A CAHNERS PUBLICATION

JULY 6, 1989

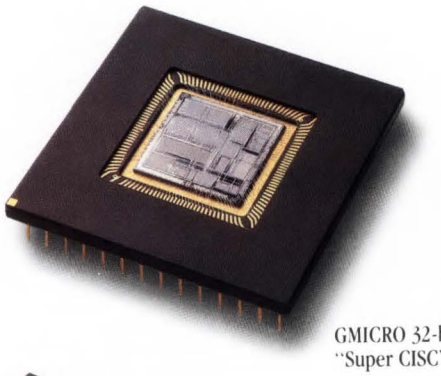
EDN®

SPECIAL ISSUE — Part 1
Product Showcase No 29

Highlighting key trends in hardware, power sources, integrated circuits, and software

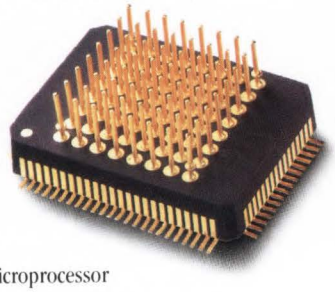
Expanded literature section

ELECTRONIC TECHNOLOGY FOR ENGINEERS AND ENGINEERING MANAGERS

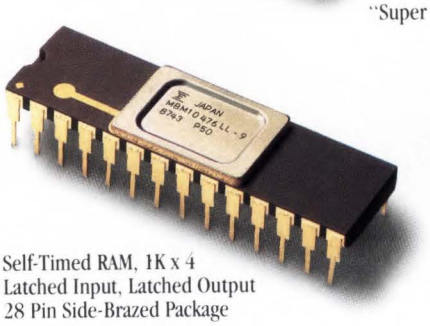


GMICRO 32-bit Microprocessor
"Super CISC"

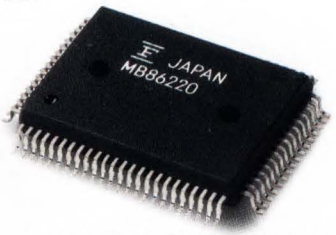
MB86220 DSP Emulation Processor
for Engineering Development



C2600AV 1.8 μ 2600 Gate
CMOS Gate Array



Self-Timed RAM, 1K x 4
Latched Input, Latched Output
28 Pin Side-Brazed Package



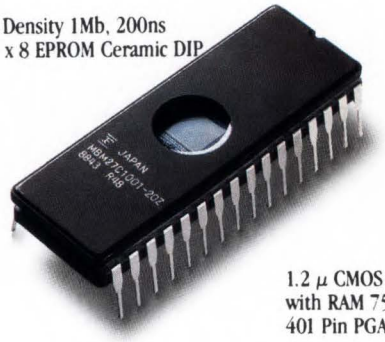
24-bit Floating-Point General Purpose DSP
1.2 μ CMOS 80 Pin Flat Package

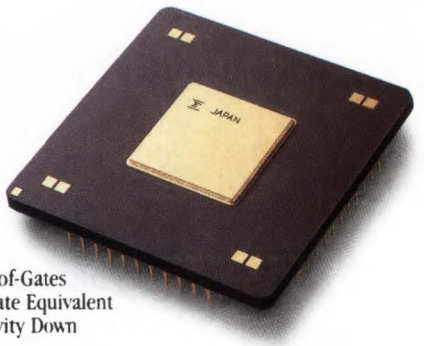
1.5 μ 12K Gate
CMOS Gate Array
with 152 I/O

4Mb DRAM
300 MIL Wide, SOJ Package

Ultra High Speed ECL
2-Input, D-Flip-flop
(3.0 GHz typical)

High Density 1Mb, 200ns
128K x 8 EPROM Ceramic DIP





1.2 μ CMOS Sea-of-Gates
with RAM 75K Gate Equivalent
401 Pin PGA, Cavity Down

On top of that, our microcomputer products let you choose from 4-bit microcontrollers, 8-bit to 32-bit microprocessors and SCSI controllers.

And our wide range of telecommunications products includes digital signal processors, prescalers and phase-locked loop devices.

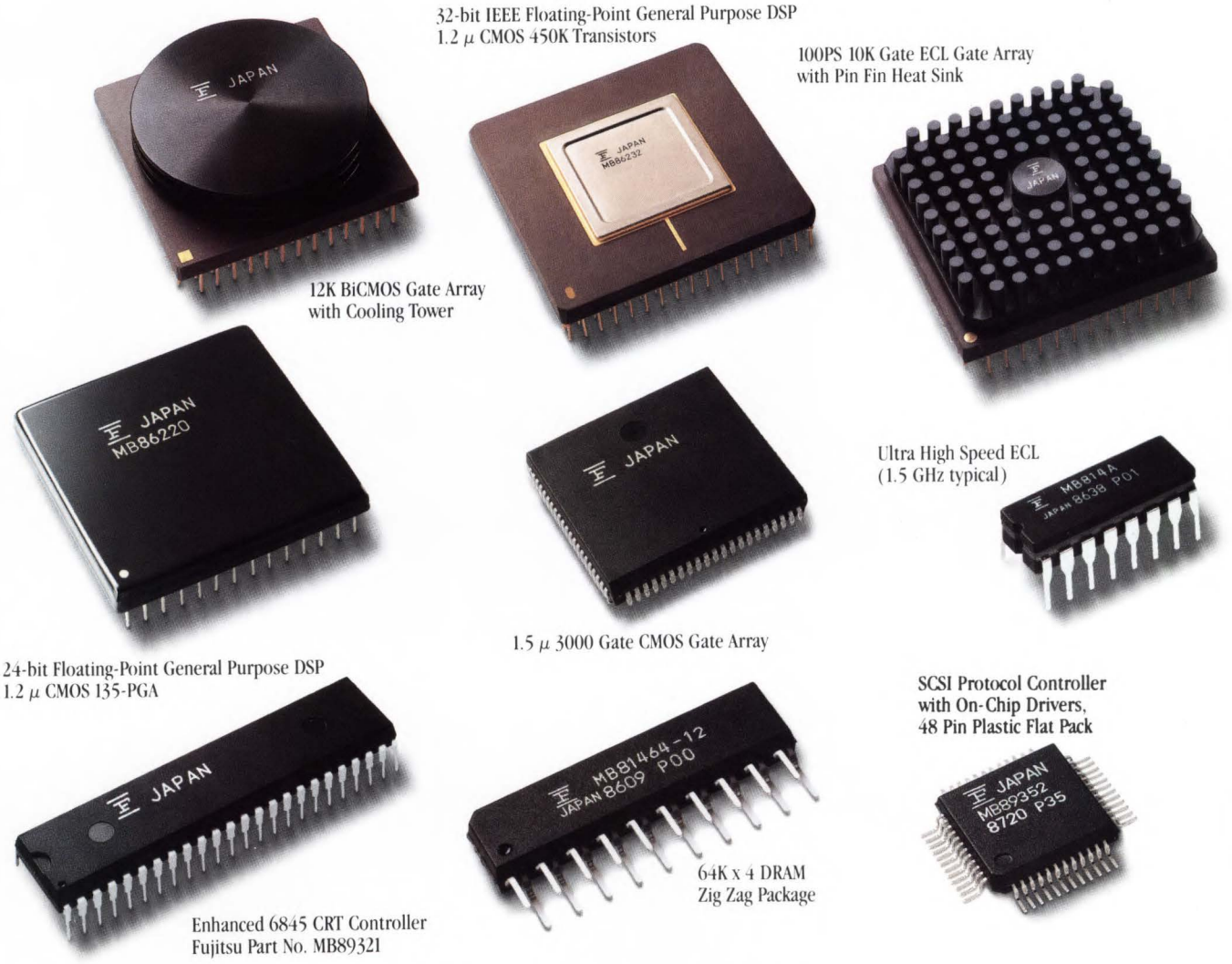
All of which means that no matter what your needs, you've got the family behind you.

To find out more, call 1-800/642-7616. Just tell us you'd like to meet the family.

FUJITSU

FUJITSU MICROELECTRONICS, INC.
Integrated Circuits Division
3545 North First Street, San Jose, CA 95134-1804. 1-800/642-7616.

Every step of the way.[SM]



Getting ahead is always easier when you have the support of your family.

Which is precisely why the Fujitsu Microelectronics family of ASIC and standard memory products gives you all the support you need every step of the way.

Our wide selection of memory and logic products, for example, is among the most complete in the industry. Which means you can choose from every product in the book. Including static and high-speed ECL RAMs, ROMs, PROMs and EEPROMs, ultra high-speed ECL RAMs, SRAMs and DRAMs.

When it comes to ASICs, we've got everything you need to develop your own. Like powerful workstation software tools.

A broad ASIC product offering in bipolar, CMOS and BiCMOS technologies.

And products that include high-speed ECL and BiCMOS arrays. CMOS sea-of-gates devices with over 100,000 gates. As well as standard cell capability to support up to 60,000 gates.

Meet the Family.

CIRCLE NO 124

NOT JUST A BUNCH OF INDUSTRIAL COMPUTERS

Ziatech computers provide distinctive solutions designed to put you in control of your application.

Software

for fast development and demanding applications

All Ziatech computers, from the board to the system level, offer the PC-compatible software support crucial to quick product development and on-line application needs. This support includes operating systems (PC DOS, VRTX), development tools (PC-Assisted Virtual System Console), networking software (ViaNet, NETBIOS), device drivers and monitoring and control packages.

Modularity

for easy configuration and expansion

Our computers are designed for straightforward configuration and expansion. Multiprocessing, mass storage, expanded memory, industrial I/O, video and networking capabilities can be added quickly with minimal system reconfiguration.

Ruggedness

for reliability in harsh environments

Ziatech computers are based on the compact and reliable STD Bus format. Designed to operate in extremely harsh environments, they support RAM and ROM disks and will operate without a keyboard or display.

Ziatech Quality and Support

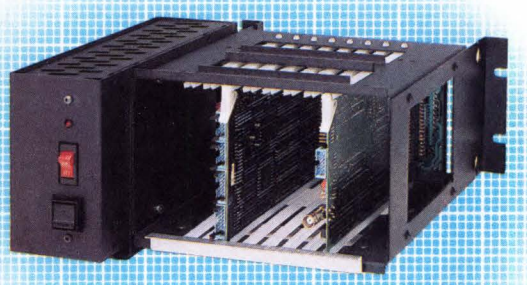
for your application's success

Our computers are backed up by on-line application support, first-class documentation and system engineering courses. Ziatech is committed to the success of every one of its customers.

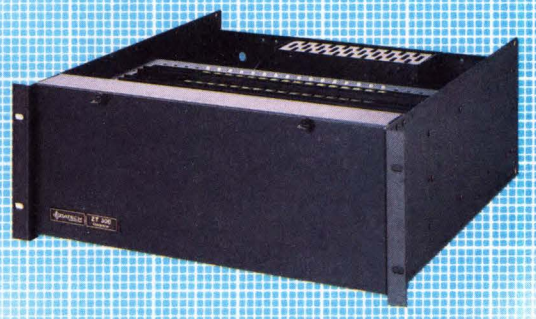
Call Today

805/541-0488

For free literature providing more details on Ziatech's line of extraordinary industrial computers, call Ziatech today.



ZT 200 EMBEDDED COMPUTER



ZT 300 INDUSTRIAL COMPUTER

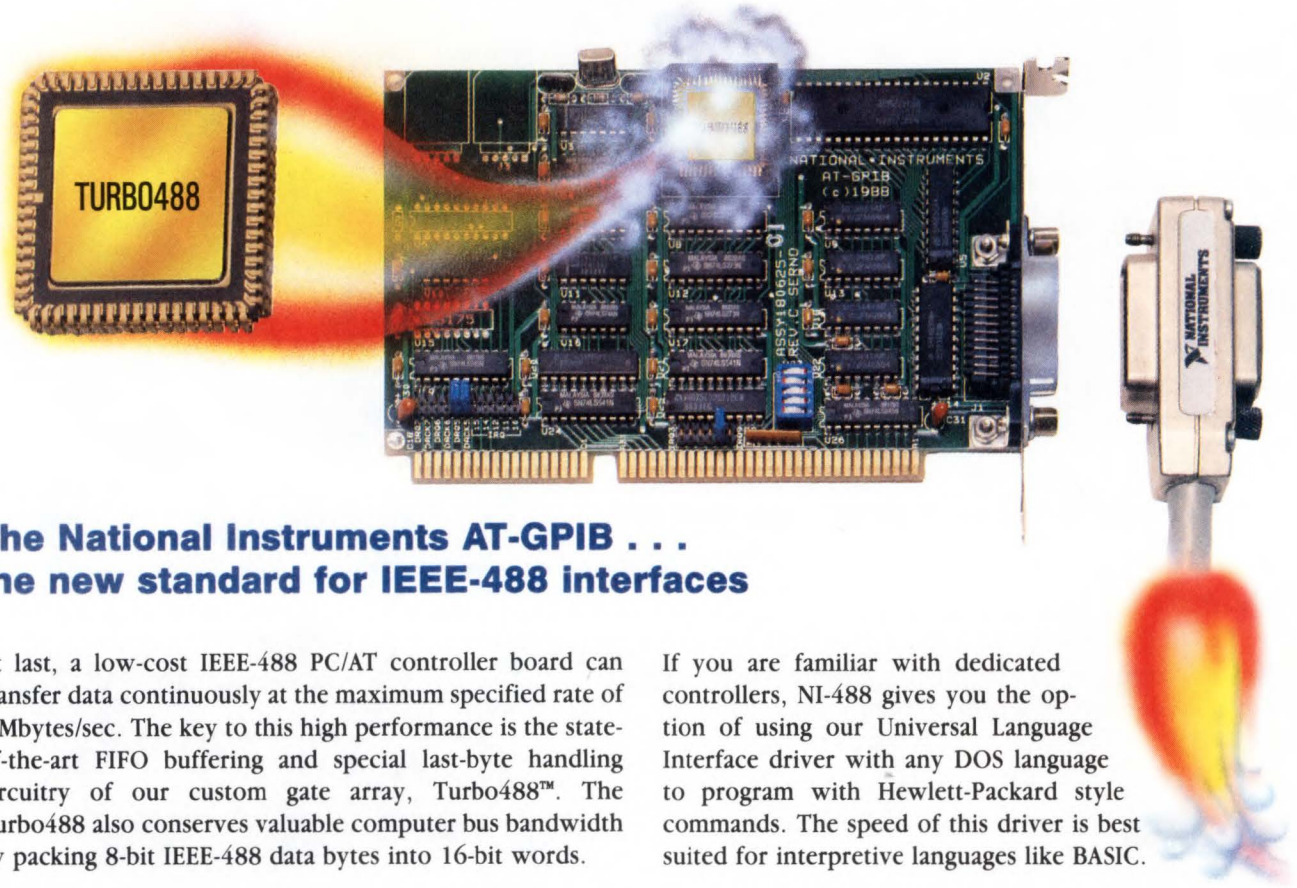
ZT 1000 INDUSTRIAL WORKSTATION

ZIATECH CORPORATION

Corporate Headquarters
3433 Roberto Court
San Luis Obispo, California 93401 USA
ITT Telex 4992316
FAX (805) 541-5088
Telephone (805) 541-0488

CIRCLE NO. 101

Maximum IEEE-488 Performance for Your High-Speed AT Computer

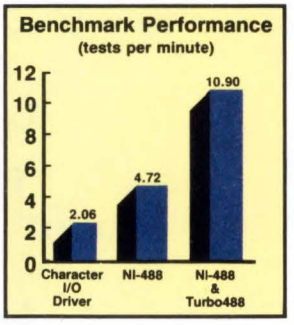


The National Instruments AT-GPIB . . . the new standard for IEEE-488 interfaces

At last, a low-cost IEEE-488 PC/AT controller board can transfer data continuously at the maximum specified rate of 1 Mbytes/sec. The key to this high performance is the state-of-the-art FIFO buffering and special last-byte handling circuitry of our custom gate array, Turbo488™. The Turbo488 also conserves valuable computer bus bandwidth by packing 8-bit IEEE-488 data bytes into 16-bit words.

By moving time consuming software functions into hardware, the Turbo488 significantly reduces the overhead of a software driver too. The combination of the AT-GPIB and our streamlined software driver gives you the power needed for today's high speed digitizers.

The AT-GPIB is controlled by the *de facto* industry standard NI-488 software. NI-488 has high-level routines that transparently handle IEEE-488 protocol and buffered DMA transfers. These routines can be used with any popular language and are the perfect match for the structured, hierarchical programming style preferred by users of high-speed, compiled languages such as C and Pascal.



If you are familiar with dedicated controllers, NI-488 gives you the option of using our Universal Language Interface driver with any DOS language to program with Hewlett-Packard style commands. The speed of this driver is best suited for interpretive languages like BASIC.

Your investment in National Instruments is a sound one. You can still run your existing NI-488 programs yet automatically take full advantage of the Turbo488. If you're just getting started, our interactive instrument control and menu-driven configuration utilities will get you up and running in no time.

Your relationship with National Instruments does not end when you purchase our products. A staff of applications engineers is always a free phone call away. Demand the best IEEE-488 controller available . . . give us a call today at **(800) IEEE-488.**

Ask for a *FREE* Catalog

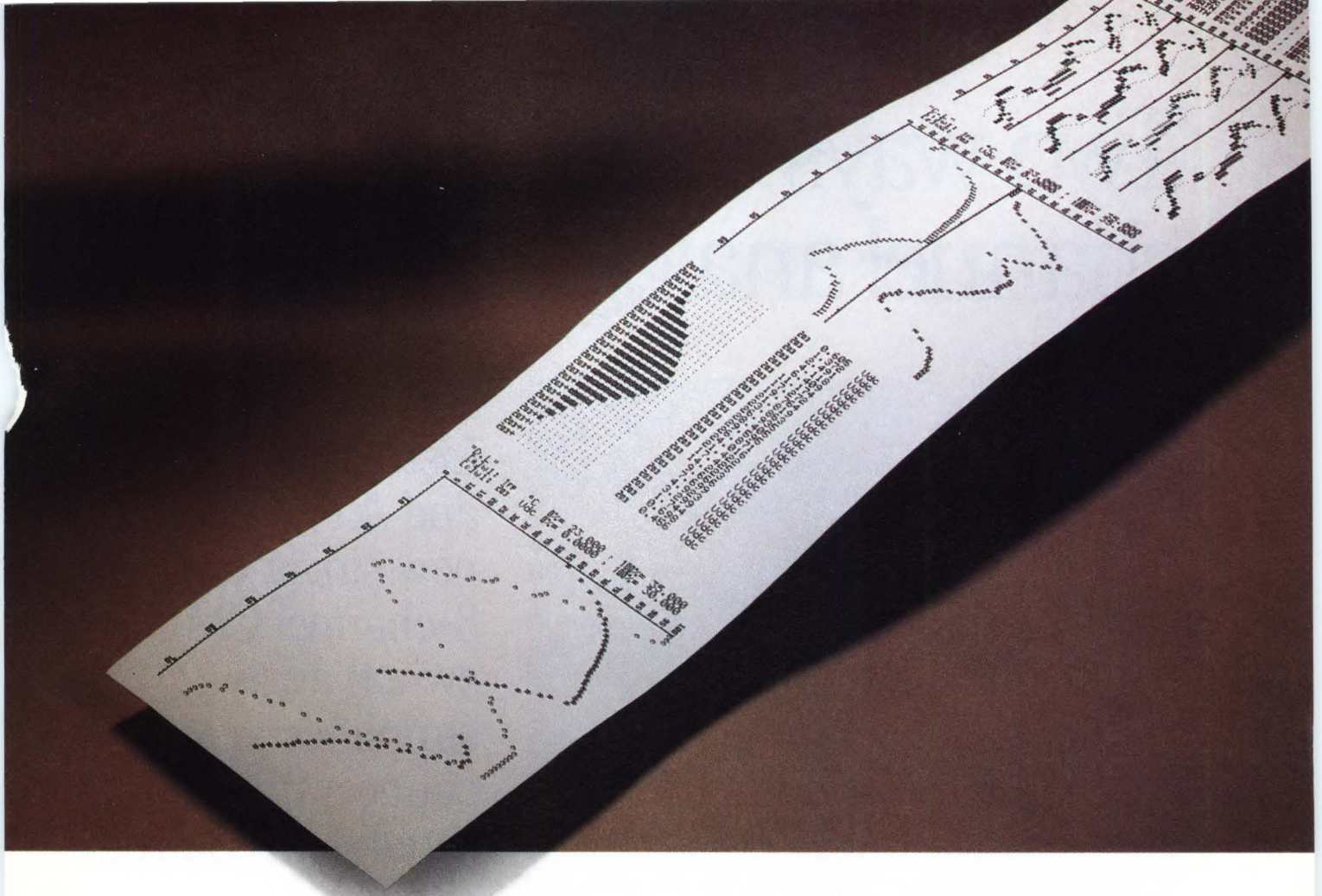
Turbo488 technology is standard on our boards for Micro Channel and Macintosh computers

NATIONAL INSTRUMENTS®
The Software is the Instrument™

12109 Technology Blvd.
Austin, Texas 78727-6204
(512) 794-0100

NATIONAL INSTRUMENTS OF JAPAN (03) 788-1921 • **NATIONAL INSTRUMENTS OF FRANCE** (1) 486 53370 • **NATIONAL INSTRUMENTS UNITED KINGDOM** (06) 355-23545 • **ARGENTINA** (1) 46-5776 • **AUSTRALIA** (2) 736-2888 • **BELGIUM** (2) 466-8199 • **CANADA** (416) 890-2010, (613) 596-9300, (514) 747-7878, (403) 295-0822, (604) 988-2195 • **CHILE** (2) 225 3689 • **DENMARK** (2) 251-122 • **FINLAND** (0) 372-144 • **GREECE** (1) 361-1283 • **HONG KONG** (2) 0426-2707 • **IRELAND** (846) 661414, (3) 427-2282 • **ISRAEL** (3) 324 298 • **ITALY** (2) 984-91071-2-3 • **KOREA** (2) 776-5340 • **MEXICO** (5) 660-4323 • **THE NETHERLANDS** (7) 099-6360 • **NEW ZEALAND** (9) 444-2645 • **NORWAY** (2) 53-1250 • **PORTUGAL** (1) 545-313 • **SINGAPORE** (65) 336-4713 • **SOUTH AFRICA** (011) 787-0473 • **SPAIN** (1) 455-8112 • **SWEDEN** (8) 792-1100 • **SWITZERLAND** (6) 552-8949 • **TAIWAN/THE REPUBLIC OF CHINA** (02) 703-6280 • **THAILAND** (2) 234-9330 • **WEST GERMANY** (89) 80-7081

CIRCLE NO. 102



A plot to get you to buy our Data Logger.

