 400-MHZ VECTOR RATE, 512 PINS



The latest member of the HP 82000 family of IC evaluation systems, the Model D400, boasts a 400-MHz maximum vector rate that lets engineers verify their designs and characterize prototype ICs and ASICs at the devices' full performance limits. In the past, designers had to use formulas to make assumptions about device behavior at full speed.

The system accuracy is an excellent ±200 ps. Maximum pin capacity is 512 pins. Memory capacity of up to 1 Mvector is available behind each I/O pin. A tester-per-pin architecture permits independent per-pin timing and voltage levels.

The HP 82000 series features a modular design, so users can start with a basic configuration and increase pin count and vector rate as the need arises. HP can supply a variety of links to all commonly used electronic design automation systems. New high-throughput software is available to make the tester suitable for small-batch production testing.

The HP 82000 Model D400 costs about $3400 per I/O channel, depending on the number of channels and the system configuration. Delivery is estimated at 12 weeks.

***Hewlett-Packard Co.** Inquiries, 19310 Pruneridge Ave., Cupertino, CA 95014; (800) 752-0900.*

CIRCLE 305

■ *JOHN NOVELLINO*

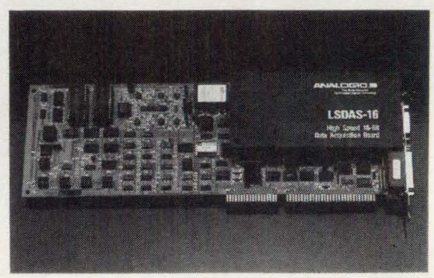
E-BEAM PROBER BOASTS 80-NM PROBE SIZE

A newly designed lanthanum hexaboride high-performance electron source produces an 80-nm probe size for the IDS 5000Plus integrated diagnostic system. The new source offers a long, reliable cathode life approaching 2000 hours on the electron-beam probing system to ensure full brightness during design debug and verification, failure analysis, and device characterization. The unit features an electron column positioning system that delivers 0.2-μm resolution over a die area four times that of other systems, so engineers can probe chips up to 32 mm square. The IDS 5000Plus costs $625,000. Current IDS users can retrofit the IDS 5000Plus submicron capabilities and other features to their older systems.

Schlumberger Technologies, ATE Div., 1601 Technology Dr., San Jose, CA 95110-1397; (408) 453-0123.

CIRCLE 306

PC/AT ACQUISITION CARD BOASTS 16-BIT PRECISION



A 16-bit multifunction data acquisition board for the PC/AT and compatibles features 16 single-ended and eight differential analog inputs. The LSDAS-16 includes an autocalibrating analog-to-digital converter, a 50-kHz sample rate, two deglitched digital-to-analog converters with optional buffer memory, a digital I/O port, and timers. An optional 32-ksample buffer memory generates waveforms independently of the host. The board comes with a full-function setup program and data acquisition utilities. Other software support available includes libraries to help in program development and a high-level language interface for C, Pascal, QuickBasic, and Fortran. Available from stock, the LSDAS-16 lists for $1395. Volume discounts are available. The optional memory costs $200.

Analogic Corp., Data Conversion Products Group, 360 Audubon Rd., Wakefield, MA 01880; (800) 446-8936. **CIRCLE 307**

i486-BASED COMPUTERS INCORPORATE MICRO CHANNEL ARCHITECTURE

A family of workstations and servers, from NCR Corp., combine the Micro Channel bus with an i486 microprocessor to achieve 27 MIPS. The first product, a 33-MHz system, is intended for compute-intensive applications including CAD, graphics, simulation, and networking. The PC486/MC$_{33}$ boasts Super VGA graphics using a chipset integrated onto the main processor board.

NCR's Micro Channel chipset includes a processor-interface controller, a dual-port memory controller, memory-error detection and correction, and direct memory access. The chipset also lets users upgrade BIOS through software without changing any hardware. The computer also achieves zero-wait-state performance for memory read and write operations using intelligent bus masters.

The base system, which comes with 4 Mbytes of RAM and a 1.44-Mbyte, 3.5-in. floppy disk drive is priced at $14,195. It will be available in July.

A second system, the S486/MC$_{33}$, is a deskside computer that functions as a high-performance network or database server for multiple users. This system contains the same graphics abilities as the PC486/MC$_{33}$. An addition to the S486/MC$_{33}$ is a 53C700 SCSI controller that increases peripheral support by decreasing system access time, resulting in faster throughput.

The system can hold a 1.26-Gbyte SCSI hard-disk drive and contains nine drive bays—six half height and three full height. It also has seven Micro Channel expansion slots, four memory slots, and a SCSI I/O slot. Available in July, base models start at $16,195.

NCR Corp., Workstation Products Div., 1601 South Main St., Dayton, OH 45479; (513) 445-7443. **CIRCLE 308**

■ *RICHARD NASS*

MACINTOSH MOUSE, SCANNER EMPLOY OPTICAL POSITIONING SYSTEM

Two products from Mouse Systems Corp., designed for use on the Macintosh computer, incorporate optical technology for improved accuracy. The Little Mouse offers a 50% higher resolution over Apple mouse alternatives. In addition, it's 22% smaller and 38% lighter than the standard Apple mouse. Its optical positioning system contains no moving parts so it requires no cleaning or adjustment. Available now, the Little Mouse costs $129.95.

The second product, the PageBrush full-page scanner, can also double as an optical mouse and digitizer. The scanner, which looks like a typical mouse, lets the user "paint in" full-page hardcopy text and images to a host computer. The size of the scanned image is limited only by the host computer's memory. PageBrush sells for $795.95.

Mouse Systems Corp., 47505 Seabridge Dr., Fremont, CA 94538; (415) 656-1117. **CIRCLE 309**

ARRAY-PROCESSOR BOARD COMBINES i860, i960 RISC CHIPS

A board-level array processor, the Warrior III, from Sky Computers Inc., combines the Intel i860 and i960 RISC processors to achieve a processing speed of 80 MFLOPS. A prevectorized software library optimizes the 64-bit i860, which performs all arithmetic operations. The i960 chip, acting as a DMA engine, handles system I/O, memory transfers, diagnostics, and other housekeeping functions. It can fetch data from anywhere in the VME host and is responsible for prefetching and caching the data. Thus feature minimizes the need for dedicated memory for the array processor.

Because of the extensive software library that exists for the Warrior III, users can easily develop custom applications in C or Fortran. There's no need to resort to complex assembly code or microcode. Users can access and manipulate data in rows, columns, or any pattern in a multidimensional array stored in memory.

Multiple Warrior III boards, operating in parallel, can be tied together without any I/O degradation. And the board uses just 37 W of power with a full complement of memory—nearly 50% less than typical array-processing boards.

Operating systems supported include Unix, SunOS, VxWorks, OS-9, and Concurrent RTU. It's available in either 6 or 9U sizes and conforms to all Sun and VME mechanical requirements. External interface options include SCSI, 32-bit parallel, and custom daughtercard. The Warrior III is priced at $8225 in OEM quantities and is available in 60 days.

***Sky Computers Inc.**, 27 Industrial Ave., Chelmsford, MA 01824; (508) 250-1920.* **CIRCLE 310**

■ *RICHARD NASS*

4096 PROCESSORS FILL ONE BOARD

Using just one 32-bit adapter slot, the Coherent Processor board gives an IBM Micro Channel workstation the power of 4096 parallel processors. The board possesses 16 processing elements, each of which contains 256 parallel processors. Content-addressable memory is used to search and operate on an entire table of data in parallel. The board is aided by a Development System that offers hardware and software support for writing, debugging, and running parallel application programs in C language. A compiler lets users create custom design routines. Typical applications are for speeding up databases, neural networks, or expert systems, or to work in a real-time environment such as local-area networks, radar, or process control. The Coherent Processor is available now for $19,500. In addition, a Sun-compatible board will be released later this year.

Coherent Research Inc., 1 Adler Dr., East Syracuse, NY 13057; (315) 433-1010. **CIRCLE 311**

SOFTWARE ENVIRONMENT MAXIMIZES WINDOWS 3.0

In conjunction with the recent Microsoft Windows 3.0 release, Hewlett-Packard Co. announced version 3.0 of their NewWave software applications environment. NewWave, which runs on any 80286- or 80386-based PC running MS-DOS, integrates applications from many different software vendors. The list of independent software vendors porting their software to NewWave is an ever-growing one and now stands at more than 100.

NewWave offers a single, consistent user environment with icons to simplify use. Users aren't forced to learn the workings of DOS or how to manage different files and programs. Version 3.0 of NewWave also includes an object-storage feature, which lets users share information on a network server by simply moving icons on the screen.

The user environment takes full advantage of all the new features added to Windows 3.0. These features include improvements to the memory management which lets NewWave run with 2 Mbytes of memory rather than 3 Mbytes. Windows also maximizes of the protected mode of 80286 and 80386 microprocessors to supply added memory for both the environment and the applications running on it. The MS-DOS Executive in the existing Windows programs are replaced with a Program Manager, a File Manager, and a Task List to supply a visual shell for completing directory, application, and file-management tasks. Color and design enhancements add to the polished user interface.

HP's NewWave will be available in August for $195. Present users of NewWave can upgrade for $50. Windows 3.0 is available now for $150.

Hewlett-Packard Co., 19310 Pruneridge Ave., Cupertino, CA 95014; (800) 752-0900. CIRCLE 312

Microsoft Corp., One Microsoft Way, Redmond, WA 98052; (800) 323-3577. CIRCLE 313

■ *RICHARD NASS*

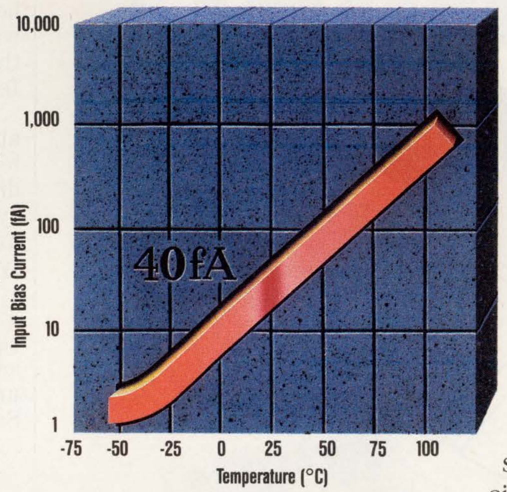
ANALYZE SOFTWARE FOR 8- TO 32-BIT CPUS

Three software-analysis products aim to meet price and speed requirements of developers working on 8-, 16-, and 32-bit microprocessor systems. The tools are based on the architecture of the company's Software Analysis Workstation (SAW), and consist of the SFA1000 for performance analysis, the SAW2000 for software debug and performance analysis on 8- and 16-bit microprocessors, and the SAW3000 for 32-bit processors. All tools are language independent. Also new is TaskView, an Ada debug and analysis tool that supplies a run-time view of an entire multitasking embedded system. The SFA1000, SAW2000, SAW3000, and TaskView cost $10,500, $15,850, $19,500 and $4500, respectively. All the tools are available now.

Cadre Technologies Inc., Portland Div., P.O. Box 1309, Beaverton, OR 97075; (800) 547-4445. CIRCLE 338

National Semiconductor

National's family of CMOS op amps rises to a new all-time low: 40 femtoamps.



INPUT BIAS CURRENT VS. TEMPERATURE: 40 fA AT 25°C

TAKING IT TO THE LIMITS WITH ULTRA-LOW INPUT BIAS CURRENT.

National's new quad/dual CMOS op amps, the LMC660/662 and the LPC660/662, feature an extremely low input bias current of 40 fA typical. You can't go much lower.

FEATURING RAIL-TO-RAIL OUTPUT SWING.

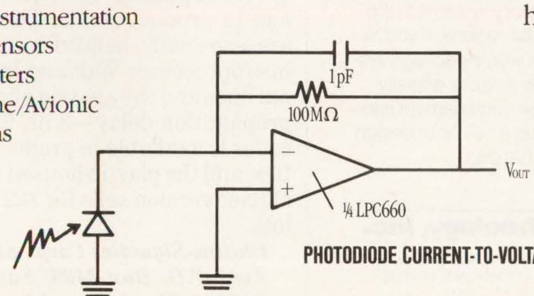
With a newly patented double feed-forward circuit architecture, National's op amps provide an output swing that extends from one supply rail to the other. You can't swing any more than that.

Use the LMC660/662 and LPC660/662 to drive rail-to-rail input A/Ds, or take advantage of the LMC's fully specified 600 Ω load capability to process audio in telecom and cellular radio applications. Other typical applications include:

- Handheld meters
- Medical instrumentation
- Remote sensors
- Electrometers
- Spaceborne/Avionic subsystems

NATIONAL REDEFINES SINGLE-SUPPLY OPERATION.

In the past, a single-supply op amp was an amplifier whose input common-mode range included ground. But in today's +5V systems, you need op amps that take advantage of every last volt that the supply provides, and whose outputs swing fully from rail-to-rail. National was the first to deliver rail-to-rail performance with the LMC660 and now has a complete family—all in CMOS.



PHOTODIODE CURRENT-TO-VOLTAGE CONVERTER

POWER UP WITH LOW POWER AND MICROPOWER.

If you're looking for low power, there's the LMC660/662, which operate at 375 μA/amplifier. Or if your application calls for 40 μA/amplifier, we offer the LPC660/662, micropower versions of the popular LMC series. In either case, you get lower power dissipation and a longer lasting battery.

LMC660/LPC660 VS. THE COMPETITION

	LMC660AI	LPC660AI	TLC274AI
Output Swing ($V^+ = +5V$)	**0.15V to 4.82V**	**0.03V to 4.97V**	**0.05V to 3.2V**
V_{OS} (max)	3 mV	3 mV	5 mV
I_b (typ)	40 fA	40 fA	600 fA
Supply Current (typ)	375 μA/amp	40 μA/amp	675 μA/amp

GET THE LOWDOWN.

For more information on our new CMOS op amps and growing family of high-performance amplifiers, including VIP,™ Bi-FET,™ Super-Blocks,™ and precision, call or write us today: **1-800-624-9613, Ext. 66. In Canada: 1-800-548-4529, Ext. 66. National Semiconductor Corporation, P.O. Box 7643, Mt. Prospect, IL 60056-7643.** And find out how we can help take your designs to new heights.

National Semiconductor

PASS DATA AT 25 MHZ WITH BIDIRECTIONAL FIFO

Rather than use two memory blocks on the same chip to form a 2-kword-by-9-bit bidirectional first-in/first-out memory, the CY7C439 employs a lone 2-k-by-9 memory block and some on-chip control logic to move data. Furthermore, Cypress Semiconductor's designers add two other data paths into the chip—a registered bypass mode and a transparent bypass mode.

The registered mode acts like a 1-word-deep FIFO register in the reverse direction to the main FIFO buffer. It permits the sending system to transfer a 9-bit status word to the FIFO buffer's write port. The transparent bypass feature allows a single 9-bit word to be immediately transferred in either direction, temporarily turning the chip into a 9-bit bidirectional buffer. With these modes, the chip can serve in applications such as a disk-drive buffer in which the transparent mode allows the host to configure a 'dumb' peripheral while the registered bypass mode holds the status response from a data transfer.

Able to access in just 30 ns and operate with a 25-MHz cycle frequency, the bidirectional FIFO register's transfer direction can be selected on a cycle-by-cycle basis. Indicator flag signals are available for conditions such as Empty/Full, and Half-Full.

Since only one memory block is required, the chip is small enough to squeeze into a 300-mil-wide DIP or small-outline J-leaded package. In 100-unit quantities the chip sells for $33.15. Samples are available from stock.

Cypress Semiconductor Corp., 3901 N. First Street, San Jose, CA 95134; Bill Eichen (408) 943-2600 **CIRCLE 314**

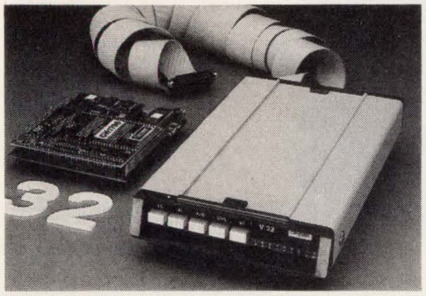
■ *DAVE BURSKY*

WIDE-INPUT PLDS DECODE ADDRESSES FAST

Designed specifically for address decoding, a very-wide-input decoder packs 36 input lines, 10 dedicated output lines and 12 additional programmable I/O lines. Fabricated in an advanced bipolar process the PHD48N22-7 can decode up to a 48-bit bus pattern (by using the 12 I/O lines as additional inputs) in just 7.5 ns from input to output (through the AND logic), making the chip the fastest wide decoder available from any company. Four of the 12 bidirectional I/O lines also serve as OR logic outputs, and three of those four provide 7 product terms; the fourth line has 12 product terms. These OR lines are especially helpful in dealing with microprocessor Wait and Interrupt signal lines and they have a slightly longer propagation delay—8 ns. The wide decoder is available in production quantities, and the plastic-housed leaded-chip-carrier version sells for $22 in 1000-unit lots.

Philips-Signetics Corp., 811 E. Arques Ave., P.O. Box 3409, Sunnyvale, CA 94088; Paul Sasaki, (408) 991-2000. **CIRCLE 315**

9600-BIT/S MODULE EASES MODEM DESIGN



Offering full-duplex operation at 9600 bits/s, the CH1790 modem module provides full V.32 compatiblity. It has fall-back and compatibility with 4800-, 2400-, 1200-, 300- and 110-bit/s rates and meets CCITT V.32, V.22 bis, V.22, V.21, and Bell 212A and 103 standards. Able to respond to the full Hayes "AT" command set, the modem can be controlled by a wide variety of available data-communication packages. Features include automatic answer, automatic speed and partiy adjustment, and call-progress tone detection. Trellis forward error correction is used at 9600 bits/s along with MNP Level 4 error control. A built-in RS-232 (5-V) serial interface allows the host to communicate with the module. An evaluation test system that contains the modem, DAA and other hardware to run the module through its paces is also available—the CSP9696A. In small quantities, a full-featured V.32 modem, sells for less than $500.