As if you didn't have enough reasons already.

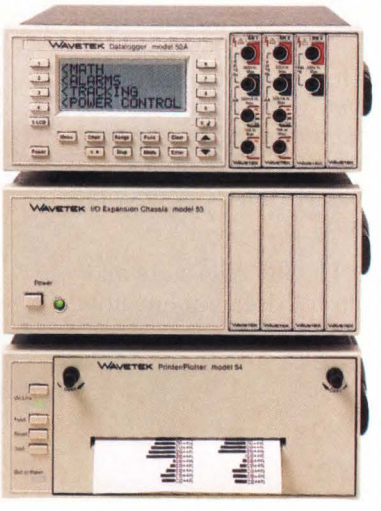
Our Series 50 Data Logger is a fraction the size of most other data loggers. Considerably less expensive. Completely portable.

And now, as you can see, Series 50 not only gathers data, it explains it.

You can plot from one to sixteen variables at a time. Divide the width of the page into one, two or four segments, with multiple variables in each.

If conditions change, Series 50 can be programmed to change the plot with them. For instance, it can switch to higher resolution and time-stamp data with messages during alarm conditions. And it does all this on its own, no computer needed. (On the other hand, it can also be controlled by a computer via IEEE-488 or RS-232.)

Series 50 will plot bar graphs next to numerical data. Create min/max plots. Or generate x-y graphs from stored data.



Speaking of stored data, Series 50 can keep up to 100,000 readings in memory. Which is a good thing, because with four independent A/D converters and up to 260 channel scanning capacity, you could be gathering plenty of data.

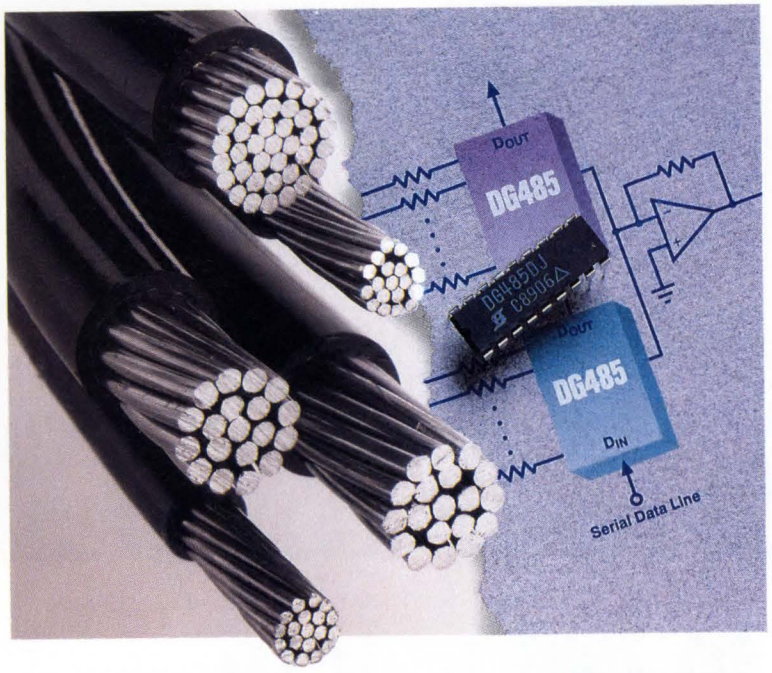
Data such as temperatures (6 thermocouple types and RTD's), AC/DC volts and current, resistance, frequency, time period, pulse width and more.

If our plot is working, you'd probably like to know more about the Series 50 Data Logger. Just phone (619) 279-2200. We'll be expecting your call.

Circle 29 for Literature
Circle 30 for Demonstration

WAVETEK®

Two ways to control multi-channel analog signals.



The wire saver for instrumentation and ATE. Siliconix' new single-chip 8-channel CMOS switch array simplifies interconnect through serial data control.

Reduce the size and weight of any digitally-controlled analog system. Cut manufacturing and maintenance costs. And improve system reliability.

Now it's easy. The industry's first switch array, the Siliconix DG485, allows any combination of eight channels to output. And controls them with a serial interface that replaces most of your wiring.

A single chip—an expandable solution. You can daisy-chain DG485s to harness all the analog inputs your system requires.

DG485 KEY PARAMETERS	
Precise	$r_{DS(ON)} < 85\,\Omega$
Fast	$t_{(ON)} < 200$ ns
Efficient	$P_D < 105\,\mu W$
Reliable	ESD protected ± 4000 V
Versatile	Any combo of 8 SPST to Output

The versatile DG485 is ideal for gain ranging, signal conditioning, routing and mixing, channel selection and multiplexing functions in microprocessor-controlled applications such as instrumentation, ATE, audio, aerospace and telecommunications.

Imagine the possibilities! Ask for your DG485 App Note and Design Kit including free sample. Call our toll-free hot line now! **1-800-554-5565, Ext. 945.**

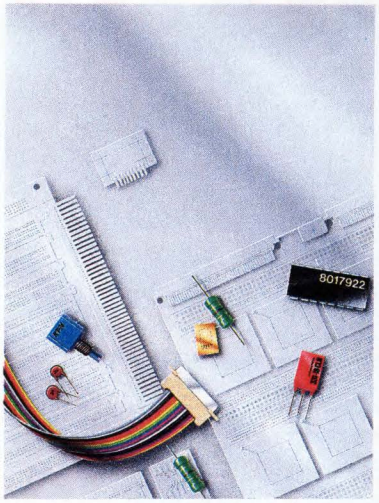
Siliconix
incorporated

2201 Laurelwood Road, Santa Clara, CA 95054

EDN Magazine Edition

Volume 34, Number 14 July 6, 1989

ELECTRONIC TECHNOLOGY FOR ENGINEERS AND ENGINEERING MANAGERS



On the cover: *Part 1 of EDN's Product Showcase No. 29 describes manufacturers' offerings in four product categories: power sources, integrated circuits, hardware and interconnect devices, and software. Leading off the product sections are in-depth looks at high-reliability power systems (pg 64), IC drivers for flat-panel displays (pg 102), prototyping techniques (pg 148), and real-time software kernels (pg 184). (Illustration by Thomas Szumowski; art direction by Ken Racicot)*

DESIGN FEATURES

Power Sources

Modern dc power systems overcome component failures and ac outages **64**

Redundancy and the use of backup power supplies aren't just for military and aerospace applications anymore. Through these techniques, commercial electronic systems—such as computers and automatic test equipment—continue to perform under conditions that would have shut down older products.—*Dan Strassberg, Associate Editor*

Integrated Circuits

Specialized ICs drive flat-panel displays to new performance levels **102**

The recent improvements in the size and image quality of flat-panel displays are, in large measure, the result of improved manufacturing techniques and the use of better materials. No less important, however, is the contribution made by innovative IC drivers that bring new levels of performance to these increasingly popular displays.
—*Dave Pryce, Associate Editor*

Hardware and Interconnect Devices

Prototyping techniques evolve to match design complexities **148**

By testing your designs with some nontraditional prototyping techniques, you can satisfy that ever-present need to make sure your circuit works before committing to silicon.
—*J D Mosley, Regional Editor*

Continued on page 7

EDN® (ISSN 0012-7515) is published 49 times a year (biweekly with 2 additional issues a month, except for February, which has 3 additional issues and July and December which have 1 additional issue) by Cahners Publishing Company, A Division of Reed Publishing USA, 275 Washington Street, Newton, MA 02158-1630. Terrence M McDermott, President; Frank Sibley, Senior Vice President/General Manager, Boston Division; Jerry D Neth, Senior Vice President/Publishing Operations; J J Walsh, Senior Vice President/Finance; Thomas J Dellamaria, Senior Vice President/Production and Manufacturing; Ralph Knupp, Vice President/Human Resources. Circulation records are maintained at Cahners Publishing Company, 44 Cook Street, Denver, CO 80206-5800. Telephone: (303) 388-4511. Second-class postage paid at Denver, CO 80206-5800 and additional mailing offices. POSTMASTER: Send address corrections to EDN® at the Denver address. Annual subscription rates for nonqualified people: USA, $105/year; Canada/Mexico, $125/year; Europe air mail, $150/year; all other nations, $150/year for surface mail and $230/year for air mail. Single copies are available for $10. Please address all subscription mail to Eric Schmierer, 44 Cook Street, Denver, CO 80206-5800.

VBPA ABP

FLUKE

PHILIPS

PHILIPS

Great Choice.

More professionals in more industries make Fluke their first choice in multimeters.

Fluke DMMs. Reliable. Accurate. Powerful. Tough. Versatile. Easy to use and simple to operate. Backed by the longest, most comprehensive warranty in the business. Made in the U.S.A. In short, Fluke makes meters you can bet your reputation on.

More choice. No matter what the job, there's a Fluke to handle it.

There's the new 80 Series—the most powerful, most complete test and measurement system available in a handheld package.

The popular 70 Series—simply put, the most requested DMM in the world, with nearly 2 million units in service since 1984. And the Fluke 21 and 23—70 Series simplicity in high-visibility yellow.

The Fluke 25 and 27—the most rugged meters ever built, totally sealed against water, dust and other contaminants.

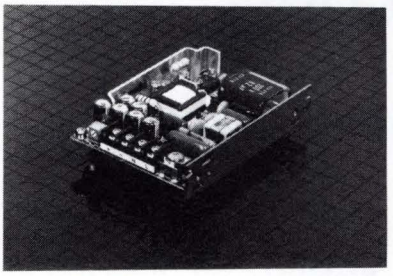
And the precise 8060 Series—with the versatility of a test lab, the accuracy of a bench instrument, and the convenience of a handheld.

Smart choice. Compare Fluke DMMs with any other handheld. No one else gives you as much meter for your money. And no other meter costs less to own.

Your choice. For the name of your nearest Fluke distributor, call toll-free **1-800-44-FLUKE, ext. 33.** And make a great choice.

FROM THE WORLD LEADER IN DIGITAL MULTIMETERS

FLUKE



***A vast amount of products** are included in EDN's Product Showcase, beginning with power sources (pg 83). Coverage continues with descriptions of ICs (pg 117), hardware and interconnect devices (pg 163), and software (pg 201).*

Software

Real-time kernels sprout into full-grown software environments **184**

Two groups of software engineers, both unused to formal, real-time software tools, are poised to invade and overwhelm the small, cozy realm of real-time kernels.
—Charles H Small, Associate Editor

PRODUCT UPDATES

Power-factor controller **57**

ECL SPARC chip set **58**

PRODUCT REVIEWS

Power Sources **83**

All types of power supplies, including batteries.

Integrated Circuits **117**

Microprocessors, RAMs, ROMs, power transistors, all monolithic function chips.

Hardware and Interconnect Devices **163**

Fiber-optic links, wire, cable, connectors, pc boards, enclosures, cooling devices.

Software **201**

All types of software, from system packages to application packages.

LITERATURE

Computers & Peripherals **212**

Components **216**

Instruments **220**

Computer-Aided Engineering **223**

Continued on page 9

Cahners Publishing Company, A Division of Reed Publishing USA ☐ Specialized Business Magazines for Building & Construction ☐ Manufacturing ☐ Foodservice & Lodging ☐ Electronics & Computers ☐ Interior Design ☐ Printing ☐ Publishing ☐ Industrial Research & Technology ☐ Health Care ☐ and Entertainment. Specialized Consumer Magazines: ☐ American Baby ☐ and Modern Bride.

Now you have a choice for your power supply controller.

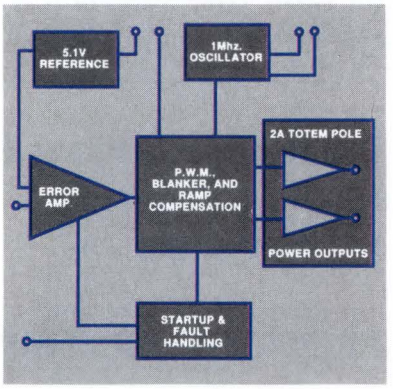
Standard devices for maximum performance.

1. Introducing three new single-chip Switch Mode Power Supply controllers that save space, money and time.

The new 16-pin ML4825 and ML4823 are improved pin-compatible replacements for the UC1825 and UC1823. A third new controller, the ML4809, is packed with extra features and functions for better compensation, easier starting and synchronization.

PART TYPE	SOFT START RESET	UNDER-VOLTAGE OUTPUT STATE	COMPARATOR TO OUTPUT DELAY
ML4823-5	COMPLETE	LOW	40 nS
UC1823-5	PARTIAL	FLOAT	50 nS

Micro Linear/Unitrode Comparison



Micro Linear PWM Controllers Provide Maximum Performance

The ML4809 starts with all the features of the ML4825, then adds even more:

Synchronization:
- separate clock I/O pins
- wide dynamic range VCO
- toggle flip-flop output and preset inputs

Stability:
- on-chip programmable ramp compensation
- blanker to reject turn-on spike
- completely independent error ramp

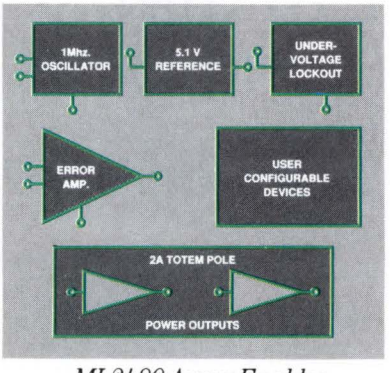
Start-up/Fault conditions:
- 7V hysteresis on under-voltage lockout
- full reset with programmable delay

If one of these new standard controllers doesn't meet your special high-frequency system needs, Micro Linear can provide a customized solution to your specific applications.

ASIC devices for maximum flexibility.

2. Announcing the new FB3480, the first semi-custom array specifically designed for high frequency Switch Mode Power Supply applications.

Unlike most other semi-custom IC's, the FB3480 is specifically designed for SMPS control. This array contains specially crafted high performance "core cells" optimized to perform the functions found in all PWM controllers. In addition, a large area of uncommitted components on the chip can be configured to your specifications using Micro Linear's library of "soft macros." These macros implement a full complement of logic, comparator and other functions which make your controller unique. This "core cell" and "soft macro" design approach provides a customized solution with a minimum of cost and effort, without sacrificing performance.



ML3480 Array Enables Easy Custom Design

For more information on the new single-chip standard and semi-custom SMPS controllers from Micro Linear, call (408) 433-5200, ext. 900.

Or write:
Micro Linear, Dept. PWM,
2092 Concourse Drive,
San Jose, CA 95131

Micro Linear

EDITORIAL

49

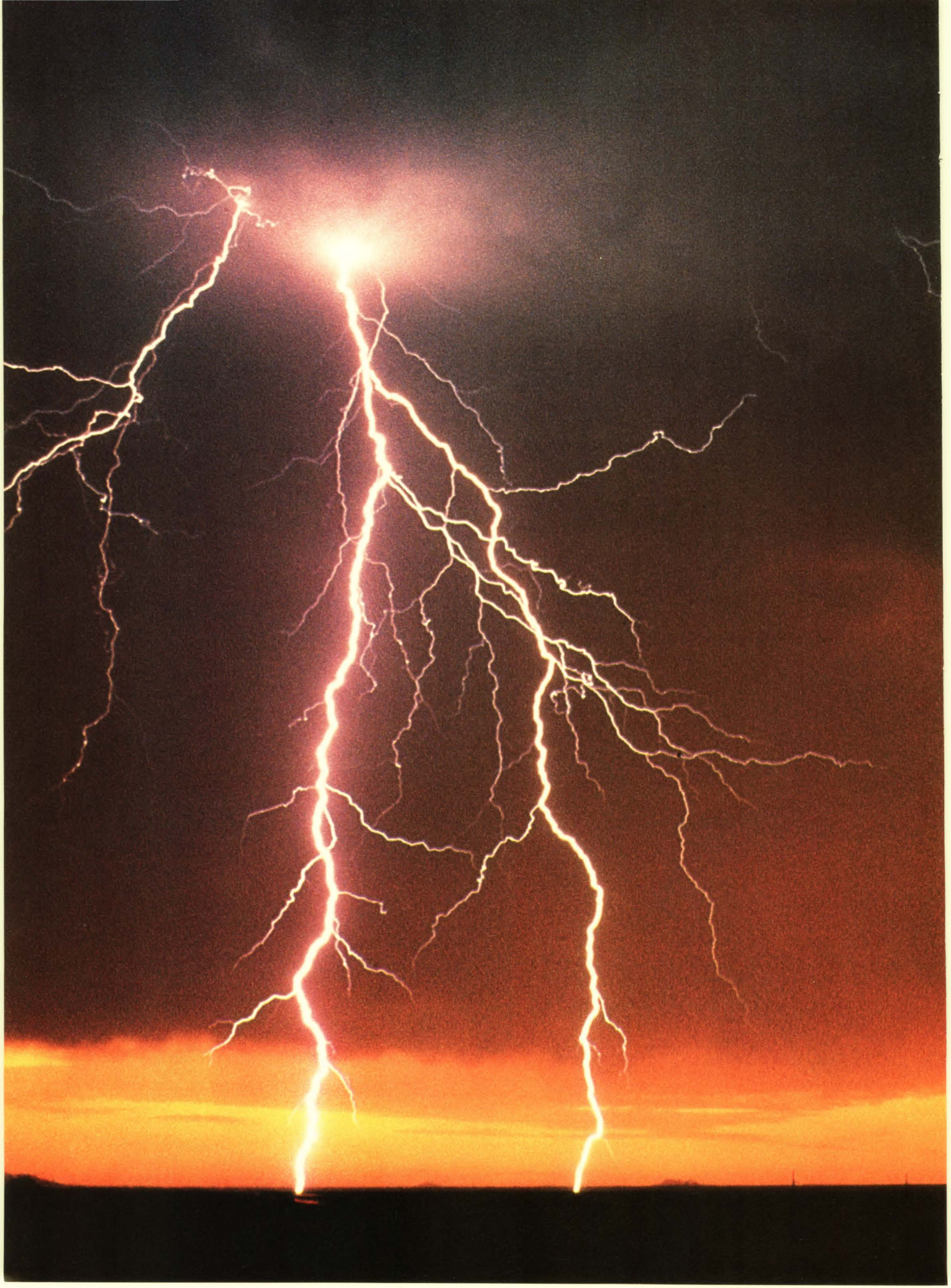
Shareholders should include engineers and managers, along with top management, for good performance.