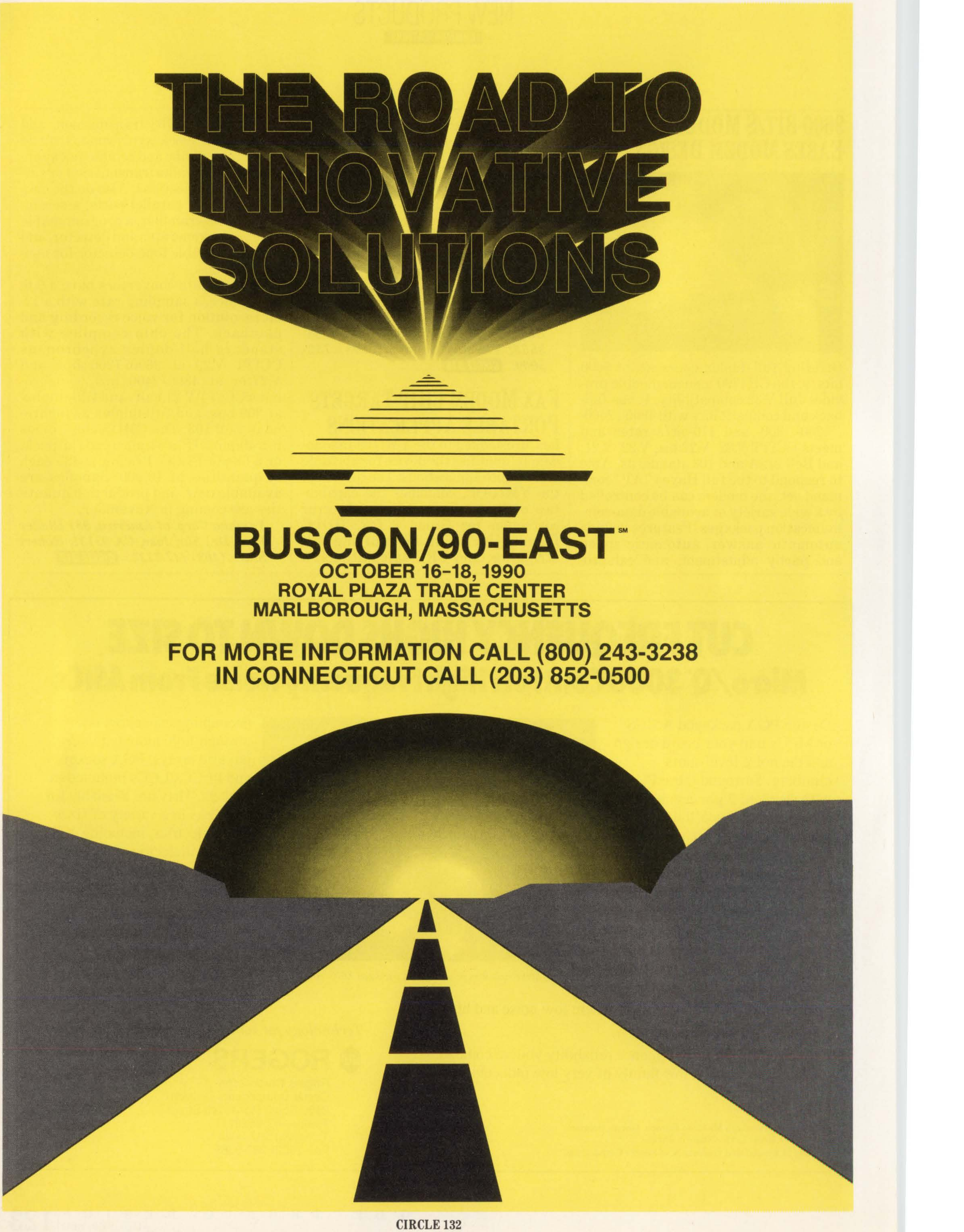
Cermetek Microelectronics Inc., 1308 Borregas Ave., Sunnyvale, CA 94088-3565; Thomas Newton, (408) 752-5000. **CIRCLE 316**

FAX MODEM CHIP TARGETS PORTABLE APPLICATIONS

Features added to the YM7109 fax modem IC qualifies the device for portable and remote applications. The new chip, the YM7109E, combines the capabilities of the earlier version with error correction for Group 3 fax, HDLC framing including bit stuffing, bit stripping, and CRC calculations, a UART for Bell 103 transmission, and an external clock synchronous mode for cellular phone and remote fax applications using radio transmission or satellite communications. Also on the chip are serial and parallel ports, a scrambler and descrambler, a programmable touch-tone generator and detector, and a programmable tone-detector for non-DTMF tones.

On-chip data converters have a 9.6-K samples/s sampling rate with a 12-bit resolution for voice recording and playback. The chip complies with standard half-duplex synchronous CCITT V.29 at 9600/7200 bps and V.27ter at 4800/2400 bps; synchronous CCITT V.21 half- and full-duplex at 300 bps; and full-duplex asynchronous Bell 103. The CMOS chip comes in a 40-pin DIP, a 64-pin quad flatpack, or a 68-pin PLCC. Pricing is $35 each in quantities of 10,000. Samples are available now, and production quantities are coming in November.

Yamaha Corp. of America, 981 Ridder Park Dr., San Jose, CA 95131; Robert Starr, (408) 437-3133. **CIRCLE 317**


THE ROAD TO
INNOVATIVE
SOLUTIONS
BUSCON/90-EAST℠
OCTOBER 16-18, 1990
ROYAL PLAZA TRADE CENTER
MARLBOROUGH, MASSACHUSETTS
FOR MORE INFORMATION CALL (800) 243-3238
IN CONNECTICUT CALL (203) 852-0500

CIRCLE 132

CONTROLLERS BOOST SERIAL COMMUNICATIONS PERFORMANCE

Two CMOS serial communications controllers from Zilog Corp. simplify system design by integrating functions previously performed by discrete devices.

The Z85130 enhanced serial communications controller (ESCC) is a dual-channel, full-duplex multiprotocol controller with each channel containing a crystal oscillator, baud-rate generator, and digital phase-locked loop. The ESCC also includes an 8-byte-deep receive FIFO buffer and a 4-byte-deep transmit FIFO buffer for reducing data overruns, interrupts, and host CPU overhead by accumulating byte strings. The programmable FIFO and DMA request levels allow the user to select packet-handling response. SDLC protocol enhancements offload the CPU with automatic handling of frame conditions.

The Z85C80 serial communications and small computer interface (SCSCI) combines Zilog's Z85C30 10-MHz serial communications controller (SCC) and the 3-Mbyte/s Z53C80 small computer system interface (SCSI). Both functions share an 8-bit address and data bus for use in any system having a SCSI interface defined by the X3.131-1986 standard. The SCSCI has all features required to build a network using a typical disk-based file server, including an interface to multiplexed or non-multiplexed CPUs, programmable channels for asynchronous or synchronous datacom protocol, and a 10-by-19-bit FIFO buffer and 14-bit byte counter that support high-speed SDLC transfers using DMA controllers.

Packaged in a 40-pin DIP and 44-pin PLCC, the Z85130 16-MHz version costs $13.65 in 1000-piece quantities. The 10-MHz part costs $8.85. Packaged in a 68-pin PLCC, the Z85C80 costs $12.43 each in 1000-piece quantities.

***Zilog Corp.**, 210 Hacienda Ave., Campbell, CA 95008; Mike Hulme, (408) 370-8000.* **CIRCLE 339**

■ *MILT LEONARD*

9600-BPS V.22 BIS-COMPATIBLE MODEM TRIMS PRICE, NOT FEATURES

Able to operate at 9600 bits/s in a full-duplex mode, the 9624 modem series employs a custom chip set developed by Sharp to achieve CCITT V.22 bis compatibility. The custom chips allow the company to incorporate MNP5 error correction as well as the company's own extended-

baud-rate technology, which, together, permit a 2400-bit/s chip set to provide 9600-bit/s full-duplex asynchronous operation, as well as standard 2400-, 1200-, and 300-bit/s data modes. (To achieve the 9600-bits/s rate, a pair of units, one on each end, must be used.)

The modems achieve a throughput equivalent to or better than that specificed by the V.42 bis standard. Two versions of the modem are available: the 9624, a 3/4-size card that plugs into the PC bus, and the 9624e, an external unit that connects to any system's serial port.

Both models include a speaker and comply with the standard Hayes (AT) command set. Single-unit prices for the modems are $299 for the card version and $399 for the external unit.