DEPARTMENTS

News Breaks 21
Signals & Noise 31
Calendar 42
Career Opportunities 231
Advertisers Index 236
Business/Corporate Staff 237

A product-oriented design aid

To save you time in your efforts to keep current, EDN's editors have surveyed the new-product offerings from thousands of companies, screening and selecting only the most significant of those offerings introduced in the last six months. We present our findings—the best of the best—in a format devised to make your product selection as easy as possible. You can keep this Product Showcase as a reference until the next one that covers these four key product areas appears in December.



It's an Analog World.

Ultimately, all circuits are analog circuits. That's why you should step into the analog EDA world of Mentor Graphics.

Here you will find advanced design automation that guarantees high quality results. Gets you to market sooner. And still leaves you time to explore creative alternatives.

Start with AccuSim,™ a robust analog simulator that consistently converges to a correct result—even on designs containing thousands of transistors.

Then turn to AccuParts.™ This library of more than 2,400 discrete and integrated components includes a large selection of European and Pacific Rim parts. In fact, AccuParts is the most complete and accurate analog library available.

With AccuSim and AccuParts, you also enjoy full integration with the far-reaching Mentor Graphics suite of EDA tools. So you have direct links to logic simulation, IC and PCB layout, thermal analysis and more.

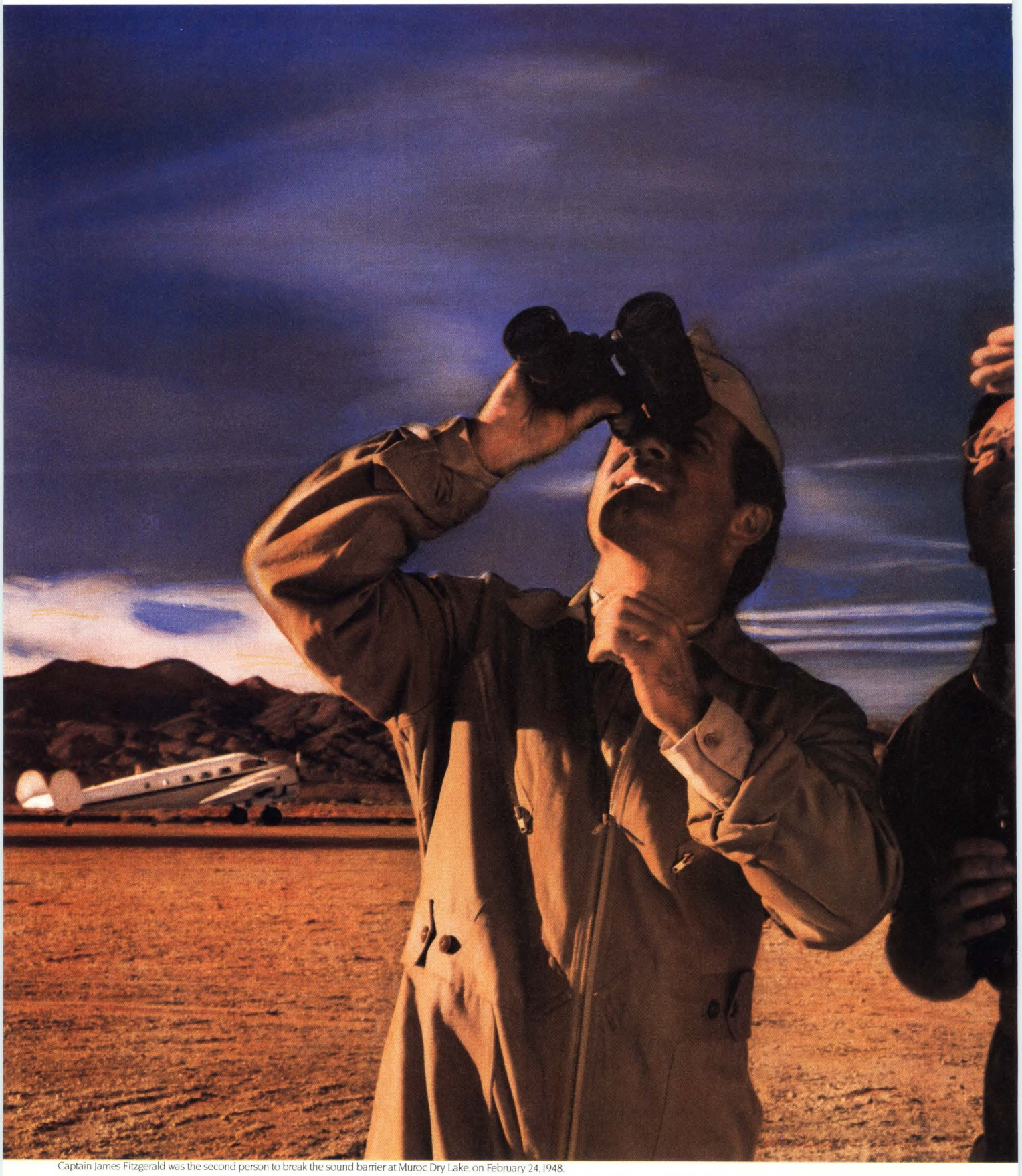
AccuSim and AccuParts draw you into a design environment that is analog at its core. So you can depend on the world's EDA leader to keep providing the tools and support you need.

For a brochure on the Mentor Graphics analog world, dial this digital, toll-free number: **1-800-547-7390.**

Mentor Graphics®

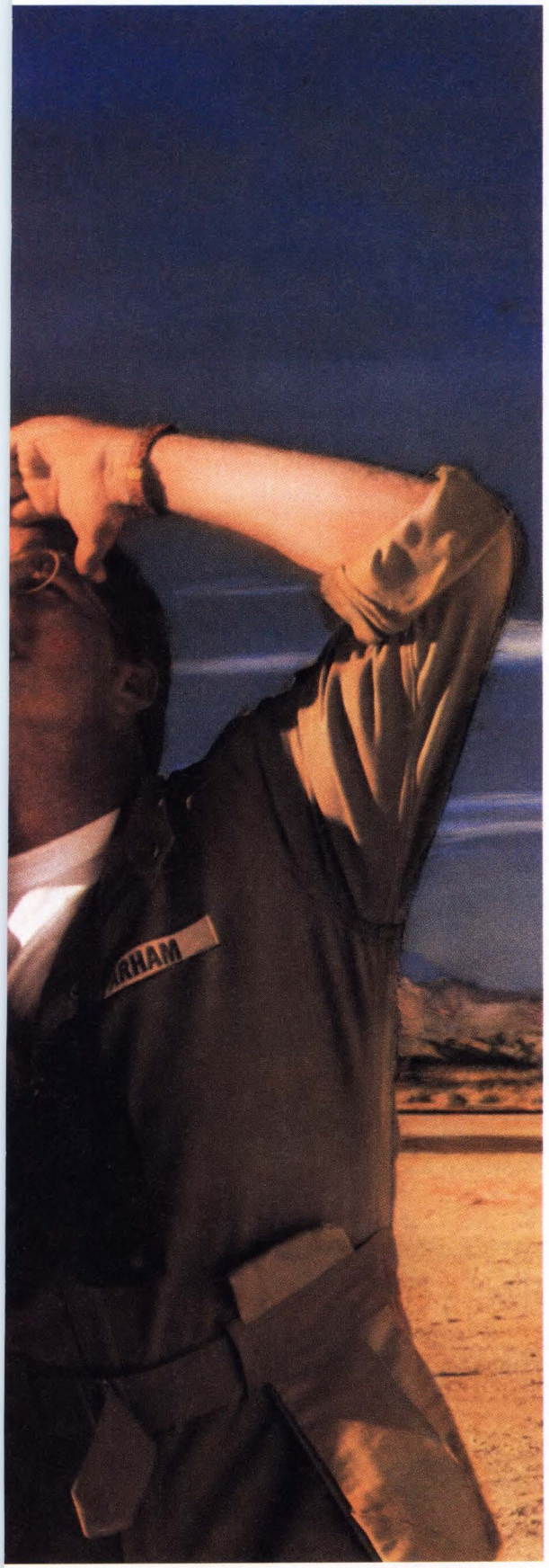
Your ideas. Our experience.

Who was the second person



Captain James Fitzgerald was the second person to break the sound barrier at Muroc Dry Lake, on February 24, 1948.

to break the sound barrier?



Someone worked every bit as hard as Chuck Yeager and came in second. The sad truth is, no matter how fast you go, getting there second isn't fast enough.

The same holds true in the marketplace.

That's why AMD concentrates on complete design solutions that cut product development time. So your product won't be obsolete before it's shipped.

Take our 32-bit RISC microprocessor, the 29K™. At 17 MIPS, it's at the heart of some of the fastest, most powerful equipment now being built.

And everything you need to get to work is here. Today. From silicon to tools for hardware and software development. From AMD or any of 40 Fusion29K™ partners.

Which makes it easy for you to go out and get your share of the profits before anyone else gets off the ground.

Take your pick. You can work hard and produce anonymous products.

Or take AMD and fly to market.

Advanced Micro Devices

901 Thompson Place, P.O. Box 3453, Sunnyvale, CA 94088.
For more information about the 29K, call (800) 222-9323.

Three isolated Power MOSFET packages and up to 1000 volts give you the Power to Win.

SGS-THOMSON Microelectronics, the leader in isolated Power MOSFETs, gives you the packaging power to race well ahead of your competition.

We cover you with a winning lineup of 7 voltages that range from the high voltage TSD5MG40 (13A, 1000V, 0.7Ω) to the TSD4M150 (135A, 100V, 14mΩ), all in the ISOTOP™ power package — now an emerging industry standard.

Replaces 4 to 5 devices. You would need 4 or 5 standard devices to equal one ISOTOP, plus all the isolating hardware, plus the heatsink space for mounting, plus the added assembly time. The bottom line? Measurably lower costs with ISOTOP.

Same heatsink space as TO-204 (TO-3). ISOTOPs take up no more heatsink real estate than a standard TO-204, yet they offer advantages that leave TO-204 high and dry:

2.5 kVRMS internal insulation

J-C thermal resistance <0.25°C/W

Internal parasitic inductance <5nH

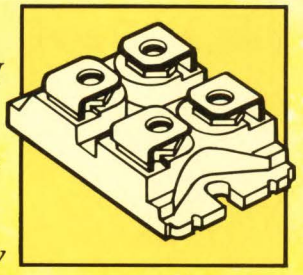
Improved reliability

Reduced EMI and RFI

High current connections all on the top of the device

Screw terminals allow parallel bus connections

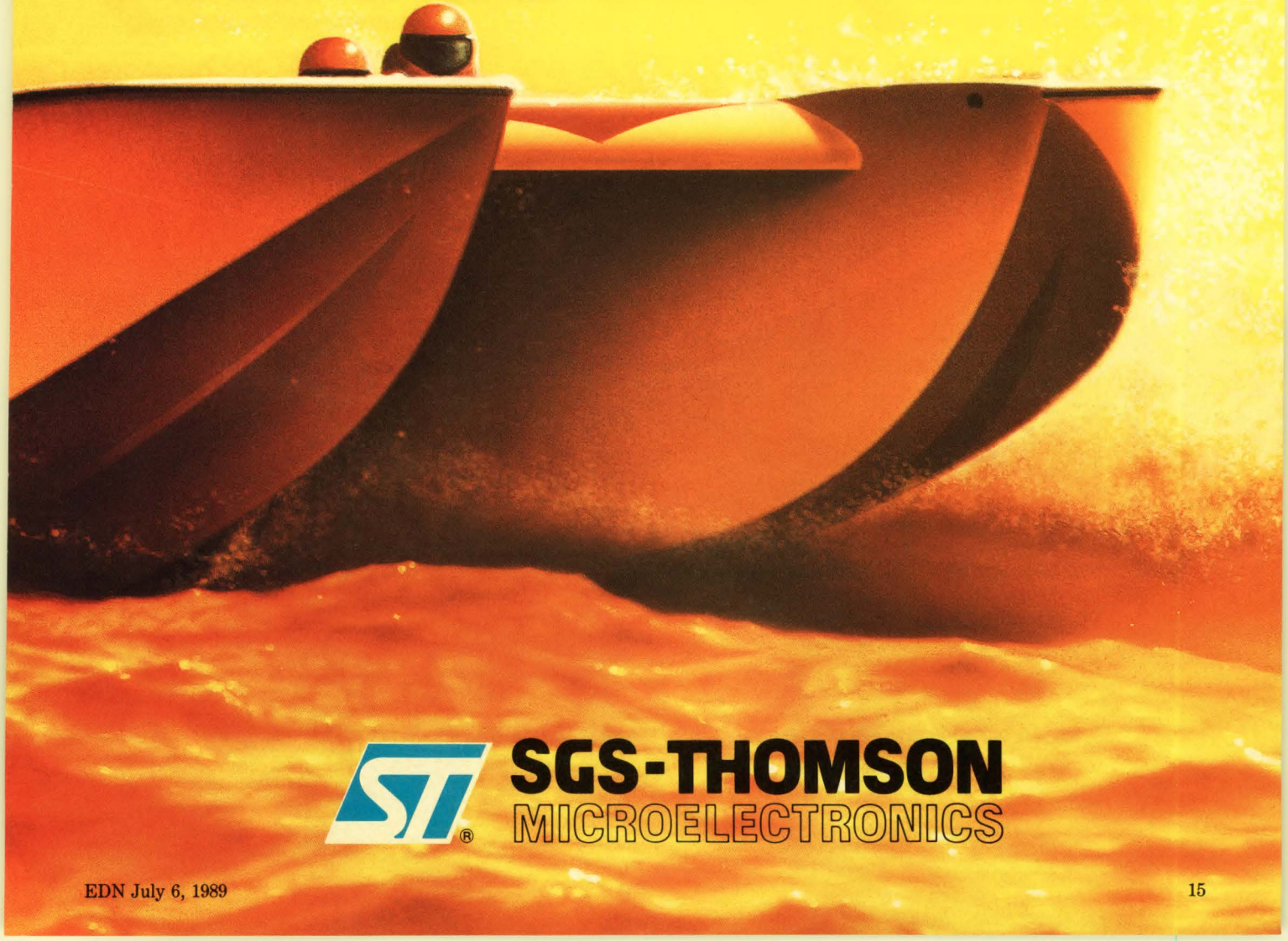
Easy assembly without external isolation hardware



New standards for TO-218 and TO-220. SGS-THOMSON also offers replacements for the standard TO-218 and TO-220 packages. These fully encapsulated packages eliminate the need for additional isolation hardware. Not to mention the cost.

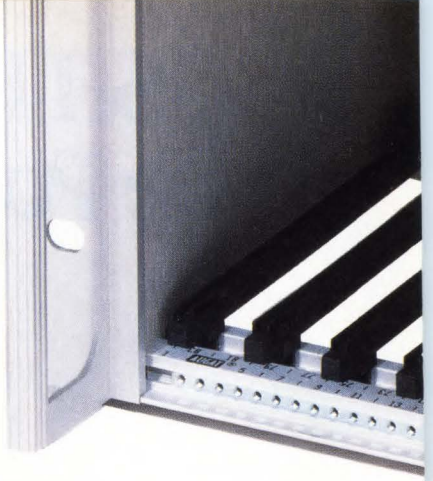
Get the facts and get the Power to Win. Call or write for data sheets from the industry's leading manufacturer of isolated Power MOSFET packages: SGS-THOMSON Microelectronics, 1000 E. Bell Road, Phoenix, Arizona 85022. 602/867-6259.

SGS-THOMSON
The Power to Win.

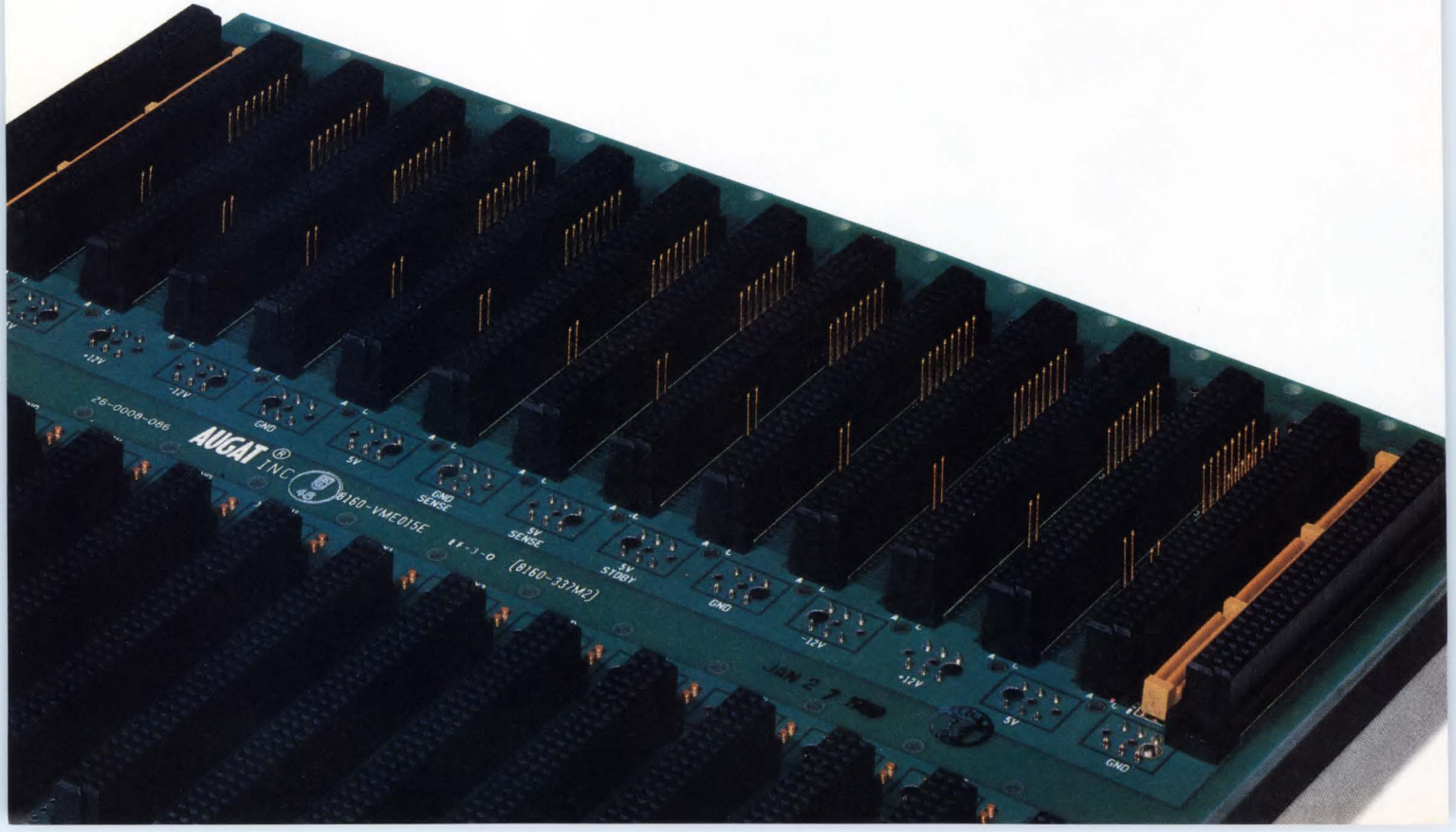


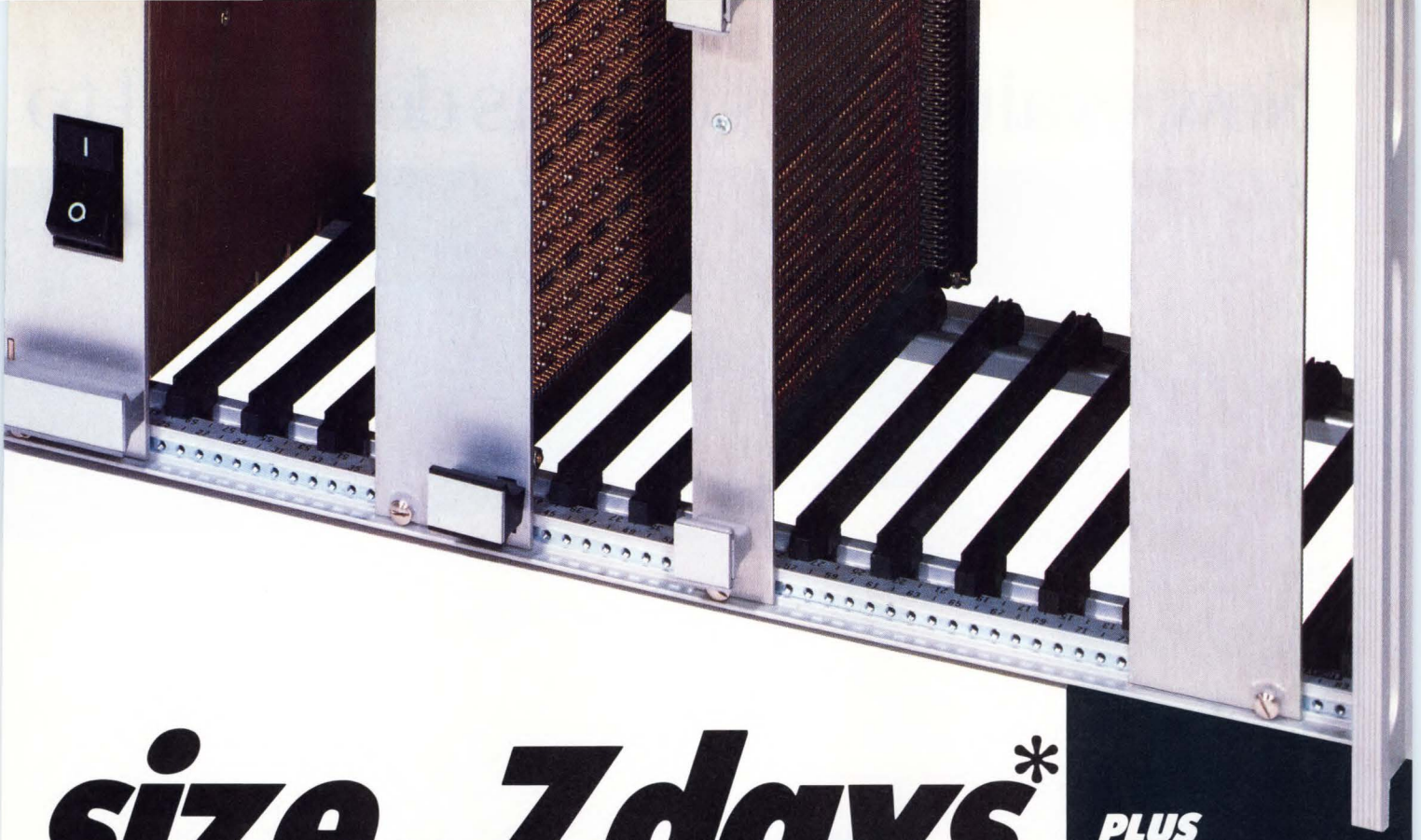
SGS-THOMSON
MICROELECTRONICS

AUGAT VME...



Any slot...Any





size...7 days*

Now, within just 7 working days, AUGAT will ship you a backplane or card cage in any size you need, from 3 through 21 slots. This isn't simply a promise — it's AUGAT's GUARANTEE*...

Or you pay 20% less!

Our no-nonsense 7-Day VME Program includes both J1 and J2 backplanes. It even includes our new high-performance monolithic backplanes, too. Only AUGAT has the production capability to guarantee 7-day shipment on such a broad selection of backplanes. Now you can plan on the arrival of your VME packaging hardware with no fear of delaying your critical development schedule.

In addition, AUGAT has greatly expanded its entire VME line to include more standard products ... including new VME power chassis complete with backplane, fully harnessed power supply, cooling, card cage and optional enclosure. AUGAT also has the engineering talent and experience to handle your customized VME packaging needs.

Send for a copy of our new VME catalog today ... because when time is of the essence in locating quality VME products with full engineering support, your surest source is AUGAT!

* AUGAT GUARANTEES to ship backplanes and/or card cage kits in any size (from 3 through 21 slots) in 7 working days from date of approved credit — or you pay 20% less! (limit: 3 pieces per part number)

PLUS
An Expanded VME Product Line

NEW Power Chassis

More Power Supplies

More Extender Boards

More Wire-Wrap† Panels

More Cage Dividers

More Support Data

For answers or orders

1-800-999-9VME

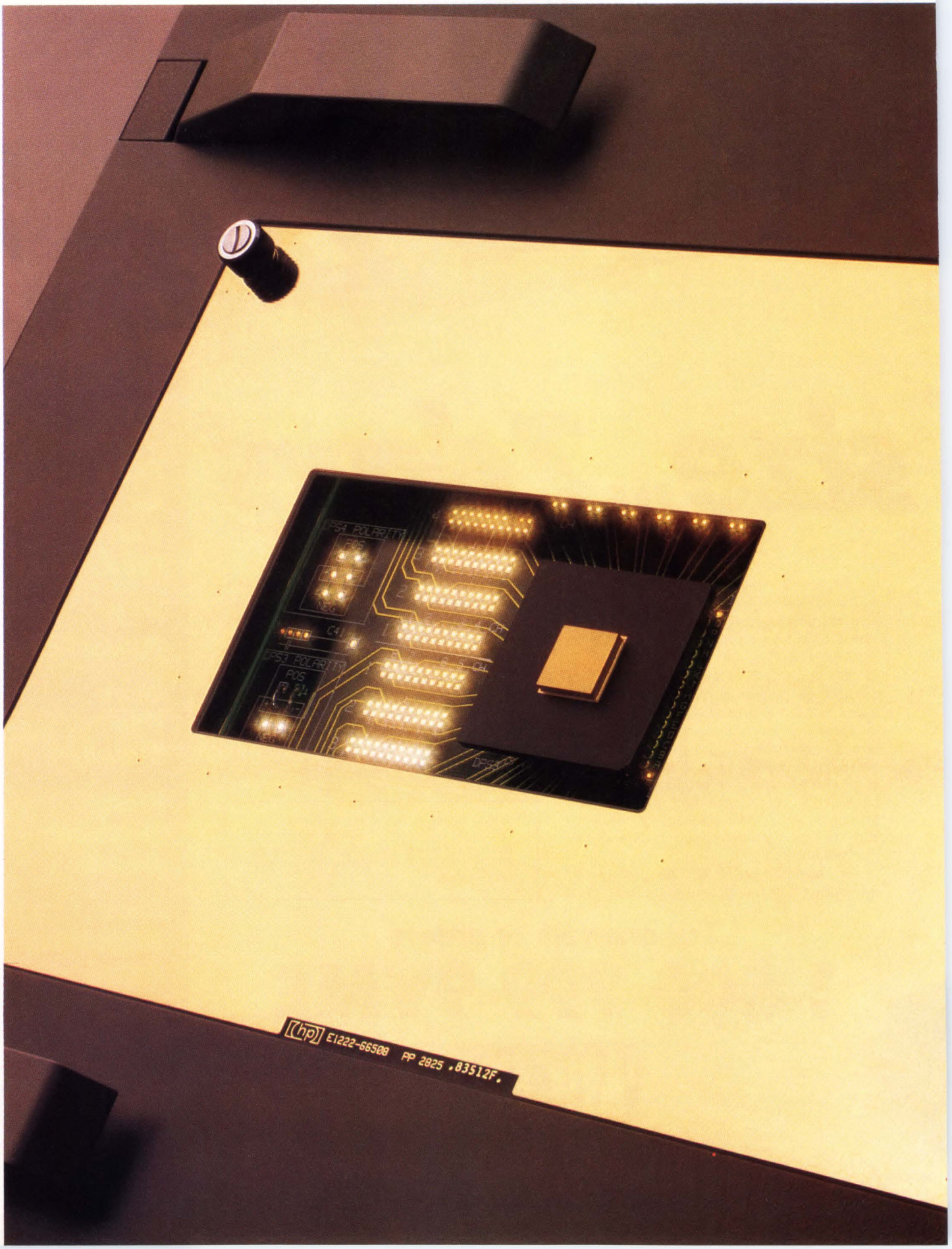
AUGAT®

AUGAT INC., INTERCONNECTION PRODUCTS GROUP

†Wire-Wrap is a registered trademark of Gardner-Denver

CIRCLE NO 35

Now, evaluation systems dedicated to



faster ASIC turnaround.

Finally, a family of testers to cut ASIC development time... the HP 82000 IC Evaluation Systems. Choose from high-performance or low-cost models. Both do prototype verification *and* IC characterization. They give you measures of confidence by making sure ASICs work right. Or showing you why if they don't.

Performance you weren't getting in verification systems.

Here's power to test fast, complex devices. Up to 200 MHz. 128 K vector depth. 384 true I/O channels. And ±250 ps accuracy. There's flexibility, too. True tester-per-pin architecture lets you define the parameters of each pin... individually.

Simplicity that ATE systems can't match.

For fast setups, automatic test generation taps your EDA databases. You get characterization of designs automatically. High-resolution displays speed analysis. And X Windows make these the friendliest test systems ever.

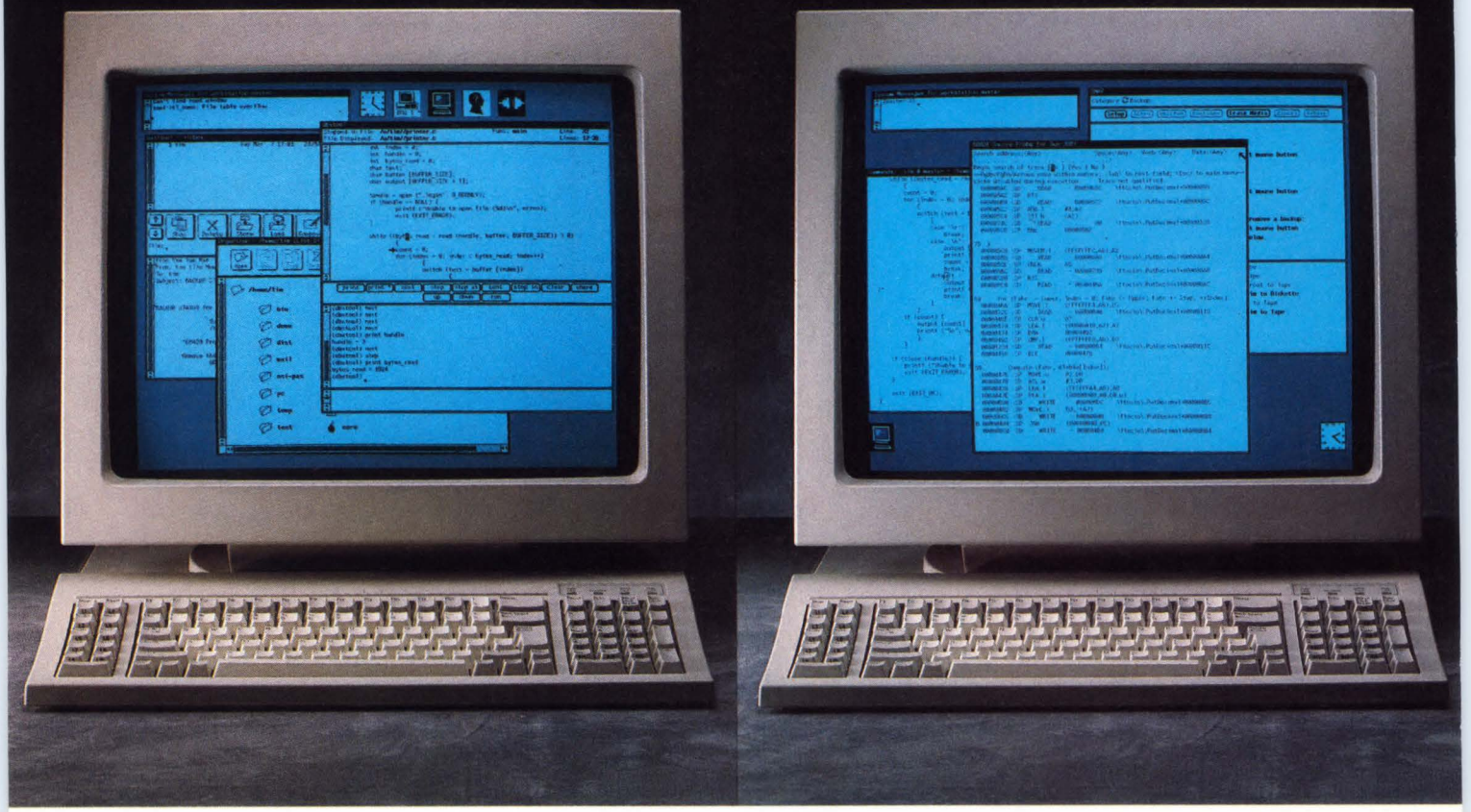
Call **1-800-752-0900, ext. 215G,** today for details on the right model to speed your ASICs to market. And ask about HP systems for parametric process control, mixed-signal testing and parameter extraction too.

HEWLETT PACKARD

CIRCLE NO 36

C A D R E

Your Workstation. Your Emulator.



Now you can use 68000/020/030 in-circuit emulators with your favorite tool—your workstation. Where you usually develop code. And write memos.

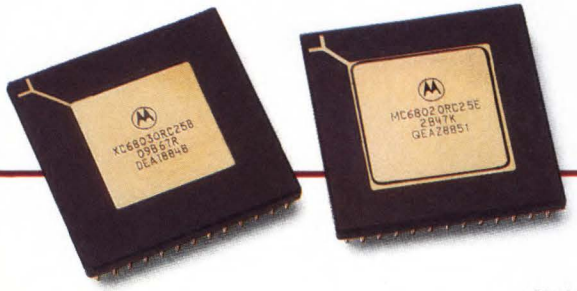
Atron's PROBE Series 68000/020/030 emulators support real-time emulation to 25 MHz. Remotely. So you can develop code on your favorite Sun or VAX™ running VMS.™ Download it fast via Ethernet™ to the PROBE. And execute it in the target in real-time. All from your desk.

The PROBE has real-time trace, so you can view the history of your program's execution. Source trace capability lets you examine program flow at the C, Ada,® or assembler level. And eight hardware breakpoints let you find sequence-dependent bugs.

The PROBE has pre-fetch dequeuing, too. Here, a special algorithm removes pre-fetched, unexecuted instructions from the trace sequence and then realigns operands in the order that they were executed.

Workstations. Emulators. What's the difference? Thanks to Atron, now there isn't any.

Call 1-800-283-5933 for more information on remote emulation with Atron's PROBE Series.



CADRE
ATRON DIVISION

Saratoga Office Center
12950 Saratoga Avenue
Saratoga, California 95070

Circle 40 for Demonstration

Circle 39 for Literature

NEWS BREAKS

EDITED BY JULIE ANNE SCHOFIELD

CAD VENDOR ENHANCES SIMULATION SUITE

Viewlogic (Marlboro, MA, (508) 480-0881) announced its enhanced Workview tool set, which has a VHDL (VHSIC Hardware Description Language) capability that supports system-level simulations of any mixture of VHDL-behavioral circuit descriptions and gate-level descriptions, at the Design Automation Conference last week. This simulation capability can be extended with the LM1000 Hardware Modeler from Logic Modeling (San Jose, CA, (408) 922-0870) and with software models from Logic Automation (Beaverton, OR, (503) 690-6900) and Quadtree Software (Bridgewater, NJ, (201) 725-2272). To convert from behavioral- to gate-level circuit descriptions, Workview also has a logic-synthesis capability. If you want to supplement the functions on Viewlogic's software, the vendor supports an open-architecture CAD system using EDIF 2.0 (Electronic Data Interchange Format) as a transfer database, so you can access and transfer data between Viewlogic's software and other EDIF-compatible applications. Viewlogic also announced at the conference that its front-end software can be ported from both PC/AT compatibles and Sun workstations to the new DECstation3100.—Michael C Markowitz

SEA-OF-GATES LAYOUT SYSTEM USES DISTRIBUTED PROCESSING

The Parallel Rene-GA Sea-of-Gates IC-layout system from Descartes Automation Systems Inc (Santa Clara, CA, (408) 986-8877) runs on computer platforms that range from engineering workstations to IBM mainframes. Aimed at design complexities of 20,000 gates and more, the software uses conventional networking and no special hardware to achieve distributed-processing speed improvements. The software performs serial placement then automatically or manually partitions the layout into modules. Next, a single processor performs global routing between modules. The software performs routing within modules—the bulk of the work—using distributed processing. This scheme lets multiple networked engineering workstations achieve the throughput of more expensive mainframe computers. The manufacturer claims six $25,000 workstations using its software outperformed a multimillion-dollar mainframe in preliminary benchmarks. Each system is tailored to the specifications of individual customers, and prices start at $150,000.—Doug Conner

FILTER STORES PROGRAMMING IN EEPROM

The SC22324 switched-capacitor filter from Sierra Semiconductor (San Jose, CA, (408) 263-9300) lets you implement an eighth-order filter in a single device with a bandwidth as great as 100 kHz. The device is cascadable for higher-order filters. It accepts serial data and stores its programming data in temporary registers whose contents can be transferred to EEPROM for nonvolatile storage. The device can operate from either the temporary or EEPROM data, thus letting you implement adaptive filtering. The device also offers two undedicated op amps for analog-filtering needs and a programmable filter clock counter. The SC22324 costs $49 (100). A designer's kit, including filter-design software, a programming station, a textbook, and two sample devices, is available for $1875.—Richard A Quinnell

NEWS BREAKS

CAD-TOOL VENDORS LAUNCH VHDL VALIDATION-SUITE PROJECT

A group of CAD-tool vendors has started a VHDL (VHSIC Hardware Description Language) validation-suite project, to be led by Dr James Armstrong of Virginia Polytechnic Institute (Blacksburg, VA, (703) 231-4723). This test suite will serve as a standard to ensure and promote compliance with the IEEE's VHDL standard. The sponsoring companies include CAD Language Systems Inc, Daisy Systems, GenRad, MCC, Vantage Analysis Systems Inc, and Zycad Corp. Sponsoring companies have submitted their internally developed tests for consideration. Tests are judged using 1100 criteria. The National Institute of Standards and Technology is coordinating the project and will maintain the test-validation suite after government funds are allocated for the task.—Steven H Leibson

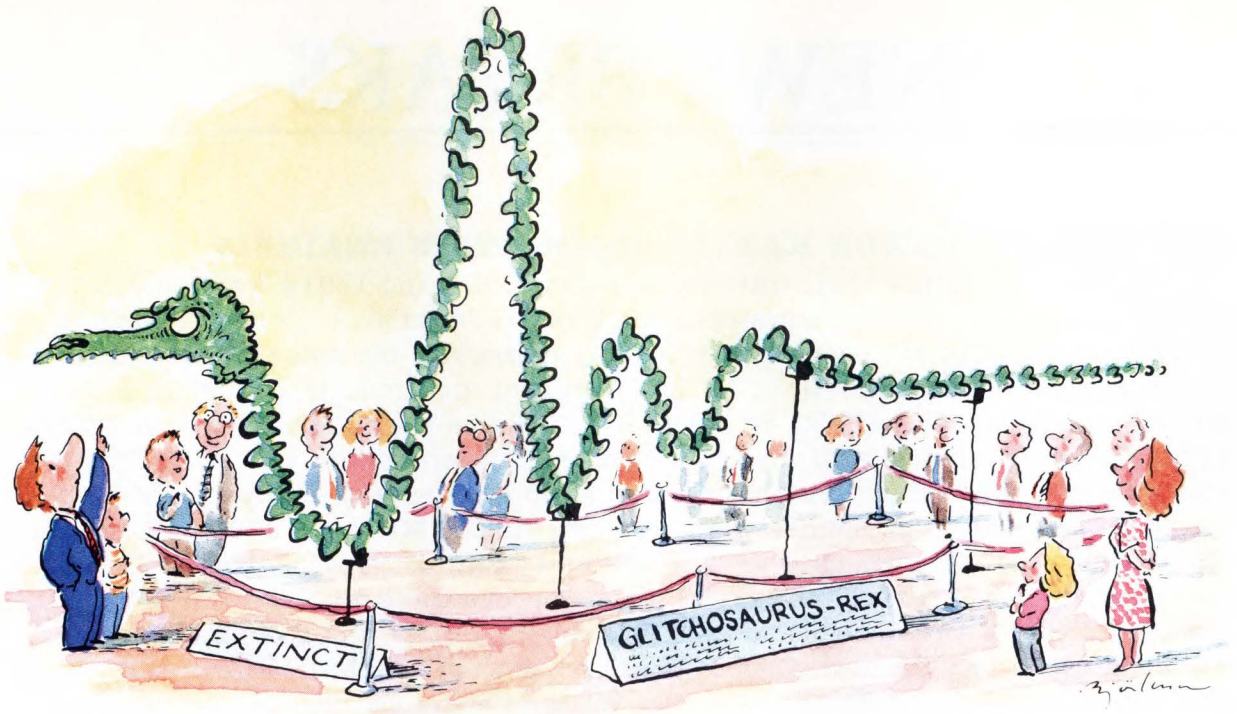
VENDORS CHOOSE SIDES OVER HIGH-RES GRAPHICS STANDARD

Expect IC vendors to introduce 8514/A-compatible graphics ICs from now through the end of the year. Manufacturers wishing to copy the PC/AT and PS/2 graphics standard developed by IBM first had to reverse-engineer the part to determine its registers. (Knowlege of the graphics adapter registers lets software developers bypass the software interface, thus resulting in faster programs.) Western Digital Imaging (Mountain View, CA (415) 960-3353), the first company to publicly release its version of the registers, can now deliver sample chips. Chips and Technologies (San Jose, CA (408) 434-0600) has announced its version of the registers and says it will deliver samples in August. And expect a similar announcement from Headland Technology (Fremont, CA, (415) 656-7800). All these companies are spurred by the promise of a huge market for a universally accepted high-resolution graphics display for PCs. Some market watchers predict monitor/adapter combinations supporting the 8514/A standard's 1024×768-pixel resolution and 256 colors and priced under $1000 will be available within 18 months.