***Sharp Digital Information Products Inc.**, 16841 Armstrong Ave., Irvine, CA 92714; Greg Peel, (714) 261-6224.* **CIRCLE 340**

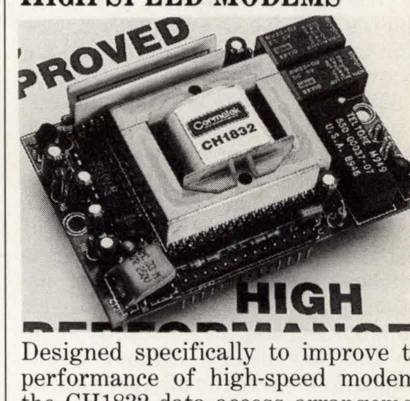
■ *DAVE BURSKY*

BOARDS PUT MACINTOSH ON ARCNET LANS

A line of board-level products enables Macintosh SE and Macintosh II computers to join an ARCNET local area network, the environment typically used for networking IBM PCs and compatibles. The Macintosh-on-ARCNET family allows the use of PC-type file servers and printers, eliminates the need for a dedicated Macintosh server, and enables Macs to share data among themselves without additional networking accommodations or cable. Furthermore, networks can employ coaxial cabling, twisted-pair wiring, or a mix of the two in star, bus, or daisy-chain topologies. Hardware consists of a controller board and a transceiver board for the MAC SE, while the MAC II requires only one board. To accommodate the various topologies and cabling systems, four versions are available. For the MAC SE, the SE100 supports the coax star topology and the SE250 handles twisted-pair star and daisy-chain topologies. For the Macintosh II, the NB210 supports coax star and bus topologies, while the NB250 is for twisted-pair star and daisy-chain topologies. The SE100 and SE250 sell for $495 each; the NB210 and NB250 cost $545 each.

Standard Microsystems Corp., 35 Marcus Blvd., Hauppauge, NY 11788; (516) 273-3100. **CIRCLE 341**

DAA MODULE TACKLES HIGH-SPEED MODEMS



Designed specifically to improve the performance of high-speed modems, the CH1832 data access arrangement mates directly to V.32, V.33 and V.29 type modems. The DAA passes voice and data at speeds starting at 300 bps and up to 38.4 kbps. High-voltage isolation and surge protection up to 1000 V are built into the DAA. System features include ringing detection, hookswitch control, billing delay, and provisions for 2-wire or 4-wire leased-line operation. A 2-wire-to-4-wire converter is included in the 2.2-by-3.25-by-0.65-in. module. The DAA module is also preregistered for FCC part 68, thus reducing the waiting time needed by a system that must obtain part 68 approval.

Cermetek Microelectronics Inc., 1308 Borregas Ave., Sunnyvale, CA 94088-3565; Thomas Newton, (408) 752-5000. **CIRCLE 342**

REVAMPED SUSIE SIMULATOR RUNS 30 TIMES FASTER

The newest version of the popular Susie logic simulator from Aldec Co. is not only up to 30 times faster than the previous version, but also supports VHDL IC models and easy-to-use windowing. Susie 6.0 achieves the speed gain with a new event-driven algorithm and by taking advantage of 32-bit direct addressing on 80386- and 80486-based computers. In addition, the simulator runs from mouse-driven pop-up menus.

Version 6.0 gives users the same real-time operation they are used to, but adds high-speed simulation of VHDL IC models. Users can toggle switches, move jumpers, change propagation delays of any IC, modify Jedec and hex files, and then instantly simulate the new design without visible compilation. Users can also perform instant simulation of selected design areas, which can speed the simulation process by 10 to 100 times.

Also, Aldec's VHDL IC timing model builder, Mobic/T, is a high-level modeling language designed specifically for Susie. It generates IC timing models with 11 input states and 15 output states, and includes predefined functions for modeling memories and PLDs. Susie 6.0 comes with TTL VHDL libraries. There are over 6000 parts available in Aldec's optional libraries.

Susie 6.0 is available now for $5995. The Mobic/T IC-model builder is $1995, and the optional libraries start at $795.

Aldec Inc., 3525 Old Conejo Rd., Suite 111, Newbury Park, CA 91320 (805) 499-6867. **CIRCLE 318**

■ *LISA GUNN*

MICROWAVE EDA TOOLS SPAN DESIGN CYCLE

The Cadence Microwave Musician design tools carry engineers from schematic capture through physical layout in one integrated package. The system offers front-to-back design capability for both monolithic microwave ICs and hybrid devices. Users can produce hierarchical schematics using a library of ideal components and a library of foundry components. In addition, the package supports multiple simulation runs at the same time. The Musician front end, which consists of schematic capture and a microwave component library and interfaces to most of the popular microwave simulators, costs $15,000. The complete system, which includes the front end as well as synthesis, layout, and design verification, costs $30,000.

Cadence Design Systems Inc., 555 River Oaks Pkwy., San Jose, CA 95134; (408) 943-1234. **CIRCLE 319**

SCHEMATIC-CAPTURE COSTS LESS THAN $100

Engineers can have a schematic-capture system for less than $100 with Omation Inc.'s Schema-Quik software, a low-cost version of the company's Schema III software. The package is aimed at PLD manufacturers as an alternative to data entry with logic equations, truth tables, or state machines. Drawings created in Schema-Quik are transferred through a system manager to the manufacturer's design and compilation software. Each system is tailored to the needs of the manufacturer by controlling libraries, hierarchies, drawing sizes, and output forms. The Schema-Quik package includes software, reference manual, and tutorial, and is upgradable to the Schema III package. The product is shipping now for $99.

Omation Inc., 801 Presidential Dr., Richardson, TX 75081; (800) 553-9119. **CIRCLE 320**

FRONT-END AUTOMATES FILTER DESIGN

Filter Designer is an interactive front-end tool that lets engineers design and analyze active filters, using such features as a menu-driven interface, hardcopy report summaries and plots, concatenation of multiple designs, and interfaces to PSpice. Available filter types include low-pass, high-pass, band-pass, and band-reject, all of which may be synthesized by Butterworth, Chebyshev, inverse Chebyshev, and elliptic functions. With the tool's editor, engineers can insert, delete, and reorder stages, and can modify coefficient values. Pricing for the Filter Designer, which is shipping now, ranges from $600 to $900 depending on configuration. A Filter Designer evaluation package is available for $35.

MicroSim Corp., 20 Fairbanks, Irvine, CA 92718; (800) 245-3022 or (714) 770-3022. **CIRCLE 321**


i80387 intel
i8087 intel
i80387SX intel
i80287XL intel
i80287XLT intel

RUGGED ON-LINE UPS SYSTEM CAN HANDLE BROAD INPUT

Aimed at military and hostile industrial applications is an online ruggedized UPS from Transistor Devices Inc. The MIL-UPS combines the company's BCE battery charger/power supply with its ACE sine-wave inverter.

The BCE module's wide input range of 90 to 250 V from 40 to 440 Hz, as well as its high power factor, provide immunity to ac-input-voltage fluctuations. The system can handle a broad range of line disturbances such as extended-brownout conditions as low as 83 V, and frequency disturbances from 40 to 440 Hz, without battery power. It's suited for remote site locations where generator fluctuations and low-power-factor loads can be too much of a burden for other UPSs. Thanks to its universal-input feature, the system can function as a frequency changer and voltage conditioner between American, European, and special military power applications.

The charger/supply module also features a battery-equalizer function, which optimizes battery-cell potentials and extends battery life. To prevent too many repetitive equalizing cycles, the function is automatically locked out at the end of each equalizing cycle. In addition, the BCE module has a reduced-voltage mode that prevents the batteries from heating excessively during a rapid recharge cycle.

From the sine-wave-inverter module, a true sine wave is generated with less than 1% total harmonic distortion. The module's fixed-frequency output is crystal-controlled to better than 0.1% stability. The zero-lead-to-zero-lag load power factor of the system's inverter easily drives unfriendly, non-linear power demands such as motors and rectifier loads.

A 2-kVA system occupies only 12 in. of height in a 19-in. rack. Without batteries, the system weighs under 65 lbs. Such a system goes for about $10,000 without batteries.

***Transistor Devices Inc.**, 85 Horsehill Rd., Cedar Knolls, NJ 07927; (201) 267-1900.* **CIRCLE 322**

■ *DAVID MALINIAK*

CONVERTER AND FILTER TANDEM NEAR MIL-STD-883C APPROVAL

With final process certification near, a combination of a dc-dc converter and EMI filter will soon pass the last hurdles to full compliance with MIL-STD-883C, method 5008. Interpoint's MHF converter and matching FMC-461 EMI filters give military designers the reliability of components that have passed test conditions applied to mission-critical components.

The 883C versions of the converters and filters have dramatically increased tolerance to temperature extremes and acceleration. That's achieved by using higher switching frequencies to reduce the magnetics' mass and by redesigning the platforms the magnetics are attached to.

Input range for the 883C-qualified converter is 16 to 40 V dc. It produces closely regulated outputs of 5, ±12, or ±15 V dc in single or dual configurations up to a maximum output of 12 W. The operating temperature is from –55 to +125°C. The package is a low-profile (0.325 in.) hermetically sealed, gold-

plated steel case that takes up just 1.6 square inches of board area. Power density for the device, which switches constantly at 600 kHz, is 30 W per cubic inch. The matching FMC-461 EMI filter reduces the converter's reflected input-ripple current to meet MIL-STD-461B CE03 standards.

Pricing for the MHF converter is $780 in quantities of 100. In similar quantities, the FMC-461 EMI filter goes for $365. Pending qualification testing for the company's process, the MIL-STD-883C-compliant devices will be available this fall.

***Interpoint Corp.**, Box 97005, Redmond, WA 98073-9705; (206) 882-3100.* **CIRCLE 323**

■ *DAVID MALINIAK*

CONTROL 400 V AT 1 A WITH 5-V LOGIC

The PWR-NCH201 IC can control solenoids, lamps, relays, and small motors with 5-V logic while powered directly from the rectified 115-V ac line. Packaged in a 16-pin "batwing" DIP, it contains a monolithic pair of MOSFETs rated at 400 V and 675 mA each. On-resistance of each is just 5 Ω. Another version, the PWR-NCH401, holds four smaller FETs with a similar voltage rating, but with a current rating and on-resistance of 335 mA and 10 Ω, respectively. It is in a 24-pin skinny DIP. With both FETs in parallel, the 201 handles up to 1 A; with all four FETs in parallel, the 401 handles up to 675 mA. Unlike other high-voltage MOSFETs, these turn on hard with just 5 V between gate and source, permitting logic-level control. The devices are current sensing, or mirror FETs. Each has a separate source output-pin that provides a scaled current equal to approximately 1/1500 of the FET's current. Versions rated at 200 and 400 V are also available. Pricing in hundreds ranges from $2.60 to $5.84.

Power Integrations Inc., 411 Clyde Ave., Mountain View, CA 94043; Doyle Slack, (415) 960-3572. **CIRCLE 324**

REGULATOR IC SENSES VOLTAGE AT LOAD

A low-dropout linear regulator, the LT1087, offers both adjustable output voltage and 4-wire Kelvin sensing of the voltage across the load. The chip is rated at 5 A and regulates down to an input-to-output voltage of just 1.5 V maximum at 5 A. The 4-wire remote sensing feature eliminates load-regulation errors caused by voltage drops in the hot side of the line to the load and in the ground return. The feature is particularly important where sensitive circuitry, such as wide-band op amps operating at high gain, must be isolated from heat or noise generated by power supplies; in most regulators today the output voltage is sensed inside the package. The chip's reference voltage is trimmed to 1% and the current limit is trimmed as well. This precision current limit minimizes stress on both the regulator and the power-source circuitry when the circuit is overloaded. The LT1087 comes in 4-pin TO-3 metal cans and 5-pin TO-220 packages. In quantities of 100 pricing for the latter runs $4.45.

Linear Technology Corp., 1630 McCarthy Blvd., Milpitas, CA 95035-7487; Bob Scott (408) 432-1900. **CIRCLE 325**

CIRCLE 84 ⟶

HIGH-RESOLUTION LCD MODULE MAKES GRADE FOR LAPTOP PCS

A thin plastic film is used in the EG9007 LCD graphics-display panel to achieve a high-contrast black-and-white display that's well suited for notebook- and laptop-PC applications. With its depth of just 0.33 in., the display offers the LCD market's thinnest profile, according to Epson OEM.

Epson's use of its newest formulated twisted-nematic technology in the EG9007 display results in a lighter, thinner module as well as lower manufacturing costs. The single-layer LCD also enabled the company to use edge lighting for the display, which further contributes to its thin profile.

Also featured in the 10-by-6.25-in., 1.5-lb. display is a chip-enable transmission system that significantly reduces power consumption. Thanks to Epson's chip-on-flex technology, the display's drivers are mounted on a flexible printed-circuit board that is lighter and more compact than traditional rigid printed-circuit boards. The display, which weighs a scant 1.5 lbs, produces white characters on a black background with a resolution of 640 by 480 dots and a 1/242 multiplex ratio.

The EG9007 display also offers a faster fluid response time (120-ms turn-on at 25°C) than competitive displays. This translates into faster animation of text and graphic images. A cold-cathode fluorescent backlight provides illumination of the display.

In quantities of 100, the EG9007 display costs $285. It is available now in OEM quantities.

***Epson OEM Division**, Epson America Inc., 3415 Kashiwa St., Torrance, CA 90505; (213) 534-4500.* **CIRCLE 326**

■ DAVID MALINIAK

TINY SURGE KILLERS SUIT AUTO TASKS

A cost-effective and reliable alternative to Zener diodes for transient-voltage suppression in automotive applications has arrived. The V24ML series of semiconducting ceramics come in leadless chip form and are fabricated to absorb internally or externally generated surges that might otherwise damage or destroy a car's electronic components. The surface-mounted devices have no lead inductance and therefore act faster. The series is rated for peak currents up to 2000 A and comes in 1206, 1210, 2220, and 2820 sizes. Samples of the V24ML1210 are available now and production lots will be available in August. In lots of 1000, the device costs $0.46.

Harris Semiconductor, Box 883, Melbourne, FL 32901; (800) 442-7747. **CIRCLE 327**

10-IN. COLOR LCD HITS PRODUCTION

Higher resolution, contrast, and brightness than the company's earlier color-TFT LCDs is offered in Hitachi's TM26D01VC 10-in. display, which is now in production. The direct-view display offers 640-by-480-pixel resolution and eight colors. When used with third-party gray-scale controllers, the number of colors can increase to 256. Contrast ratio is 100:1 and the display's brightness level is 80 NT, which meets or exceeds the brightness of CRTs. Response is quick enough for real-time monitoring applications. The display's wide viewing angles suit it to use in medical instruments. Production units are available now with samples priced at $3500 each. Initial production pricing is less than $2000 per unit.

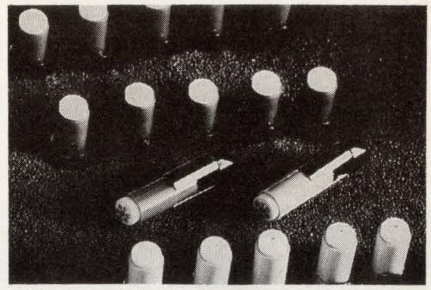
Hitachi America Ltd., Electron Tube Div., 300 N. Martingale Rd., Suite 600, Schaumburg, IL 60173; Tim Patton, (708) 517-1144. **CIRCLE 328**

TO-254 HEATER REGULATES TEMPERATURE

Hermetically sealed in a TO-254 package, the DN-501 is the first in a series of proportionally controlled heaters whose temperature can be programmed between 50° and 100°C by one external resistor. What's more, it can deliver up to 28 W of power from an unregulated supply. The subminiature device, which operates from –55° to +100°C, can be used for regulating the temperature of sensitive electronic components, such as crystal oscillators and microwave filters. It features 28-V operation and is electrically isolated from the case. The part can also be customized to meet specific application requirements.

Dawn Electronics Inc., 2049 California St., Suite 2, Carson City, NV 89701; (702) 882-7721. **CIRCLE 329**

SLIDE-BASED LED REPLACES BULBS



Slide-based incandescent lamps can be directly replaced with a high-intensity packaged-LED device. The 5SBF multi-LED device uses six discrete chips and boasts a lifetime of 100,000 hours. The incandescent pilot light it replaces, the 120PSB, lasts only 7500 hours. That suits the LED to tasks with high vibration. The LED device draws 7 mA at 120 V and comes in seven colors with peak wavelengths ranging from 555 to 660 nm. Pricing starts at $3.56 for lots of 1000 with availability in six weeks after receipt of order.

Data Display Products, 445 S. Douglas St., El Segundo, CA 90245-4630; (213) 640-0442. **CIRCLE 330**

5-IN. COOLING FAN BOOSTS AIR FLOW

Air flow that's improved by up to 50% while reducing noise by 50% compared with 4.7-in. fans is featured in the Galaxy 5-in. fan. The 1.5-in.-deep unit delivers air-flow levels of 150, 125, and 110 cfm at 12, 24, and 48 V. Comair Rotron's

ThermaPro-V circuitry provides programmability, voltage regulation, and thermal speed control. Other features include electronic locked-rotor protection with automatic restart. The fan costs from $18 to $20 in OEM quantities. Samples are available now and production lots will ship in late August.

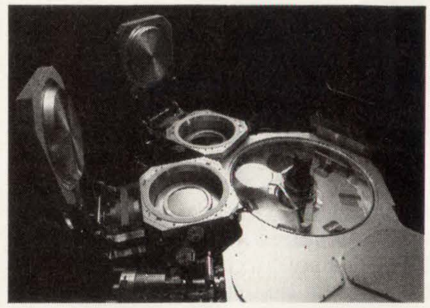
Comair Rotron, North St., Saugerties, NY 12477; (914) 246-3615. **CIRCLE 331**

PHYSICAL-VAPOR-DEPOSITION SYSTEM BOASTS HIGH VACUUM FOR PURER FILMS

An ultra-high vacuum level (10^{-9} torr base pressure) in the process chamber of Applied Materials' Endura 5500 physical-vapor-deposition (PVD) system is the key to purer aluminum-alloy and barrier-metal films for advanced IC metallizations. Besides higher purity, films produced with the system also exhibit a nine-fold improvement in resistance to aluminum electromigration.