Not all companies in the PC-graphics market are convinced of the 8514/A's imminent success. Cirrus Logic (Milpitas, CA (408) 945-8300), for example, figures that the high-resolution PC-graphics market will be too fragmented and that the 8514/A's drawbacks, such as a slow software interface, limited graphics primitives, and an interlaced display, will limit its acceptance. Look for Cirrus to develop a chip that lets graphics boards based on Texas Instruments's TMS34010 graphics processor maintain compatiblity with the lower-resolution PC-graphics standard, the VGA.
—Margery Conner

CONVERTER LINKS ETHERNET LAN AND SCSI BUSES

The Ether+ from Compatible Systems Corp (Boulder, CO, (303) 444-9532) converts the SCSI port of Apple Computer's Macintosh into an Ethernet node and accommodates both thick and thin Ethernet cables. The $495 converter supports the Macintosh's built-in software communications protocols and the TCP/IP Ethernet standard. It can also be modified to support other network protocols. The Ether+ is compatible with several existing Macintosh network programs including AppleShare, TOPS, and Novell Inc's Netware. At 10M bps, the Ethernet LAN is approximately 40 times faster than Apple's AppleTalk/LocalTalk network.—Steven H Leibson



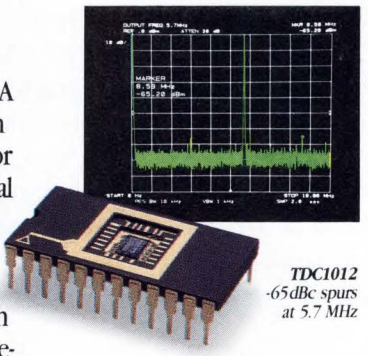
The Glitch is History

The Glitch won't disturb performance or raise the cost of your design again. Not if you specify TRW LSI's high speed 12-bit DAC. Because our TDC1012 is virtually glitch-free. It settles to ±0.012% of full-scale within 30ns. It operates at data rates to a guaranteed minimum of 20MHz, and reduces spurious harmonics to -65dBc or less, all without need of a sample-and-hold.

That's the finest harmonic distortion performance available, yet the TDC1012 is priced about the same as ordinary 12-bit DACs. But because it comes without the Glitch, your system cost will drop dramatically. Why? Because data registers are built-in. You won't need to add them or their potential for ground-loop noise. Nor will you need to de-skew data inputs with individually adjustable trimming capacitors. The peak glitch area is less than 25 pico-volt seconds, an order of magnitude less than other DACs. It will drive a 1V signal directly into a 50-ohm doubly terminated line (40mA full-scale), eliminating the need for an output amplifier. Without the need for trimming, de-glitching and these external components, you'll save time, too.

Segmented architecture that replaces the outmoded R-2R ladder, along with several other proprietary design enhancements help account for the TDC1012's record-setting performance. It belongs in your next digital RF, IF or waveform synthesizer, vector graphic display — or anywhere you need a fast, high resolution, distortion-free DAC. It's available now in ceramic or plastic DIP packages from TRW LSI Products or your nearest Hall-Mark or Hamilton/Avnet location. If you need a faster 12-bit DAC, specify our 50MHz TDC1112.

TRW LSI Products — Bringing the worlds of Data Acquisition and DSP together.



TDC1012
-65dBc spurs at 5.7 MHz

TRW LSI Products Inc.
P.O. Box 2472, La Jolla, CA 92038
619. 457.1000

In Europe, phone:
TRW LSI Products Inc.
Munich, 089.7103.115;
Guildford (U.K.), 0483.302364

In the Orient, phone:
Hong Kong, Tektron, 3.880629;
Tokyo, Dia Semicon, 3.487.0386,
Teksel, 3.461.5311;
Taipei, Sea Union, 2.751.2062;
Seoul, M.S., 2.553.0901;
Singapore, Seamax, 65.747.6155;
Australia, Email, 613.544.8244

TRW

TRW LSI Products Inc.

NEWS BREAKS

LOGIC ANALYZERS NOW HANDLE 35-MHz STATE ANALYSIS

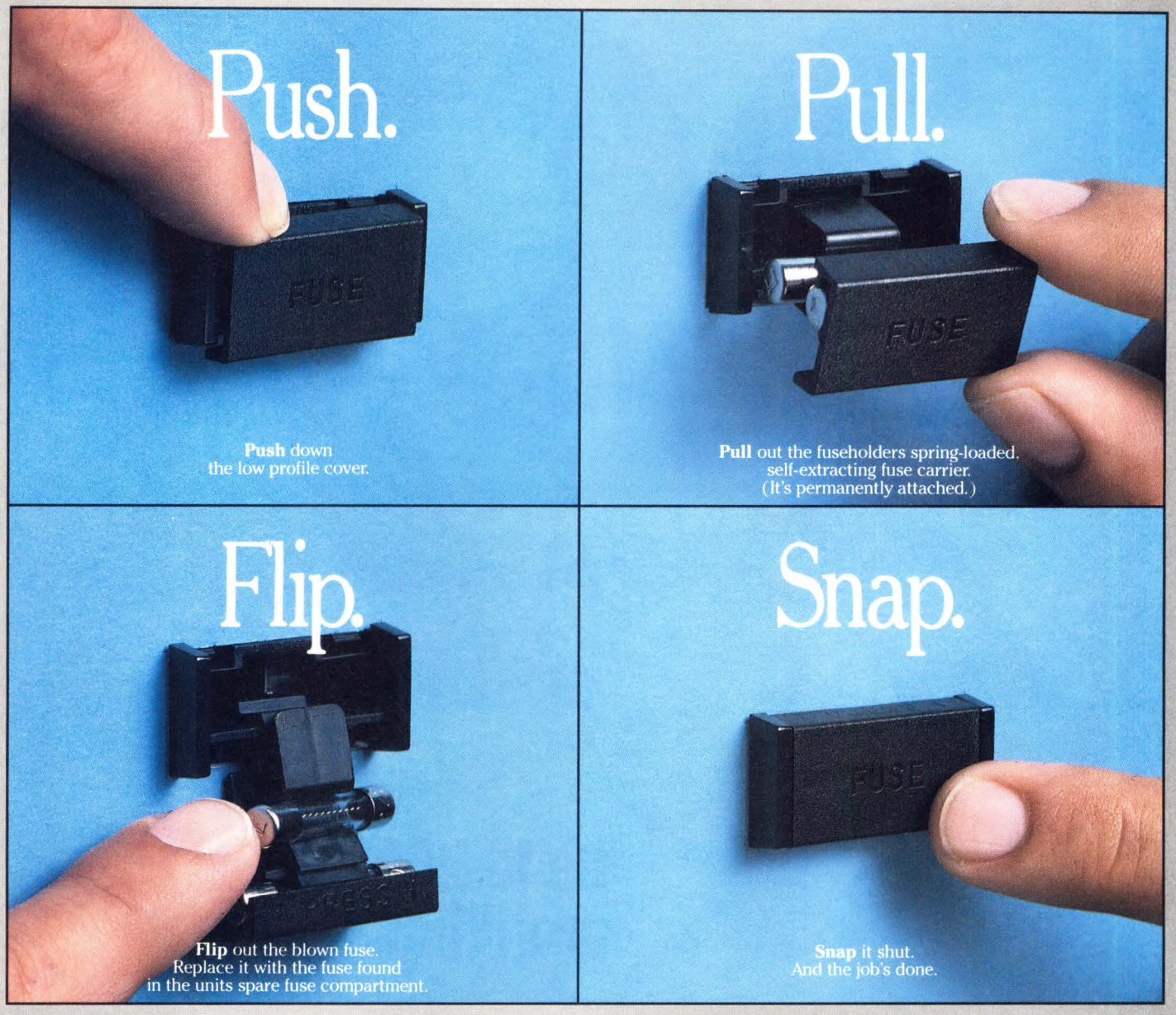
In the two years since their introduction, the 1650A and 1651A logic analyzers and the 16500A logic-analysis system from Hewlett-Packard Co (Colorado Springs, CO, (800) 752-0900) have been extraordinarily successful because of their outstanding price/performance ratio. Now, HP has upgraded the products and is holding the line on most prices. The $7800, 80-channel, 1650B and the 400-channel-max 16500A ($12,600 when equipped with the 16510B logic-analyzer module) now offer 35-MHz state analysis; the earlier versions operated at 25 MHz in state-analysis mode. The timing-analysis speed of the new versions remains 100 MHz. The $3900, 32-channel 1651B, which is used primarily on 8-bit systems, retains its predecessor's 25-MHz state-analysis speed but shares several other improvements with the 1650B and upgraded 16500A, such as the addition of compare-, chart-, and state-waveform display modes. The 16500A now permits 160-channel trigger qualification; it previously could use only 80 channels for triggering. HP is offering methods of adding most of the new and upgraded capabilities to existing 1650As, 1651As, and 16500As and is adding support for the 68030, 80386, AM29000, and NS32532 μPs.—Dan Strassberg

PACKAGE ALLOWS STD-BUS MULTIPROCESSING

Your STD Bus-based system may benefit from the speed advantages of multiprocessing when you partition system control functions into smaller tasks and assign each subtask to a V40-based ZT 8832 I/O control processor (ICP) from Ziatech (San Luis Obispo, CA (805) 541-0488). This board contains 800k bytes of RAM, two serial ports, three parallel ports, an interrupt controller, three 16-bit counter-timers, a 2-stage watchdog timer, optional battery backup, and an SBX multimodule expansion socket with DMA capability. The ICP communicates with a master STD Bus processor through 32k bytes of shared memory, which is physically located on the ICP but mapped into the system's main memory. The board comes with the DOS Multiprocessing Extension (DOS MPX) software support package, which provides an operating system and development environment to support multiple ICPs as DOS devices. The board costs $785.—Margery Conner

PC-BASED DSP CARD SPECS 33M-FLOP PERFORMANCE

A $2495 add-in card for IBM-compatible PCs called the Spirit-30 performs 33M flops. Sonitech International Inc (Wellesley, MA, (617) 235-6824) offers the board, which is based on the Texas Instruments TMS320C30 DSP μP and targets applications such as signal processing, array processing, and graphics. Software support for the board includes a DSP library, a C compiler, a debugger, and a real-time operating system. The board includes 128k bytes of 25-nsec static RAM, which is dual ported between the TMS320C30 and the PC host bus. You can add an additional 512k bytes of static RAM via a daughter card. In addition to the PC host-bus interface, the accelerator board includes six expansion connectors that support external devices such as memory boards, data-acquisition boards, and graphics products.
—Maury Wright



Here's the shock-safe fuseholder family that puts the right replacement fuse at your fingertips. That eliminates the aggravating search for a misplaced fuseholder cap. And that ends the risk of accidental live terminal shock.

That's good news for everyone from design and production engineers, to the consumers of your products.

Because only the Littelfuse family of 2AG, 5x20mm, and 3AG Flip-top™ Shock-safe fuseholders are UL Recognized, CSA Certified and have been designed to meet or exceed IEC Shock-safe Standards 65 and 257.

But best of all, these low profile, panel-mount fuseholders are affordable, easy to install, and are as quick and safe to service as *push, pull, flip and snap.*

For your free product bulletin, samples, pricing and delivery dates, talk to your local Littelfuse representative or distributor.

Littelfuse®
a subsidiary of **Tracor**

800 E. Northwest Highway • Des Plaines, IL 60016
(312) 824-1188

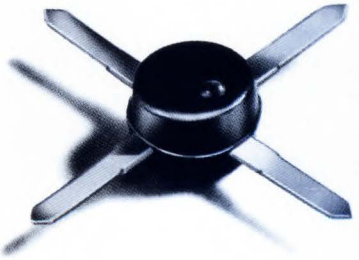
Talk to Littelfuse.

2AG Fuse
.177" x .580"

5x20mm Fuse
.197" x .787"

3AG Fuse
.250" x 1.250"

99¢ from



dc to 2000 MHz amplifier series

SPECIFICATIONS

MODEL	FREQ. MHz	GAIN, dB 100 MHz	1000 MHz	2000 MHz	Min. (note)	•MAX. PWR. dBm	NF dB	PRICE $ Ea.	Qty.
MAR-1	DC-1000	18.5	15.5	—	13.0	0	5.0	0.99	(100)
MAR-2	DC-2000	13	12.5	11	8.5	+3	6.5	1.50	(25)
MAR-3	DC-2000	13	12.5	10.5	8.0	+8□	6.0	1.70	(25)
MAR-4	DC-1000	8.2	8.0	—	7.0	+11	7.0	1.90	(25)
MAR-6	DC-2000	20	16	11	9	0	2.8	1.29	(25)
MAR-7	DC-2000	13.5	12.5	10.5	8.5	+3	5.0	1.90	(25)
MAR-8	DC-1000	33	23	—	19	+10	3.5	2.20	(25)

NOTE: Minimum gain at highest frequency point and over full temperature range.
• 1dB Gain Compression
□ +4dBm 1 to 2 GHz

Unbelievable, until now…tiny monolithic wide-band amplifiers for as low as 99 cents. These rugged 0.085 in.diam.,plastic-packaged units are 50ohm* input/output impedance, unconditionally stable regardless of load*, and easily cascadable. Models in the MAR-series offer up to 33 dB gain, 0 to +11dBm output, noise figure as low as 2.8dB, and up to DC-2000MHz bandwidth.

*MAR-8, Input/Output Impedance is not 50ohms, see data sheet. Stable for source/load impedance VSWR less than 3:1

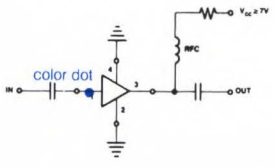
Also, for your design convenience, Mini-Circuits offers chip coupling capacitors at 12 cents each.†

Size (mils)	Tolerance	Temperature Characteristic	Value
80 × 50	5%	NPO	10, 22, 47, 68, 100, 220, 470, 680, 1000 pf
80 × 50	10%	X7R	2200, 4700, 6800, 10,000 pf
120 × 60	10%	X7R	.022, .047, .068, .1μf

† Minimum Order 50 per Value
• Designers kit, kcap-1,50 pieces of each capacitor valve, only $99.95

designers amplifier kit, DAK-2

5 of each model, total 35 amplifiers only $59.95



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

C113-Rev. D

value-packed filters from $11.45

dc to 3GHz

- less than 1dB insertion loss over entire passband
- greater than 40dB stopband rejection
- 5 section, 30dB per octave roll-off
- VSWR less than 1.7 (typ)
- over 100 models, immediate delivery
- meets MIL-STD-202
- rugged hermetically sealed package (0.4 x 0.8 x 0.4 in.)
- BNC, Type N, SMA available

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

LOW PASS Model *LP-	10.7	21.4	30	50	70	100	150	200	300	450	550	600	750	850	1000
Min. Pass Band (MHz) DC to	10.7	22	32	48	60	98	140	190	270	400	520	580	700	780	900
Max, 20dB Stop Frequency (MHz)	19	32	47	70	90	147	210	290	410	580	750	840	1000	1100	1340

Prices (ea.): Qty. (1-9) P $11.45, B $32.95, N $35.95, S $34.95

HIGH PASS Model *HP-		50	100	150	200	250	300	400	500	600	700	800	900	1000
Pass Band (MHz)	start, max.	41	90	133	185	225	290	395	500	600	700	780	910	1000
	end, min.	200	400	600	800	1200	1200	1600	1600	1600	1800	2000	2100	2200
Min. 20dB Stop Frequency (MHz)		26	55	95	116	150	190	290	365	460	520	570	660	720

Prices (ea.): Qty. (1-9) P $14.95, B $36.95, N $39.95, S $38.95

*Prefix P for pins, B for BNC, N for Type N, S for SMA *example:* **PLP-10.7**

C105 REV. E

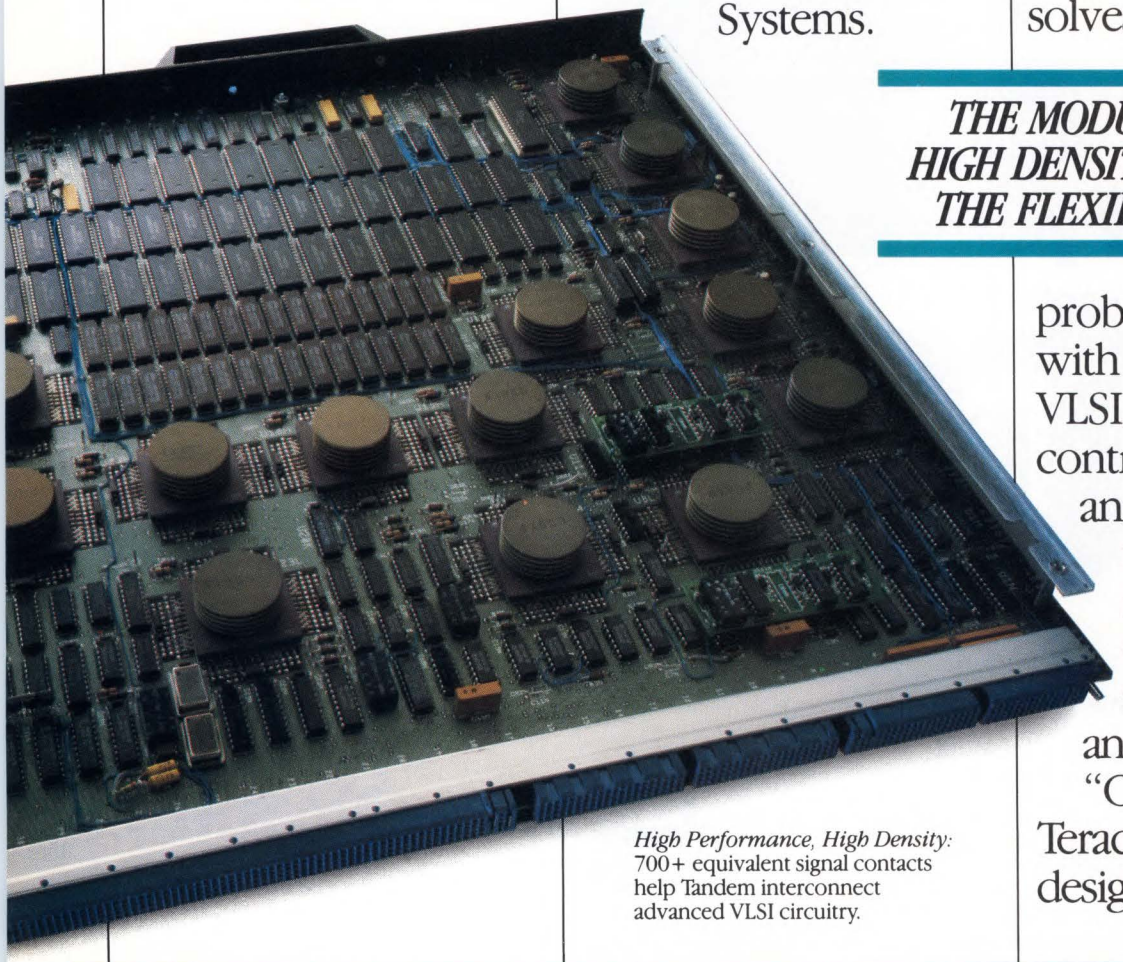
Tandem's powerful NonStop VLX™ computer systems are packed with proprietary technology. Including bi-polar and CMOS gate array logic designed with Tandem's own CAD system. When it came to connecting it all, however, Tandem chose to rely on interconnection specialists: Teradyne Connection Systems.

WE NEEDED CONNECTION TECHNOLOGY AS SOPHISTICATED AS OUR DEVICE TECHNOLOGY.

"We needed connection technology every bit as sophisticated as our VLSI technology," says Larry Laurich, V.P. of the Transaction Systems Division at Tandem. "And Teradyne's High Density Plus™ backplane system solves many of the problems associated with interconnecting VLSI. Everything from controlled impedance and low inductance to preserve signal integrity, to high contact density and solid power and ground returns."

THE MODULAR DESIGN OF HIGH DENSITY PLUS PROVIDES THE FLEXIBILITY WE NEED.

"On top of all that, Teradyne's modular design provides the

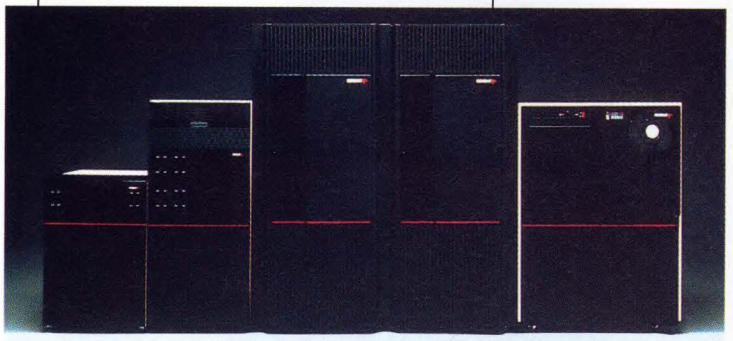


High Performance, High Density: 700+ equivalent signal contacts help Tandem interconnect advanced VLSI circuitry.

TANDEM CONNECTS

flexibility we need to tailor our backplanes to each application."

Now, nearly 1,000 backplane systems

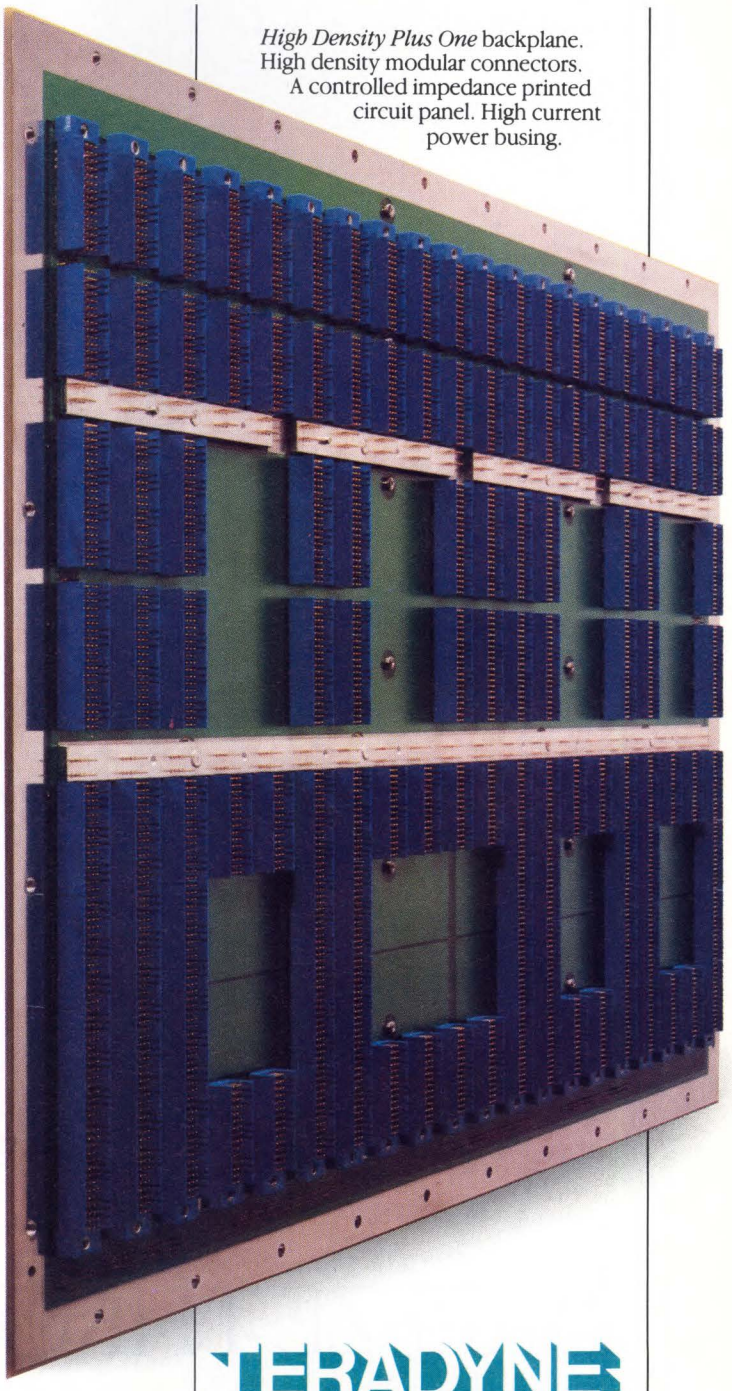


The Tandem NonStop VLX™ system.

later, is Tandem still completely sold on Teradyne's High Density Plus? "We made the right choice with Teradyne. And we look forward to working with Teradyne to meet future interconnection requirements."

If you want uncompromising interconnection performance and reliability, your choice should be Teradyne, too. To find out how we can help interconnect your VLSI designs, call us today at (603) 889-5156, ext. 374. Or just write: Teradyne Connection Systems, 44 Simon St., Nashua, NH 03060.

WE MADE THE RIGHT CHOICE.

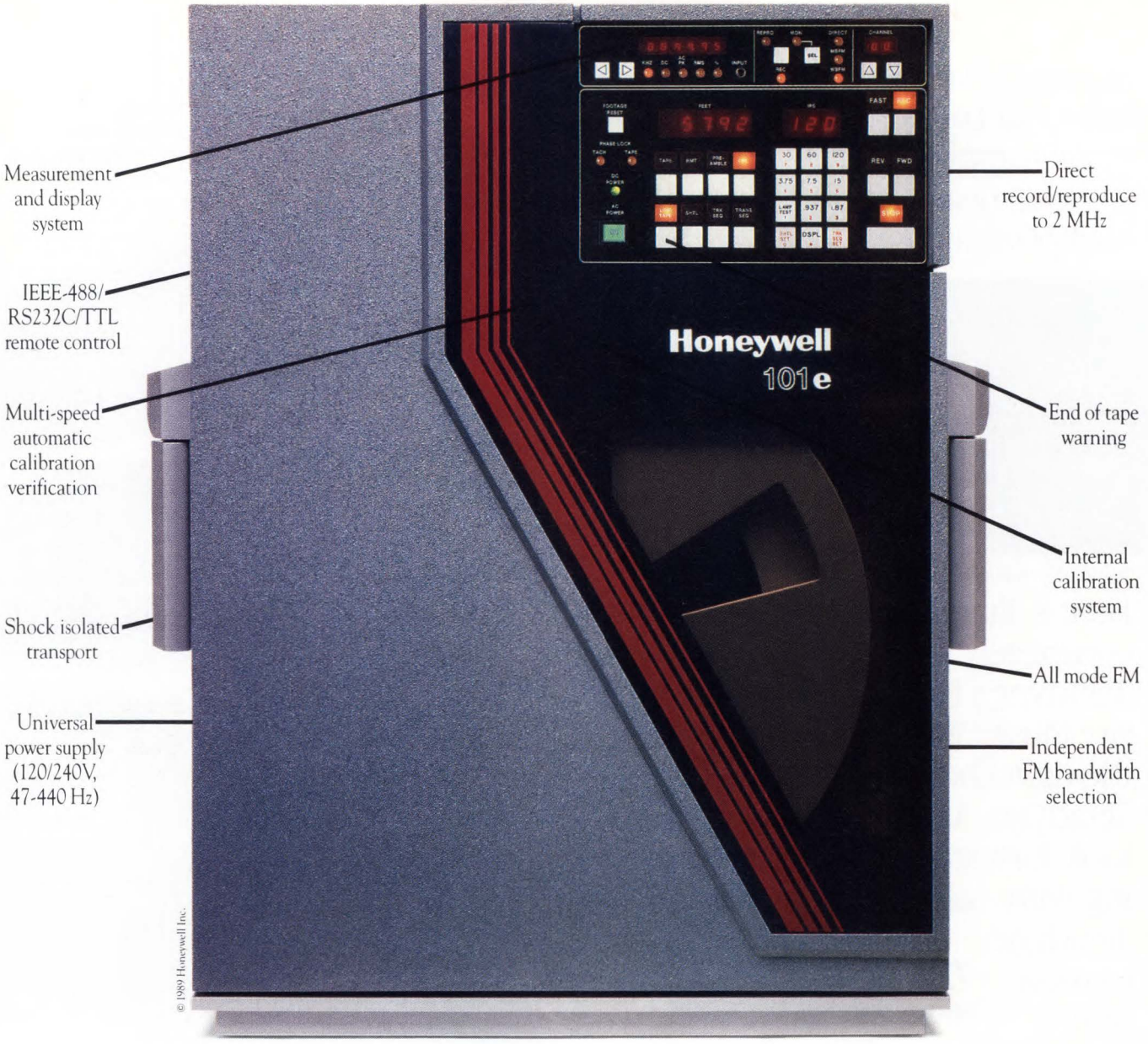


High Density Plus One backplane. High density modular connectors. A controlled impedance printed circuit panel. High current power busing.

TERADYNE

Interconnecting problem...and solution.

WITH TERADYNE



BREEZE THROUGH ANY TEST.

Want to be confident that you'll accurately capture all the data you need in most any kind of test?

Just hook up with the Honeywell Model 101e—an enhanced version of the rugged Model 101 that has proven its reliability in a wide range of applications over many years.

Augmenting the many qualities of its predecessor, the Model 101e features: preamble recording with a "known" signal • microprocessor-controlled auto test for calibration verification at the speed *you* select • total system control via a direct-access panel • gentle tape handling • 5-year/5,000-hour unprorated warranty on the ferrite heads • field services and a worldwide parts network unsurpassed for more than 30 years.

For details, contact Darrell Petersen, Honeywell Inc., Test Instruments Division, Box 5227, Denver, CO 80217-5227. (303) 773-4835.

Honeywell

HELPING YOU CONTROL YOUR WORLD

SIGNALS & NOISE

In design, expect the worst

I really enjoyed your recent series on troubleshooting by Bob Pease (EDN, January 5 through March 2, 1989). Although I'm not much of an analog designer, I have gained experience over the years in digital-system design, development, and debugging. Very few people can appreciate the artistic or "seat-of-the-pants" techniques we apply. I recently supervised somebody in the design of a circuit pack. It took him *a few days* to do the actual logic design. It took him several months (on and off) to prepare that design so that somebody could actually build it (a printed-circuit board). He was amazed. He never learned any of that in school. He still has to get the circuit pack, get parts (a nontrivial task), and *debug* it. Needless to say, it's quite an educational experience for a novice. Even for an experienced designer like me, it's no trivial task.

This fact is probably responsible for the attitude I have developed over the years: I expect the worst and am surprised when anything works at all. I am rarely disappointed. I design with this philosophy in mind. (I detected this philosophy in Bob's articles, too.)

I run into many people with the opposite frame of mind: They expect the best and are surprised when it doesn't work. I have little patience with these people. They are either geniuses (and I have met two or three of those over the years in this trade), or they've never gone through the design and debug process. It is a truly humbling process.

One more comment touched on in Bob's article: People are continually amazed when I tell them that I solve most of my problems at my *desk* with an *ohmmeter*. That fact simply points to where over half the problems have occurred over the years—in interconnections.

John D Loop
Research Engineer
BellSouth Services
Atlanta, GA

Some pc-board cautions

Robert A Pease has been writing an excellent series of articles, as he always does. This series reminds me of the old days when I used to be able to fix things. It's necessary to pass this type of wisdom along to each generation to keep common sense in the field of engineering development.

However, as with all us old timers, he slipped on a few points, to wit: Eyelets are out, especially in multilayer boards. They are still

OK for 2-sided experimental boards and single-sided boards where changes in components are desired. In the latter case, an eyelet socket is used during development, then solder is applied to the finished circuit to hold everything stable. Using an eyelet in a multilayer board will distort the plated barrel, frequently causing separation from the inner layers of copper. This shows up only as a temperature-induced, intermittent problem during testing; it will become a hard failure only when it gets to the customer, or is in the field. Good plating shops can create excellent plated-through holes at a reasonable cost today, so give them a try.

The use of lock washers on printed wiring boards is fraught with danger. We spent a lot of money at one company in trying to find out why our screws kept backing out of their holes, causing the boards to come loose in their mounts. The problem happened during a thermal/vibration test. Running the same boards through the vibration test without the thermal test did not loosen the screws. Thermal cycling was the culprit. It caused the board to expand, and near the glass transition temperature (125°C), it caused the board to deform to relieve the stress. When the assembly cooled, there was no incentive for the material to flow back into the gap; thus, the board was loose. A spring washer, be it a star or a Belview type, will eventually loosen to the point that the desired electrical connection is poor, if not lost altogether. It's better to solder if you can. If a screw is needed, make the pad very large and the washer under the screw wide, in order to spread the load and maximize the joint's life.

Keep the good practical articles coming, and we will all benefit.

Richard T Lamoureux
Hawthorne, CA

From Bob Pease

Dan Sheingold of Analog Devices recently pointed out to me that Analog Devices' *Data Converter Handbook* has a few pages of advice on troubleshooting. I looked there, and he is quite right; there are some good notes and ideas about troubleshooting, about eight pages, including even several items I forgot to include in my 5-part series on the subject. Any serious student of troubleshooting is encouraged to look in that book. There may be a lot of overlap with my writing, but the slightly different viewpoints may prove valuable to the reader.

Robert A Pease
Contributing Editor

Data Converter Choices Holding You Up?

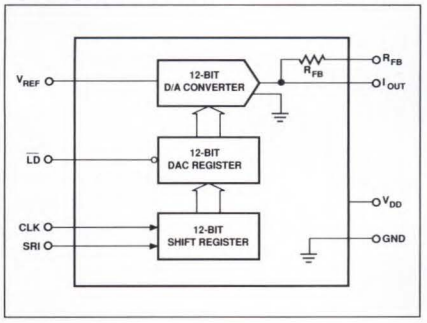
Choosing a data converter from the stampede of products available can really hold you up. PMI's family of conversion products offers solutions that separate us from the herd.

Free up valuable PC board space with PMI's new **DAC-8043 12-bit D/A Converter** in a small 8-pin mini-DIP package. Also, scout PMI's new **DAC-8143 12-bit DAC** with serial daisy-chainable interface serial input/output pins to build board-saving, 3-wire digital interfaces. These are just two of the many exciting new products in PMI's data converter corral.

Save again with PMI's roundup of dual 12-bit D/A converters in 24-pin narrow 0.3" DIP and SO packages. Choose from parallel, single-buffered/double-buffered, and 8-bit bus interfaces.

Additionally, many of these converters feature full four-quadrant multiplying capability such as the **DAC-8408 quad 8-bit D/A converter** ideal for digitally-controlled signal level adjustments.

DAC-8043 Functional Block Diagram



PMI®

Precision Monolithics Inc.
1500 Space Park Drive
Santa Clara, California 95054

PMI offers an extensive line of 8-bit, 10-bit, and 12-bit resolution converters with improved accuracy resulting from our proprietary Si-Cr thin-film resistor technology. Single, dual, and quad DACs with current or voltage output are available. And, our pioneering **ADC-912 12-bit CMOS analog-to-digital converter** gives you the industry's lowest transition noise.

Don't be held up on price, either. PMI offers a wagon train of alternate source converters. When you see our prices, you'll know how the other vendors have been taking you to town.

To receive your complete guide to the PMI data converters, circle the reader service number below. If you can't be held up any longer, call us at **800-843-1515.**

ALTAMONTE SPRINGS: (407) 260-9780, **ATLANTA**: (404) 263-7995, **BOSTON**: (508) 794-0026, **CHICAGO**: (312) 250-0808, **DALLAS**: (214) 690-3495, **DENVER**: (303) 792-9595, **DETROIT**: (313) 930-2051, **LOS ANGELES**: (818) 886-6881, **MILPITAS**: (408) 942-8060, **ORANGE COUNTY**: (714) 637-9602, **PHILADELPHIA**: (215) 953-1070

THE BIGGEST HEAD

The 20 GHz Tek 11800 Series Digital Sampling Oscilloscope: More sampling heads, 30 times more channels, 1 ps repeatability and .01 ps sample interval are way out front in meeting your unique needs.

If you really want to leverage the full power of high-resolution, high-frequency measurements—now and *in the future—the Tek 11800 Series is the only real choice.*

Only the 11800 offers you more than four direct channels of signal acquisition, plus TDR. Here, with the modularity of the 11800, you can expand to 136 *channels—without multiplexing.*

Only the 11800 offers more than a handful of sampling heads. We've introduced six within six

START IN SAMPLING

months—including optical-to-electrical convertors, loop-through and low-noise heads—with even more to follow.

Extensive TDR and the only differential TDR capability in the business. *Other systems give you a single TDR channel. The 11800 lets you do TDR measurements on every channel in your system. And it's the only system to do true* differential *TDR—on up to 68 channels.*

And for the accurate results you need, nothing rivals the 11800's 1 ps measurement repeatability and .01 ps sample interval.

Let us show you other exclusive capabilities of the 11800 Series: its automatic statistics, continuous display updates and powerful waveform processing. Contact your Tek sales engineer, or call toll free: 1-800-426-2200.

CIRCLE NO 47

ASIC design with all the excitement and none of the stress.

A S I C

Oki takes the pressure off with complete ASIC design support.

ASIC design opens a world of exciting possibilities for reducing size, improving system performance and increasing reliability, while lowering costs and power requirements. Make the most of this potential—and eliminate the stress—by working with Oki Semiconductor. Oki's unusually high level of design support will help you avoid the pitfalls and maximize the advantages of working with ASICs.