By building on the company's experience in chemical-vapor deposition, the PVD system is designed to give exceptional step coverage and step-coverage symmetry—even in high-aspect-ratio, sub-micron features over wafers up to 200 mm. A down-sputtering source design uses rotating permanent magnets to give complete surface target erosion, with no adjustment needed in process parameters over the life of the target. The result is better uniformity and step-coverage symmetry.

A low-voltage precleaning chamber, which is part of the mainframe unit, conditions each wafer before metal deposition. This yields maximum wafer-surface cleanliness with no damage. Then, within the process chambers, careful attention is paid to achieving a very low particulate level. Special anti-flake shields greatly reduce particle generation, while a redesigned robotic handling system with external magnetic couplings keeps particulates out of the vacuum chamber.



Base pricing for the Endura 5500 PVD system starts at under $2 million. The first system was shipped in April.

***Applied Materials**, 3050 Bowers Ave., P.O. Box 58039, Santa Clara, CA 95052; (408) 727-5555.*

CIRCLE 332

■ *DAVID MALINIAK*

FIBERGLASS WEBS PROVIDE INSULATION

Craneglas fiberglass webs offer thermal and electrical insulation for a wide range of industrial, commercial, and consumer applications. When laminated with dielectric films and papers, as well as woven fabrics, they offer unique advantages as electrical tapes, wire and cable coatings, gaskets, flame retardants, and thermal-insulation materials. Combining Craneglas with foil results in an excellent heat-shield material. Non-wicking and abrasion-resistant treatments are also available. As a carrier for thermosetting electrical insulating resin systems, Craneglas webs are a low-cost means of insulating motors, generators, transformers, and reactors. They are also a cost-effective alternative as a core material for composite laminates in printed circuit boards. Craneglas is offered in a range of thicknesses from 5 to 120 mils (0.005 to 0.120 in.). Call for pricing and availability.

Electrolock Inc., P.O. Box 368, 16838 Park Circle Dr., Chagrin Falls, OH 44022; (216) 543-6626.

CIRCLE 333

POWER CONNECTOR HAS SECONDARY LOCKS

The Mini-Fit TPA power connector incorporates secondary locks in the form of red-colored keys that are inserted into the housings, ensuring that the terminals within are correctly and permanently sealed. The connector is particularly useful in wire-harness applications, where wires and connectors are often abused during manufacture. The red secondary locking keys cannot be inserted unless the terminals are properly inserted, fully seated, and locked in the housings. An optional lock — a redundant, independent secondary housing lock — is applied after the connectors are mated. The Mini-Fit TPA can handle up to 9 A per circuit, at 250 V depending on circuit size. The centerline between contacts is 0.165 in. and from row to row is 0.217 in. The envelope size of a mated pair of wire-to-wire connectors is 1.36 in. Typical pricing for a 10-circuit housing is $0.06 per mated line (production quantities). Lead time is four to six weeks.

Molex Inc., 2222 Wellington Ct., Lisle, IL 60532; (312) 969-4550.

CIRCLE 334

ELECTRONIC DESIGN

DIRECT CONNECTION ADS

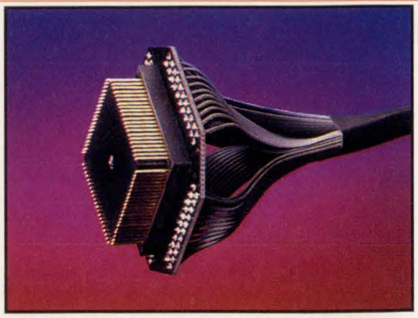
New Products/Services Presented By The Manufacturer.
To Advertise, Call JEANIE GRIFFIN At 201/393-6080

FREE! 120 Page Catalog

"Optics for Industry"

ROLYN OPTICS supplies all types of "Off-the-Shelf" optical components. Lenses, prisms, mirrors, irises, microscope objectives & eyepieces plus hundreds of others. All from stock. Rolyn also supplies custom products & coatings in prototype or production quantities. Write or call for our free 120 page catalog describing products & listing off-the-shelf prices. **ROLYN OPTICS CO.**, 706 Arrowgrand Circle, Covina, CA 91722, (818) 915-5707 & (818) 915-5717. TELEX: 67-0380. FAX: (818) 915-1379.

FREE CATALOG **CIRCLE 252**



Easy Emulator Pods & Adapters

- Plug your PLCC and LCC packages into your PC board in minutes, with these easy-to-use adapters.
- Emulator/logic analyzer users: Adapt-a-Pod™ converts one package type to another (LCC, PLCC, PGA, and DIPs).
- Emulator pods and adapters are available in all standard pin counts, with ribbon or ribbon cable headers.
- Custom engineering services and do-it-yourself emulator pod converters. Free catalog.

ET

Emulation Technology, Inc.
2368-B Walsh Ave. Santa Clara, CA 95051
Phone: 408-982-0660 FAX: 408-982-0664

EMULATION TECHNOLOGY **CIRCLE 253**

OrCad Users

Discover a menu system that saves you time and increases productivity.

The **Intelligent Menu System** ties together all utilities with a user-friendly, pop up menu. And **IMS** does not impact working RAM space.

Start using powerful new features:

- Plot spooler
- File/view editor
- Directory manager
- On-line help system
- Easy custom configuration
- Stuff file builder

IMS *The "Intelligent Menu System"*

We **guarantee satisfaction** or your money back

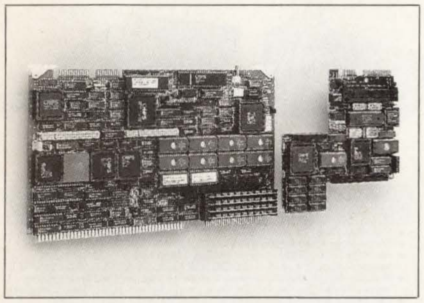
Call now for a FREE demo disk

Velotec **1-800-966-8856**

3156 Unit A, East La Palma, Anaheim, CA 92806

IMPACT 1990

VELOTEC **CIRCLE 289**



MULTIBUS™ AT-COMPATIBLE SBC

Multibus I is now IBM PC/AT™ compatible with MAT286™, our newest single board solution. MAT286 includes all of the functions of a 10 MHz AT motherboard, plus 2 serial ports, a parallel port, two SBX expansion-module interfaces, up to 512K EPROM/EEPROM/SRAM, and up to 4M of parity-checked, dual-ported DRAM. A piggy-back card, MATxSYSIO™, adds EGA, floppy, and SCSI interfaces. Embed all the guts of an AT, two SBX modules, and more, into Multibus slots!

Phone (408) 253-0250 or write for more information.

Single Board Solutions, Inc.
20045 Stevens Creek Blvd, Cupertino, CA 95014

Multibus is a registered trademark of Intel Corp.
MAT286 and MATxSYSIO are trademarksof Single Board Solutions, Inc.
IBM and PC/AT are trademarks of International Business Machines Corp.

SINGLE BOARD SOLUTIONS **CIRCLE 255**

Design:

Industry-standard language for PLDs

With new ABEL-PLD at just $895*.

- 150 PLD architectures supported (over 4000 devices).
- Uses ABEL™ Hardware Description Language (AHDL).
- Intelligent synthesis and optimization.
- Upgradable to full-featured ABEL.

Call for your **FREE** ABEL-PLD demonstration diskette.

1-800-247-5700

*U.S. list price only.

DATA I/O Corporation

DATA I/O **CIRCLE 265**

Program:

16L8, 20V8, 22V10, 27C020, and 450 other CMOS devices

PLDs and memories with the low-cost 212.

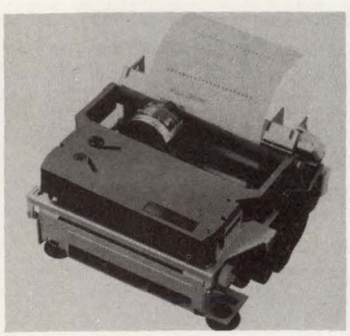
- Memory cards for easy updates.
- Extensive editing capabilities.
- Compatible with JEDEC standard programming files.

Call for your **FREE** 15-day trial AND ABEL-PLD demonstration diskette.

1-800-247-5700

DATA I/O Corporation

DATA I/O **CIRCLE 267**



PRINTERS WITH IMPACT

Citizen dot matrix impact printer mechanisms provide for the perfect low-cost solution for point-of-sale, data logging, etc. Avail. in 23, 28 or 40 columns, serial or parallel, w/sprocket feed, auto-cutter & journal winder options. Fast (120 cps) & reliable (over 50 million char. head life). Also avail. in stand-alone versions.

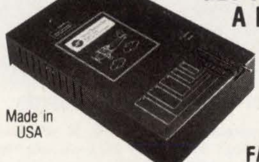
MELFESS FIVE, INC.
12304 Santa Monica Blvd., #121, Los Angeles, CA 90025. 800/533-2297.