Complete ASIC design capabilities

Oki offers complete capabilities for channeled gate arrays, sea-of-gates, and standard cells, using advanced CMOS technology. We offer density to usable 40K gates and performance of < 0.46 ns. In addition, we support full custom design in high-voltage CMOS, BiCMOS, and bipolar technologies.

Experienced ASIC team at your service

Whether you're an ASIC design pro or tackling your first project, Oki's team of experienced design engineers is ready to assist you. We understand the pressures you're under. And we'll help you shorten development time, improve testability and manufacturability, and achieve first-time design success. We'll work with you to optimize your circuits or develop special cells. From start to finish, we'll do whatever it takes to help you succeed.

Comprehensive set of design tools

Oki has a full set of powerful mainframe design tools which ensure that your design will work, be efficient to manufacture, and perform reliably: logic, timing and fault simulations, automatic layout, detailed checking of design rules, and automatic test program generation. We support many popular workstations. Our large cell library includes many highly complex macrofunctions.

Flexible interface capabilities

We'll support your own design efforts with training, local field engineers, design kits, manuals, and libraries. Or you can work in our state-of-the-art design centers—independently or with our resident engineers—where we offer 24-hour access to private, secure, fully equipped work areas. And Oki can interface at any input level, from schematics to a simulated net list. In addition, we offer a variety of packaging options, including through-hole and surface mount, and we deliver reliable volume manufacturing.

At Oki, we can't promise an island paradise —but we can give you everything else you need for stress-free ASIC design. To get all the facts, call for our free brochure detailing Oki's ASIC capabilities.

OKI
SEMICONDUCTOR

So. Calif.
(Irvine)
714/752-1843
(Sherman Oaks)
818/990-3394
No. Calif.
(San Jose)
408/244-9666

Boca Raton, FL
407/394-6099
Atlanta, GA
(Norcross)
404/448-7111
Chicago, IL
(Rolling Meadows)
312/870-1400

Boston, MA
(Stoneham)
617/279-0293
Detroit, MI
(Livonia)
313/464-7200
New York, NY
(Poughkeepsie)
914/473-8044

Philadelphia, PA
(Horsham)
215/674-9511
Dallas, TX
(Richardson)
214/690-6868

EDN070689

When it comes to transformers, no one has higher standards.

And no one has more standards, either.

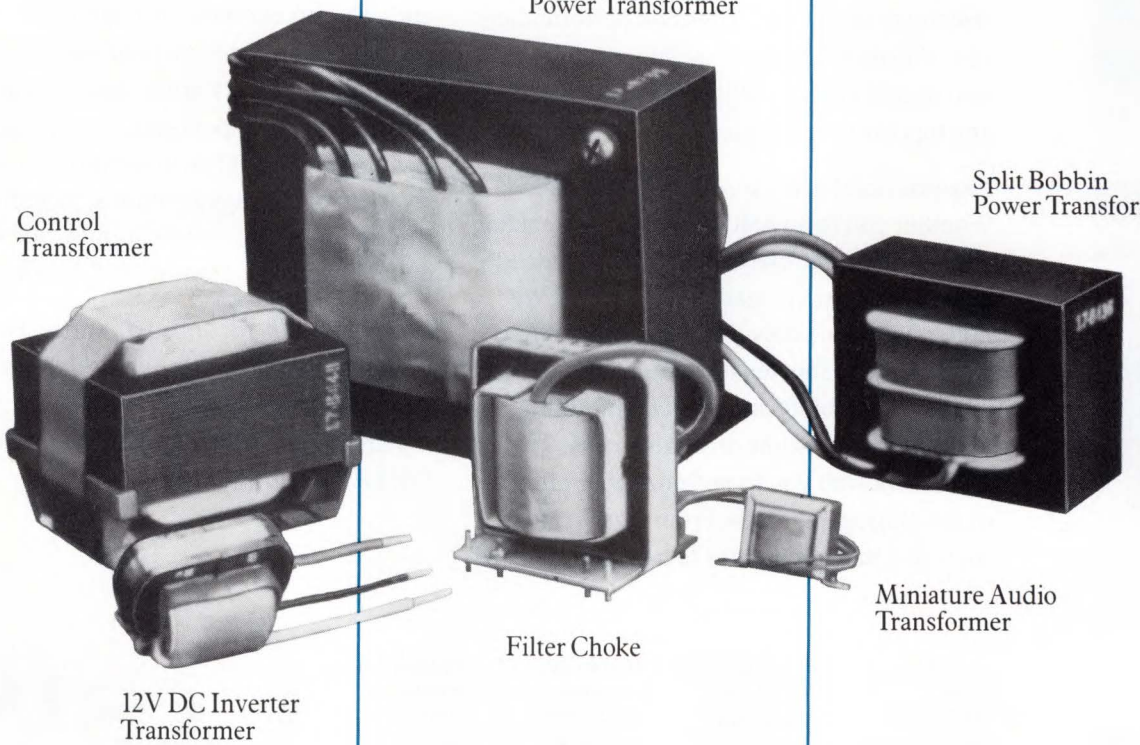
Because at MagneTek Triad, we make thousands of different standard off-the-shelf transformers.

Everything from Split Bobbin Transformers with split bobbin winding and low capacitive coupling that eliminates costly electrostatic shielding yet increases Hi Pot testing up to 2,500 V, to transformers with dual primaries for use in equipment that's being sold in both foreign and domestic markets.

Even miniature audio transistor transformers designed to permit the reversing of primary and secondary windings with virtually no loss in coupling characteristics and low current plug-in printed circuit types with fixed mounting centers that give you increased benefits without the increased cost. And maximum power with optimum equipment miniaturization.

And because we keep a multi-million dollar inventory, every one is available off the shelf from our network of nationwide distributors.

For more information on our full line of standard transformers, call **MagneTek Triad** at (219) 356-7100. Or write us at 1124 E. Franklin Street, Huntington, IN 46750.



MagnéTek transforms transformer problems into simple solutions.

Whether you're replacing one transformer or specifying hundreds, nobody can afford to play around. The challenge is to transform a clutter of hardware choices into one, cost-effective solution. MagnéTek can help simplify the process for you.

First of all, we offer a comprehensive line of transformer products, including our Triad-Utrad®, Better Coil®, Jefferson®, Polygon® and Ohio Transformer® brands. From tiny microcircuit coils to single- and multi-phase Powerformers®, thousands of MagnéTek transformers are standard stock or catalog items at distributors nationwide.

Add to that our application engineering and service capabilities (we've rebuilt industrial and utility transformers up to 200,000 kVA) and you've got a single, easy-to-tap resource for all your transformer needs. Us.

MagneTek

11111 Santa Monica Blvd., Los Angeles, CA 90025

800-541-9997

CALENDAR

National Conference of Standards Laboratories (NCSL '89) Workshop and Symposium, Denver, CO. Ken Armstrong, NCSL, 1800 30th St, Suite 305B, Boulder, CO 80301. (303) 440-3339. July 9 to 13.

Quality Management Conference, Denver, CO. Pam Frye, Quality Management Conference, ACEC, 1015 Fifteenth St NW, Washington, DC 20005. (202) 347-7474. July 12 to 14.

Third International Workshop on Computer-Aided Software Engineering, London, UK. John O Jenkins, Imperial College, School of Management, London, SW7 2PG, UK. 01 589 5111, ext 7112. Elliot J Chikofsky, Index Technology Corp, 1 Main St, Cambridge, MA 02142. (617) 494-8200, ext 1989. July 17 to 21.

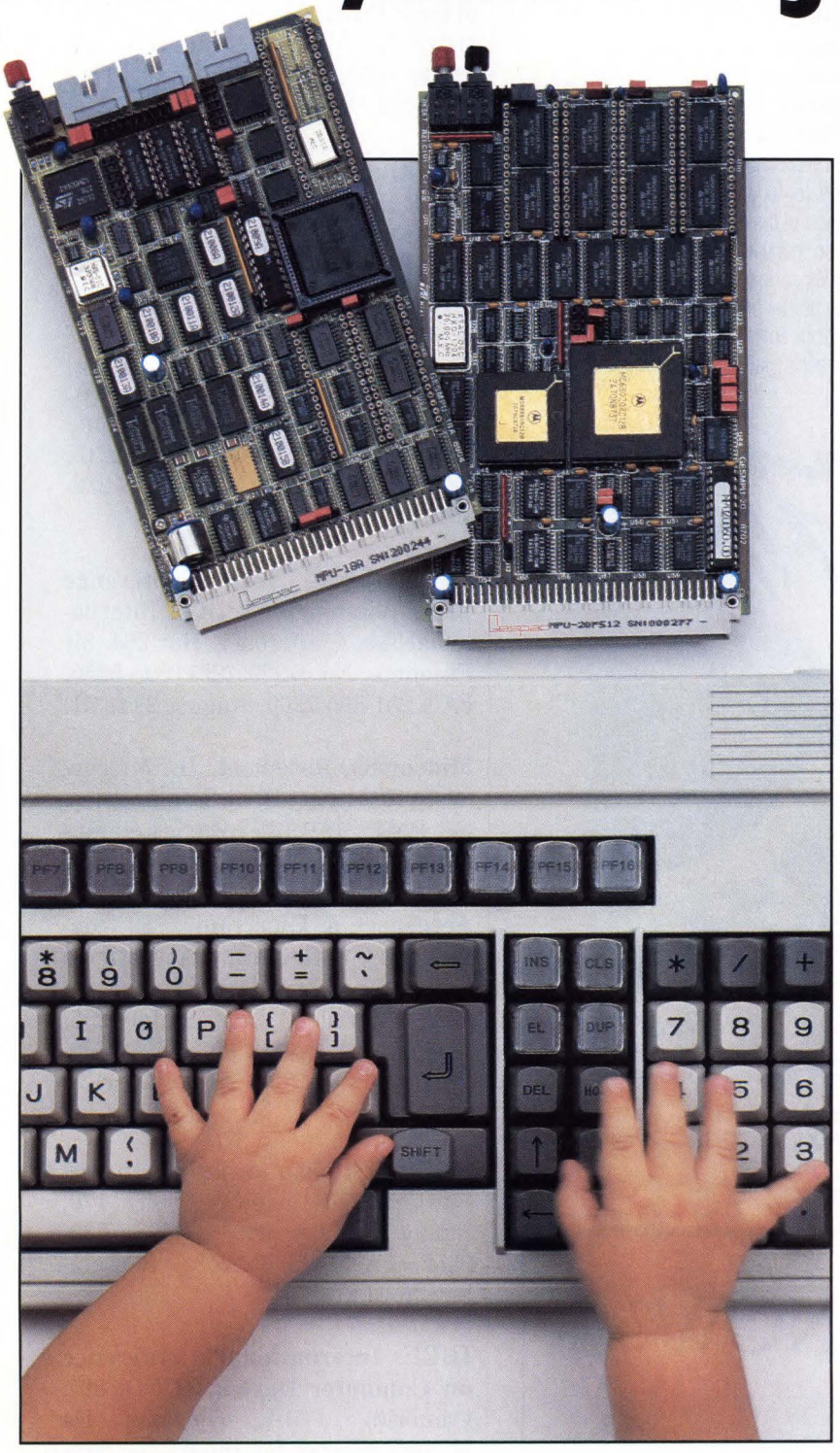
Computer-Aided Software Engineering, Hands-On (short course), Washington, DC. John Valenti, Integrated Computer Systems, 5800 Hannum Ave, Culver City, CA 90231. (800) 421-8166; in Canada, (800) 267-7014. July 18 to 21.

Network Cabling and Wiring Techniques (short course), Washington, DC. John Valenti, Integrated Computer Systems, 5800 Hannum Ave, Culver City, CA 90231. (800) 421-8166; in Canada, (800) 267-7014. July 19 to 21.

SparcIntosh (conference), San Francisco, CA. Corey Green, The Yankee Group, 200 Portland St, Boston, MA 02114. (617) 367-1000. July 25 to 26.

Supercomputers, Hypercubes and High Performance Architectures (short course), Boston, MA. John Valenti, Integrated Computer Systems, 5800 Hannum Ave, Culver City, CA 90231. (800) 421-8166; in Canada, (800) 267-7014. July 25 to 28.

Our PC Based Development Tools Make System Design Child's Play.



Designing embedded microcomputer systems has never been faster or easier. First, open your GESPAC catalog of 200 single Eurocard board level products, then choose the Intel (8088, 8186, 80286) or Motorola (68000, 68020, 68030) CPU board of your choice. Pick any combination of serial, parallel, analog I/O, or other special functions required by your application. Count the boards and select the appropriate backplane, card cage and power supply.

Now the fun part: choose one of four powerful, inexpensive and user friendly PC based cross development software packages. Each of these programs lets you use your PC to write, compile, assemble, link and download programs for your target system. These packages include powerful debug functions, such as symbolic and/or source level debug, and are fully supported with detailed documentation and GESPAC's acclaimed technical support hotline. Download your program into your EPROM programmer and that's it! Never before has so little investment delivered so much system design productivity.

80x86	680x0
GENESCOPE Symbolic assembly and source level debugger. Accepts output of all Intel and Microsoft® Compilers (PL/M86, C, PASCAL)	**PROBE** Window oriented source level C cross debugger. Accepts standard .COF files produced on PC or Workstations.
C_Thru_ROM User friendly, window oriented C source level debugger. Similar to CodeView® . Works with Microsoft® C5.0.	**PC-BRIDGE** Integrated PC software allows development and debug of OS-9® software in C and assembly for embedded systems.

To receive your free catalog and information on our PC based tools.

Call Toll Free 1-800-4-GESPAC or call (602) 962-5559.

Gespac

USA - CANADA
50 West Hoover Ave.
Mesa, Arizona
85210 USA
Tel. (602) 962-5559
Fax. (602) 962-5750

EUROPE
Z.I. des Playes
83500 La Seyne
France
Tel. 94 30 34 34
Fax. 94 87 35 52

INTERNATIONAL
18, Chemin des Aulx
CH-1228 Geneva
Switzerland
Tel. (022) 794 3400
Fax. (022) 794 6477

CIRCLE NO 50

CALENDAR

Basic Integrated Circuit Technology Seminar, Sunnyvale, CA. Integrated Circuit Engineering Corp, 15022 N 75th St, Scottsdale, AZ 85260. (602) 998-9780. FAX 602-948-1925. August 15.

11th Quartz Devices Conference and Exhibition, Kansas City, MO. Electronic Industries Association, 1722 Eye St NW, Washington, DC 20006. (202) 457-4981. August 28 to 31.

Surface Mount '89, San Jose, CA. MG Expositions Group, 1050 Commonwealth Ave, Boston, MA 02215. (800) 223-7126; in MA, (617) 232-3976. August 28 to 31.

International Test Conference 1989, Washington, DC. International Test Conference, Box 264, Mt Freedom, NJ 07970. (201) 895-5260. FAX 201-895-7265. August 29 to 31.

Midcon/89, Rosemont, IL. Midcon/89, 8110 Airport Blvd, Los Angeles, CA 90045. (213) 772-2965. September 12 to 14.

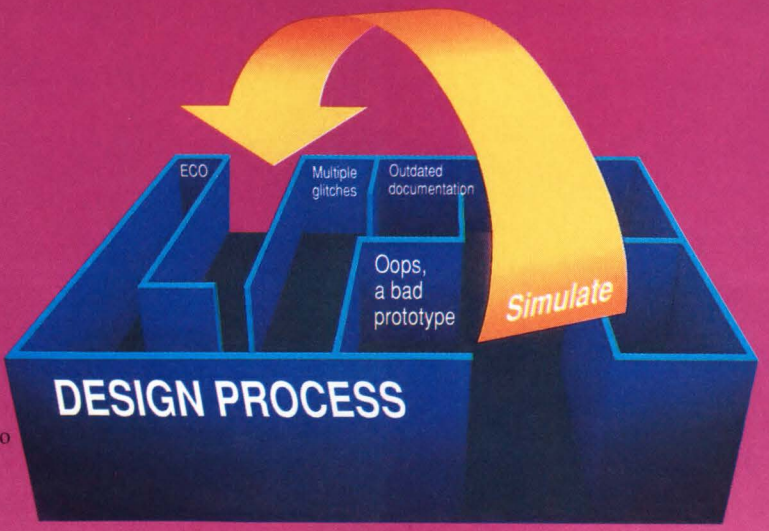
Aerospace & Electronics '89 (conference), Santa Clara, CA. National Computer Graphics Association, 2722 Merrilee Dr, Suite 200, Fairfax, VA 22031. (703) 698-9600. FAX 703-560-2752. September 12 to 15.

DISKCON, San Jose, CA. Julie Sunseri, 710 Lakeway, Suite 170, Sunnyvale, CA 94086. (408) 720-9352. FAX 408-736-2523. September 26 to 27.

IEEE International Conference on Computer Design (ICCD '89), Cambridge, MA. Giovanni De Micheli, Center for Integrated Systems, Room 129, Stanford University, Stanford, CA 94305. (415) 725-3632. October 2 to 4.

OrCAD Answers Your Questions About

Logic Simulation



Q: Why simulate?

A: To save time.

The ideal development cycle is schematic to prototype to production. Simulation dramatically decreases the dreaded loop of schematic to prototype to schematic to prototype to schematic to...

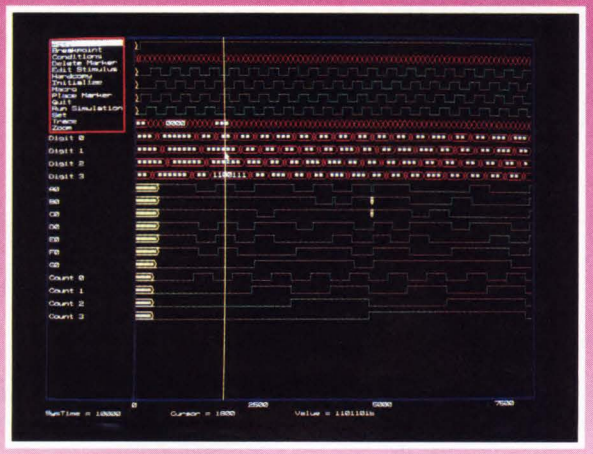
A: To save money.

If your design goes through several iterations, is the documentation still accurate? Suddenly your time and budget are being spent on laying in patches, not producing.

A: To make you look good.

Your schematic is supposed to be the best answer to someone else's design problem. Think of how great you'll look when you present a solution with no glitches, timing violations or other problems.

Verification of your design doesn't have to be handled at the prototype stage (or worse yet, the production stage).



You need a digital simulator that helps you find timing violations and design anomalies before you spend time and money on prototypes. The result: fewer iterations, a shorter design cycle, a more reliable product and getting the project right.

Why OrCAD/VST?

A: OrCAD/VST enables you to interactively verify your design as it develops. A netlist from OrCAD's powerful Schematic Design Tools is all that's required to get started.

A: OrCAD/VST features a user interface similar to OrCAD/SDT III, including easy-to-use menu driven commands and powerful keyboard macros. Your valuable time is spent designing and testing rather than trying to learn a new system.

A: OrCAD/MOD extends OrCAD/VST to PLDs. A set of PLD Simulation Modeling Tools, OrCAD/MOD produces models of PLDs for OrCAD/VST to use in simulation of the larger circuit in which the PLD will operate.

A: OrCAD/VST at only $995 offers unsurpassed performance on a PC. Independent benchmark tests have hailed OrCAD's logic simulator as superior to other simulators costing 20 times as much. Add OrCAD/MOD for only $495 simulate PLDs in a larger design.

- Event driven, 12-state functional simulator
- 16,000+ events/sec. on an 8 MHz AT
- 65,000+ events/sec. on a 20 MHz 386
- Over 14,000 gate capability without additional memory
- Logical analyzer display format (virtual screen displays 50 channels)
- User selectable min. and max. displays
- Includes component models of TTL, ECL, CMOS, Memory devices & utilities for creating custom models
- OrCAD's excellent support: technical staff, 24 hour BBS, 1 year free product updates, and a trained sales and support network.