MELFESS FIVE **CIRCLE 278**

QUALITY & DEPENDABLE EPROM/MICRO PROGRAMMER

- Fast PC Interface via Standard Parallel Port
- Field Upgradable From One Model To Another

"GET IT FROM A REPUTABLE COMPANY"



Made in USA

408-243-7000
800-627-2456
FAX 408-736-2503

(★ = Field Upgradable)

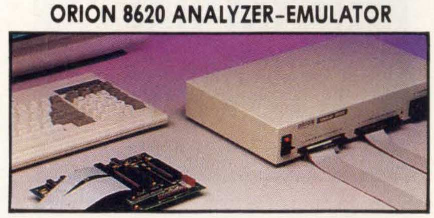
	24, 28-pin EPROMs	32-pin EPROMs	40-pin EPROMs	874X	875X
PILOT-145 $995	YES	YES	YES	YES	YES
PILOT-144 $795	YES	YES	YES	★	★
PILOT-143 $595	YES	YES	★	★	★
PILOT-142 $495	YES	★	★	★	★
PILOT-S51 $495	★	★	★	★	YES
PILOT-S48 $495	★	★	★	YES	★

ADVIN SYSTEMS INC.
1050-L East Duane Avenue • Sunnyvale, CA 94086

ADVIN SYSTEMS **CIRCLE 256**

How To Get More Emulation for Less

ORION 8620 ANALYZER-EMULATOR



■ High-Level language/Symbolic debug support ■ Over 170 processors supported with the same base hardware and software environment ■ Easy-to-use, powerful triggering ■ Extensive MACRO capabilities ■ Program Performance Analyzer ■ Built-In EPROM programmer

Go ahead and compare. The 8620 Analyzer-Emulator gets your product to market faster and costs less. Base prices start at $5080. Send for more information and free demo disk.

Toll Free 800/729/7700 or 415/327/8800

ORION INSTRUMENTS

180 Independence Dr., Menlo Park, CA 94025

ORION INSTRUMENTS **CIRCLE 281**

Cross-Assemblers as low as $50.00
Simulators as low as $100.00
Cross-Disassemblers as low as $100.00
Developer Packages
as low as $200.00(a $50.00 Savings)

A New Project
Our line of macro Cross-assemblers are easy to use and full featured, including conditional assembly and unlimited include files.

Get It To Market--FAST
Don't wait until the hardware is finished to debug your software. Our Simulators can test your program logic before the hardware is built.

No Source!
A minor glitch has shown up in the firmware, and you can't find the original source program. Our line of disassemblers can help you re-create the original assembly language source.

Set To Go
Buy our developer package and the next time your boss says "Get to work.", you'll be ready for anything.

Quality Solutions
PseudoCorp has been providing quality solutions for microprocessor problems since 1985.

BROAD RANGE OF SUPPORT
- Currently we support the following microprocessor families (with more in development):

Intel 8048	RCA 1802,05	Intel 8051	Intel 8096
Motorola 6800	Motorola 6801	Motorola 68HC11	Motorola 6805
Hitachi 6301	Motorola 6809	MOS Tech 6502	WDC 65C02
Rockwell 65C02	Intel 8080,85	Zilog Z80	NSC 800
Hitachi HD64180	Motorola 68000,8	Motorola 68010	Intel 80C196

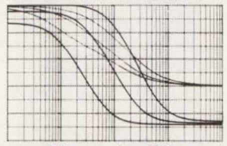
- All products require an IBM PC or compatible.

So What Are You Waiting For? Call us:

PseudoCorp
Professional Development Products Group
716 Thimble Shoals Blvd, Suite E
Newport News, VA 23606
(804) 873-1947 FAX: (804)873-2154

PSEUDOCORP CIRCLE 259

Interactive/Real-Time



Analog Circuit Simulation

ECA-2 Electronic Circuit Analysis offers the best MonteCarlo and Worst-Case analyses with the capability to concurrently plot random samples or Min/Max/Nominal values.

• AC, DC, Transient, Fourier, and Temperature Analysis • Interactive or batch modes • Full nonlinear simulator • Sine, Pulse, PWL, SFFM, and Exponential generators • IBM PC/Mac/SUN • Multiple plots • On-line real time graphics - **2 to 50 times faster than SPICE** • Over 500 nodes • Advanced component parameters • Component Sweeping • Full editing, built-in or external • Detailed 525 page manual

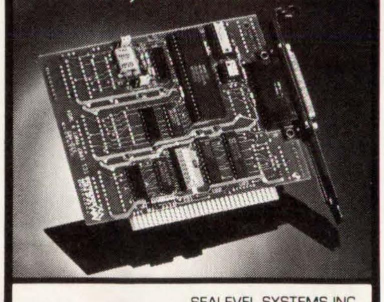
Call for FREE DEMO!

Tatum Labs, Inc.
3917 Research Park Dr. B-1, Ann Arbor, MI 48108
313-663-8810

TATUM LABS CIRCLE 260

RS-422

- RS-422/485
- Selectable Address/IRQ
- Two/Four Wire Operation
- One/Two/Four Port Versions
- Delivery From Stock



SEALEVEL
SEALEVEL SYSTEMS INC.
PO BOX 1808
EASLEY, SC 29641
(803) 855-1581

SEALEVEL SYSTEMS CIRCLE 279

UNIPRO,

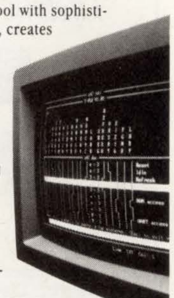
the PC/XT/AT/386 based universal programmer/tester programs PROMs, EPROMs, EEPROMs, up to 4MB and 32-bit wide, PALs, PLDs, GALs, EPLDs, PEELs, and Micro Controllers. JEDEC file compatibility and Test Vector verification allow the use of most popular PLD compilers. The unit also tests TTL/CMOS Logic ICs and Dynamic/Static RAMs. 40-pin Gold ZIP socket, built-in protection for short circuit and over current, high speed parallel interface to the PC, and menu-driven software are included at $585.

XELTEK
473 Sapena Ct., Unit 26
Santa Clara, CA 95054
Phone: (408) 727-6995
Fax: (408) 727-6996

XELTEK CIRCLE 262

Tango-PLD. The New Price/Performance Leader.

Tango-PLD, a universal PLD design tool with sophisticated features at an affordable price, creates complex designs with multiple PALs and GALs. Our top-down approach, emphasizing logic description first and part selection second, along with a "C-like" design language, makes Tango-PLD easy to use.



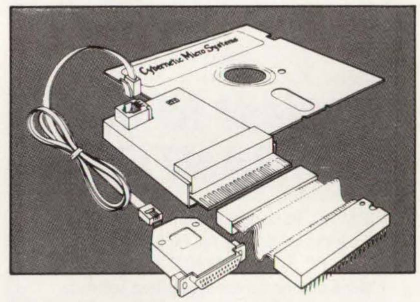
Tango™

Describe designs with Boolean equations, truth tables, state machines, high-level C expressions, or existing JEDEC files. Simulation with test-vector coverage checking guarantees no surprises. Rich functionality, one year's updates, free tech support and BBS, plus our 30-day guarantee. All this for **just $495**. Call today.

FREE EVALUATION PACKAGE
800 433-7801 619 554-1000 619 554-1019 Fax

ACCEL™ Technologies ■ 6825 Flanders Drive ■ San Diego, CA 92121 USA
International prices may vary. Contact us for the distributor nearest you.

ACCEL TECHNOLOGIES CIRCLE 264



8051 Emulator - $1250

d²ICE is a low cost, Full Speed, real time 8051 Emulator.. Powerful user interface for Hi-level multi-window source code debugging. Uses IBM-PC COM1/2. No Slots! Portable, fits in shirt pocket. Assembler and test bed included.

Cybernetic Micro Systems
PO Box 3000 • San Gregorio CA 94074
Ph: (415) 726-3000 • Fax: (415) 726-3003

CYBERNETIC MICRO SYSTEMS CIRCLE 276

X.25	SDLC
QLLC	HDLC
ADCCP	PAD

- C source code
- ROM-able
- Full porting provided
- No OS required

GCOM, Inc.
41 E. University
Champaign IL 61820
(217) 352-4266

Specialists in Computer Communications
FAX 217-352-2215

GCOM CIRCLE 269

NEW NEW NEW NEW NEW

Telecom Design!

MF (R1) or MFC (R2)
TRANSCEIVER

M-986 transmits and receives CCITT R1 or R2 forward and backward multifrequency signals. For trunk adapters, test equipment, and other applications.

- Single or dual channel versions available
- Versions for North American (R1) or International (R2) toll signals
- Binary or 2 of 6 input/output format
- Complete microprocessor interface
- 40 pin IC, 5 volt power, crystal time base

For more info call: **1-800-426-3926**

TELTONE® Let's Talk.™
10801-120th Avenue NE, Kirkland, WA 98033
Phone: 206-827-9626 Fax: 206-827-6050

TELTONE CIRCLE 292

ELECTRONIC DESIGN AUTHOR'S GUIDE

Thinking of writing a technical article for publication in Electronic Design? This 12-page brochure contains just about everything you need to know about the process: submitting the outline, tips on writing the manuscript, preparing the artwork, and more.

ELECTRONIC DESIGN
611 Route #46 West
Hasbrouck Heights, NJ 07604

ELECTRONIC DESIGN CIRCLE 293

ELECTRONIC DESIGN

Chairman and CEO: Sal F. Marino
President and COO: Daniel J. Ramella
Senior Vice President: James D. Atherton
Group Vice President: James W. Zaremba

Advertising Sales Staff

Publisher: Paul C. Mazzacano
Hasbrouck Heights, NJ; (201) 393-6060
San Jose, CA; (408) 441-0550

National Sales Manager:
Andrew M. Dellins
San Jose, CA; (408) 441-0550

Hasbrouck Heights:
Judith L. Miller, Robert Zaremba
Sales Support Supervisor: Betsy Tapp
611 Route #46 West
Hasbrouck Heights, NJ 07604; (201) 393-6060
TWX: 710-990-5071

Boston: Ric Wasley
400 Fifth Ave.
Waltham, MA 02154; (617) 890-0891
FAX: (617) 890-6131

Colorado: Lou Demeter (408) 441-0550

Chicago/Midwest: Russell Gerches
Sales Assistant: Susan Johnson
2 Illinois Center Bldg., Suite 1300
Chicago, IL 60601; (312) 861-0880
FAX: (312) 861-0874

Arizona: James Theriault (408) 441-0550

Los Angeles/Orange County/San Diego:
Ian Hill
Sales Coordinator: Debi Neal
16255 Ventura Blvd., Suite 300
Encino, CA 91436; (818) 990-9000
FAX: (818) 905-1206

Pacific Northwest: Bill Giller (408) 441-0550

San Jose:
Lou Demeter (408) 441-0550
Bill Giller (408) 441-0550
James Theriault (408) 441-0550
Sales Administrator: Amber Hancock
2025 Gateway Pl., Suite 354
San Jose, CA 95110; (408) 441-0550
FAX: (408) 441-6052 or (408) 441-7336

Texas/Southeast: Bill Yarborough
12201 Merrit Dr., Suite 220
Dallas, TX 75251; (214) 661-5576
FAX: (214) 661-5573

Direct Connection Ad & DAC Sales Representative:
Jeanie Griffin (201) 393-6080

Eastern Canada: Andrew M. Dellins (408) 441-0550

Holland: W.J.M. Sanders, S.I.P.A.S.
Oosterpark 6-P.O. Box 25
1483 DeRyp, Holland
Phone: 02997-1303
Telex: 13039 SIPAS NL
Telefax: (02997)-1500

Austria, Belgium, Germany, Switzerland:
Friedrich Anacker
InterMedia Partners GmbH
Katernberger Strasse 247
5600 Wuppertal 1
West Germany
Phone: 02-02-711-091/92

Japan: Hirokazu Morita
Japan Advertising Commincations
New Gunza Buiding 3-13
Gunza 7-chome
Chuo-Ku, Tokyo 104 Japan
FAX: 011-81-3-511-8710

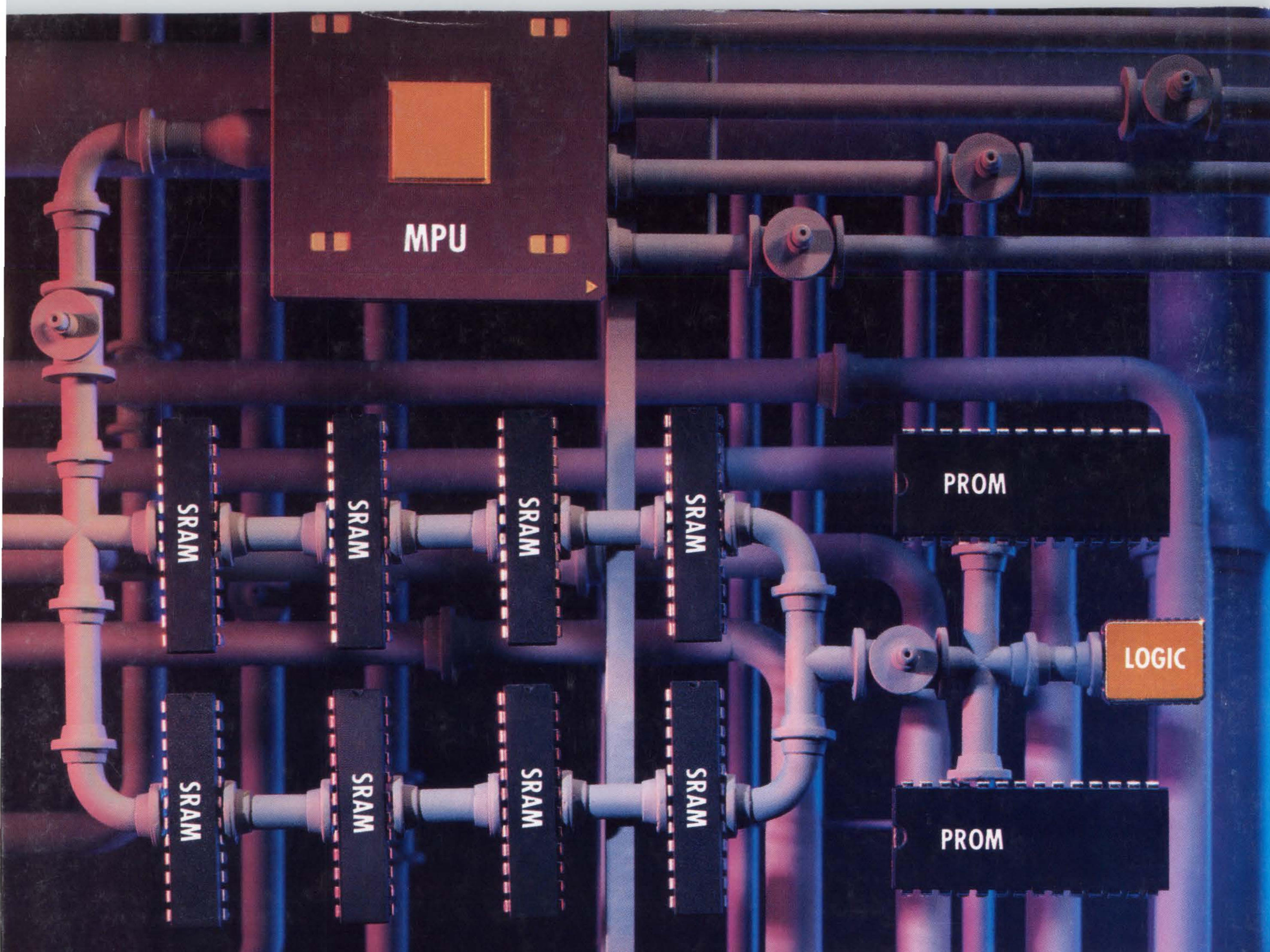
Korea: Young Sang Jo
Business Communications Inc.
K.P.O. Box 1916
Midopa Building 146
Dangju-Dong, Chongo-Ku
Seoul, Korea
Phone: 011-82-2-739-7840
FAX: 011-82-2-732-3662

Taiwan: Tomung Lai
United Pacific International
No. 311 Nanking E. Rd., Sec. 3
Taipei, Taiwan R.O.C.
Phone: 011-886-27-150-751
FAX: 011-886-27-169-493

United Kingdom/Scandinavia/Israel:
John Maycock
Huttons Buildings
146 West St.
Sheffield, England S1 4ES
Phone: 742-759186

INDEX OF ADVERTISERS

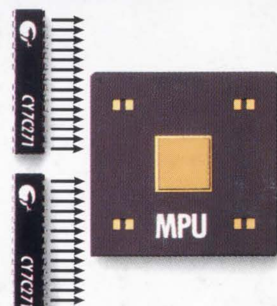
The advertisers index is prepared as an extra service. Electronic Design does not assume any liability for omissions or errors.



There's a much faster way around all this.

New Ultra-Fast 256K PROMs:

At 35 ns, these 300-mil parts are so fast you can run code right from PROM, eliminating SRAM and logic expense. You cut space and cost requirements significantly.



For applications such as embedded control, where space is at a premium, these new high density, high performance

256K PROM.

PROMs let you build a smaller system, or pack more functions into your existing space.

You save on more than space and SRAM part costs.

You save on power, because all these PROMs are in our proven, high performance, low power CMOS.

They are available in a wide variety of packaging, including plastic DIP, CERDIP, and PLCC.

They are erasable. That lets us test every part 100% before shipping, and lets you specify windowed, reprogrammable versions.

So if you need more memory in less space with less power, go direct with our ultra-fast 256K PROMs.

256K Registered CMOS PROM. 30 ns.

256K Registered CMOS PROM. 35 ns.

Call the Hotline for your free Data Book and get the full info on all our PROMs. 1-800-952-6300.*
Ask for Dept. C3H

32 K x 8 Power Switched CMOS EPROM. 35 ns.

256K Power Switched CMOS PROM. 35 ns.

CYPRESS SEMICONDUCTOR

*1-800-387-7599 in Canada. (32) 2-672-2220 in Europe.
 3901 North First Street, San Jose, CA 95134. Phone: (408) 943-2600, Telex: 821032 CYPRESS SNJ UD, TWX: 910-997-0753.