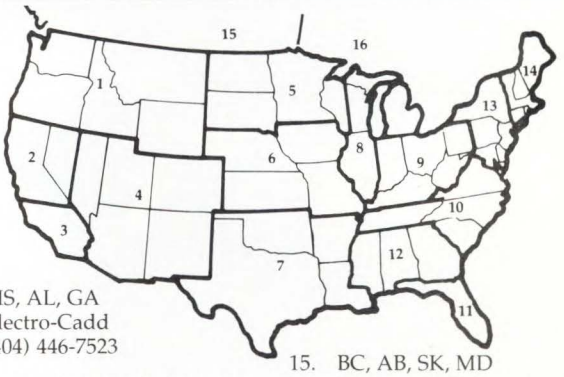
Call or write today for your **FREE** Demo Disk and brochure.

OrCAD®
Systems Corporation

1049 S.W. Baseline Street Suite 500
Hillsboro, Oregon 97123
(503) 640-9488

Contact your local OrCAD representative for further information

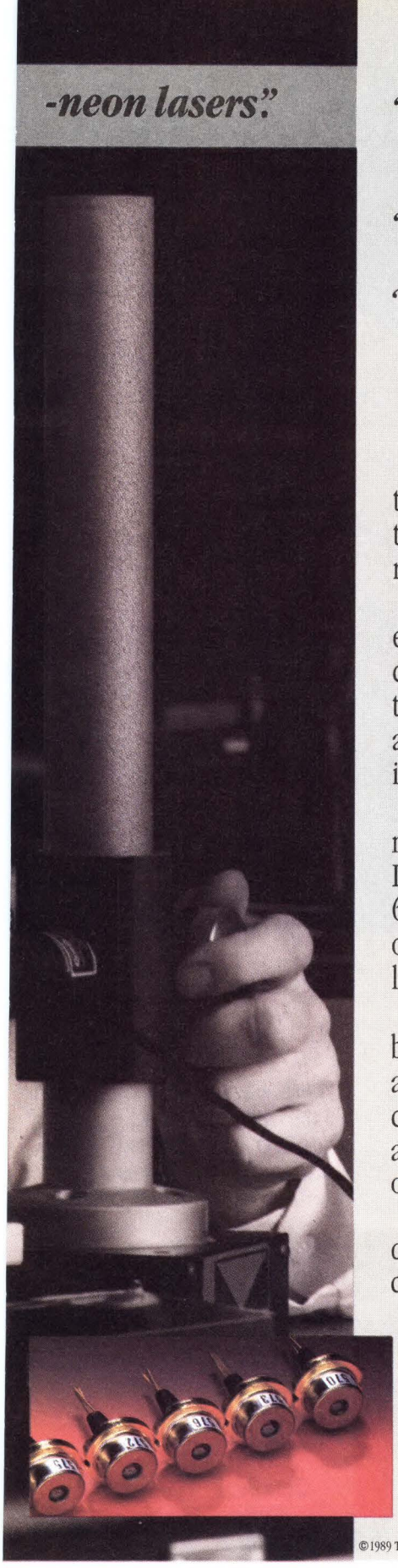
1. WA, OR, MT, ID, AK
   Seltech, Inc.
   (206) 746-7970
2. N. CA, Reno NV
   Elcor Associates Inc.
   (408) 980-8868
3. So. CA
   Advanced Digital Group
   (714) 897-0319
4. Las Vegas NV, UT, AZ, NM, CO
   Tusar Corporation
   (602) 998-3688
5. ND, SD, MN, W. WI
   Comstrand, Inc.
   (612)788-9234
6. NE, KS, IA, MO
   Walker Engineering, Inc.
   (913)888-0089
7. TX, OK, AR, LA
   Abcor, Inc.
   (713)486-9251
8. MI, E. WI, IL
   Mackeller Associates
   (313) 335-4440
9. IN, OH, KY, WV, W. PA
   Frank J. Campisano, Inc.
   (513) 574-7111
10. TN, VA, NC, SC
    Tingen Technical Sales
    (919) 878-4440
11. FL
    High Tech Support
    (813) 920-7564



12. MS, AL, GA
    Electro-Cadd
    (404) 446-7523
13. E. PA, NJ, NY, DE, MD, DC
    Beta Lambda, Inc.
    (201) 446-1100
14. CT, RI, MA, VT, NH, ME
    DGA Associates, Inc.
    (617) 935-3001
15. BC, AB, SK, MD
    Interworld Electronics & Computer Industries, Ltd.
    (604) 984-4171
16. ON, PQ & Maritimes
    Electralert, LTD.
    (416) 475-6730

OR8839

CIRCLE NO 51



-neon lasers."

"But . . ."

"And it's solid state. That means it's a lot more durable, too."

"But . . ."

"Easy to use for pulse drive. Up to 100 MHz."

"But . . . I hear it's not available in quantity."

"Nonsense. Check the back room. We just got our first shipment this morning. Toshiba's in volume production."

Don't believe everything you hear. Toshiba not only developed the first laser diode visible to the human eye but they are the first to manufacture this innovative technology in volume for delivery right now.

The new TOLD9200 visible laser diode requires a simple, less expensive drive circuitry that requires a smaller power supply and can even be battery-powered. Not only does it consume less power than helium-neon or infrared, but unlike infrared, it does not need an additional LED light source. Toshiba's clearly visible light makes it easier to aim, making it easier to scan information.

Providing solid-state reliability, Toshiba's visible laser diode is more resistant to mechanical shock than helium-neon laser tubes. It doesn't require periodic adjustment either. Toshiba, with a shorter 670nm wave length, features a 3mW optical power output and an operating case temperature of up to 50° centigrade. And it has a lifetime of over 100,000 hours.

Toshiba's visible laser diode helps to provide a more efficient, better way to perform a variety of tasks. These include hand-held and fixed bar code readers for use in supermarkets and inventory control. Robotics and production line scanners essential to factory automation. Long distance measurement and equipment and optical cable quality check.

You don't have to wait to discover what Toshiba's visible laser diode can do for you. It's available now. For complete information call 1-800-888-0848 ext. 517 today.

In Touch with Tomorrow

TOSHIBA

TOSHIBA AMERICA ELECTRONIC COMPONENTS, INC.

SPD-88-011

The mighty cascades.

FIFO.

Take a vacation from design headaches that strike when you're connecting asynchronous systems. Forget about addresses. Go to the cascades! Cascade FIFOs to build the buffer size you need. And get:

More performance. Speeds to 16ns and 35MHz. No propagation delay — cascade as many as you need.

More choices. We have 12 devices, available in just about any configuration you could want. From 64 x 4 to 2048 x 9, with many in between.

Less work. Designing with FIFOs is easier and quicker. No addresses to contend with.

Less space. Available in 300-mil DIP (including our 2K x 9 FIFO), PLCC and SOJ packages, so that your buffer logic doesn't consume acres of precious real estate.

Cool, low power. From our cool, 0.8 micron CMOS fab, less power and heat for your system.

Less waiting. Because ours are available, off the shelf, now.

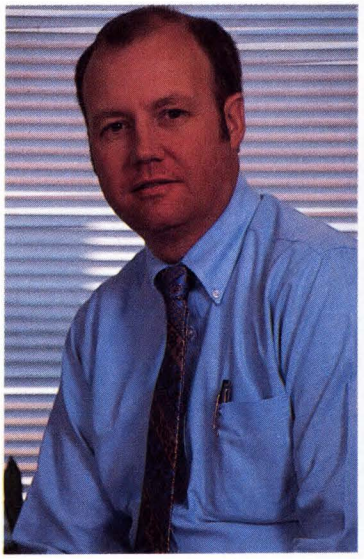
It's all in our data book. Call today. First come, first served.

Data Book Hotline: 1-800-952-6300* Ask for Dept. C4C.

CYPRESS SEMICONDUCTOR

*1-800-387-7599 In Canada. (32)2-672-2220 In Europe. ©1989 Cypress Semiconductor, 3901 North First Street, San Jose, CA 95134 Phone: (408)943-2666, Telex 821032 CYPRESS SNJUD, TWX 910-997-0753.

Reward performance



Recently, *Business Week* published its list of the highest paid executives in the US. Some of the salaries and bonuses are exorbitant and far exceed the amounts that *stockholders* should be paying for the results these executives deliver. For example, Michael Eisner of Walt Disney Co received over $40 million in salary and bonuses in 1988. On *Business Week*'s list of those who gave shareholders the most for their pay, Eisner was second from the bottom. Overall, the average CEO's compensation rose by 17% in 1988, an increase over three times the 5% rise realized by middle managers and professional employees—such as engineers.

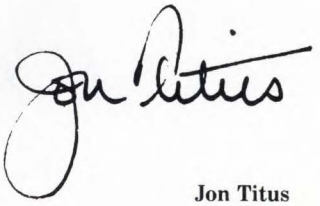
Business Week also shows that many top executives also received bountiful "golden parachutes," which are those payments made to executives who bail out or are kicked out of a company after an acquisition or during a merger. F Ross Johnson, who left RJR Nabisco in February, received a golden-parachute package comprising cash, stock, and benefits valued at over $53 million. There's no doubt that top executives should share in a company's good fortune and that their compensation should be tied to how well—or how poorly—their company does. However, stockholders should be asking themselves how much compensation is excessive.

Employees are now asking if they shouldn't share in some of the wealth, too. Obviously a company's president, chief executive officer, and board of directors chart its direction, but managers, engineers, and production workers actually implement policies and are responsible for the success or failure of the course set at the top. These people, too, should share in the profits of success. The increasing pay disparity at the top, middle, and bottom of the company may soon lead to a backlash.

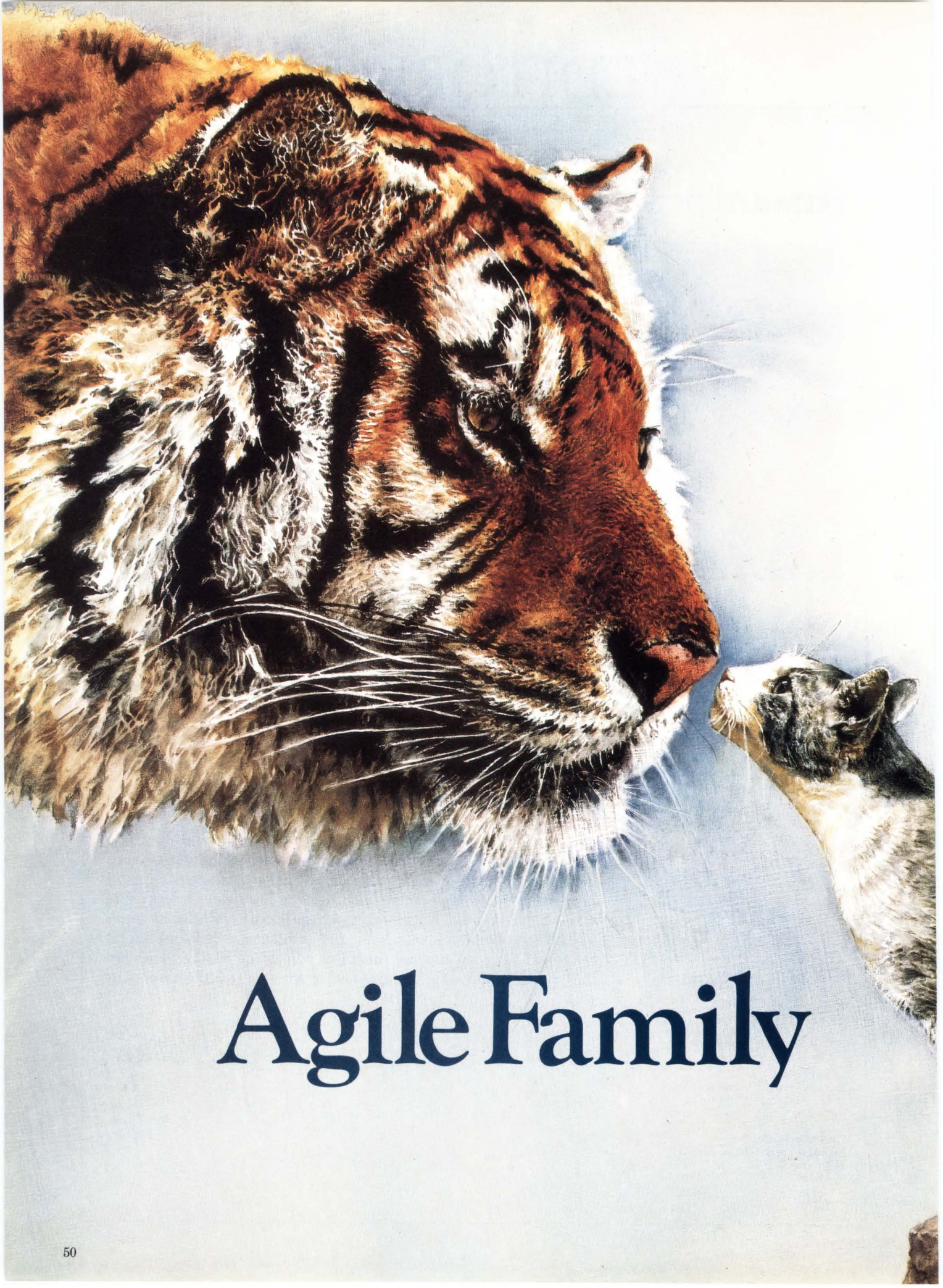
Chief executives may be the ones to decide whether or not to bet the company's future or a new product line or on a new marketing strategy, but the pressure on electronics engineers and their managers can be intense, too. Choosing the wrong microprocessor family or the wrong semiconductor technology can spell disaster for new-product developments and destroy a company's foray into a new product area. Engineers make such critical decisions every day. If stockholders are so willing to compensate those people at the top of the company, we think they should be willing to reward the engineers and other creative people who really make a company what it is.

Jesse H Neal
Editorial Achievement Awards
1987, 1981 (2), 1978 (2),
1977, 1976, 1975

American Society of
Business Press Editors Award
1988, 1983, 1981



Jon Titus
Editor



Agile Family

Hitachi Brings You Fast Memory Devices In All Types and Sizes

Cats—regardless of size—are built for speed. Each member of the cat family demonstrates an extraordinary degree of grace and quickness. Whether it's a tiger running down prey, or a house cat playing with a toy, their common heritage is unmistakable.

Now, Hitachi offers you an unmatched variety of memory devices: fast DRAMs, TTL I/O SRAMs, ECL I/O SRAMs, and EPROMs. Their common heritage. . . high-speed performance combined with Hitachi quality.

The fastest of these advanced memories are built with our Hi-BiCMOS™ process for ECL-like speed with CMOS power consumption. You can take full advantage of today's higher clock-speed microprocessors, so your whole system will run faster.

If you design PC-based systems, our fast memories can eliminate WAIT states and increase your throughput, while maintaining cost-effectiveness. If you design control storage systems, image processing, CAD/CAM equipment, mainframes or simulators, our high-speed memories will keep up with the fast hardware in the rest of your system.

New design possibilities open up with Hitachi's fast memories. Our Hi-BiCMOS 1M DRAMs deliver a fast 45ns access time with low power consumption. Higher speeds available soon. They're available in 1M x 1 and 256K x 4 organizations, and in cost-effective plastic packages.

Hitachi Hi-BiCMOS SRAMs come in a wide variety of densities, with both TTL and ECL I/O. Our TTL SRAMs deliver 12ns access times in 64K densities, and 20ns access times in 256K densities, with x1 and x4 organizations. Hitachi ECL SRAMs are even faster: 64K/10ns and 256K/15ns versions are available.

Hitachi's newest 1M EPROMs are among the fastest available anywhere: 85ns for our 64K x 16 device, and 100ns for our 128K x 8.

When you need really fast memories, there's only one solution: Hitachi's agile family. For more information, call your local Hitachi Sales Representative or Distributor Sales Office today.

Literature Fast Action: For product literature only. CALL TOLL FREE, 1-800-842-9000, Ext. 6809. Ask for literature number M11.

Hitachi America, Ltd.
Semiconductor & I.C. Division
Hitachi Plaza
2000 Sierra Point Pkwy., Brisbane, CA 94005-1819
Telephone 415/589-8300

HITACHI®

Our Standards Set Standards

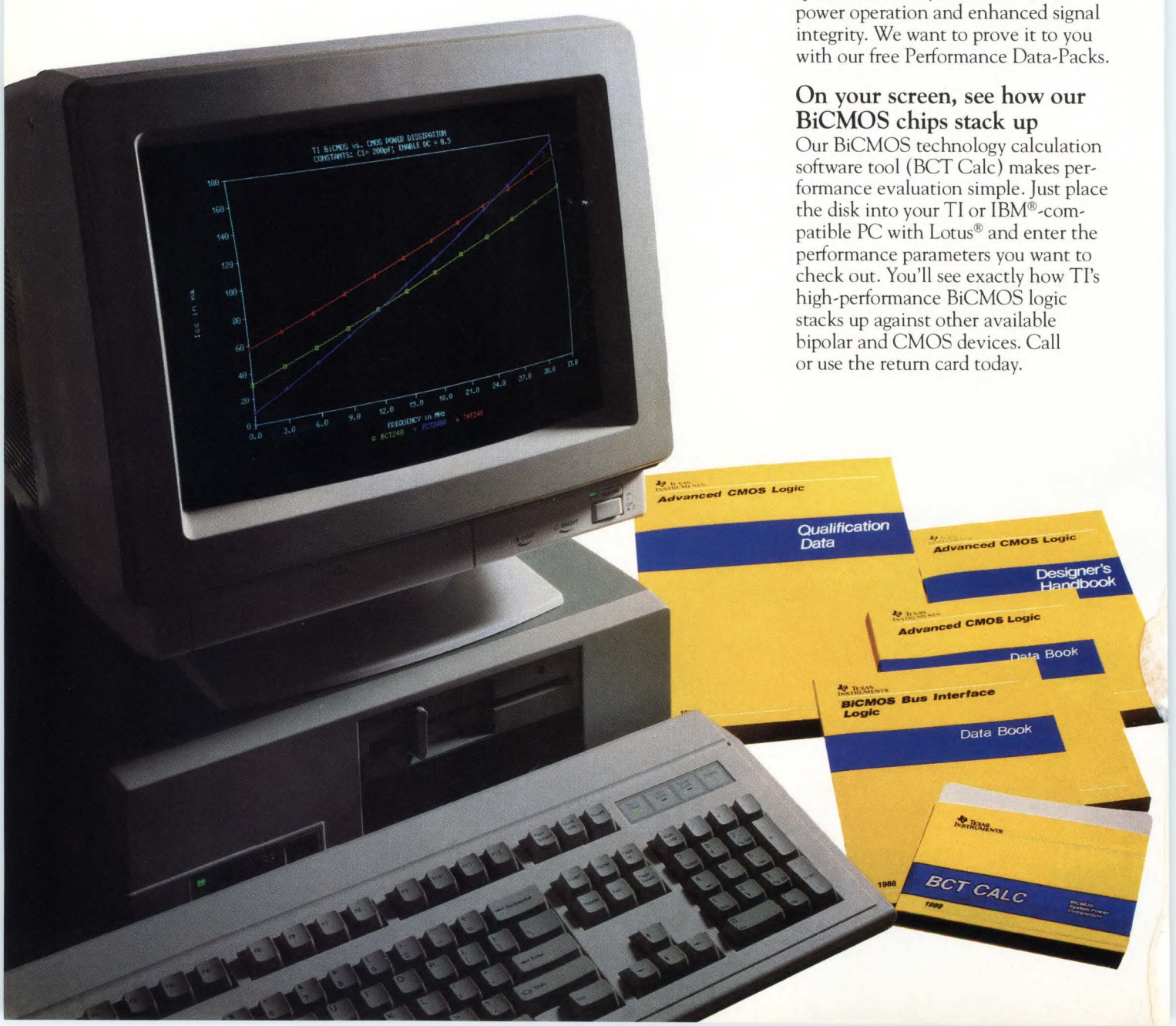
TEXAS INSTRUMENTS REPORTS ON HIGH-PERFORMANCE, IN THE ERA OF MEGACHIP™ TECHNOLOGIES

Speed, power, drive, noise — system logic design can be a long series of trade-offs. To put the odds in your favor, get our *free* BiCMOS and ACL Performance Data-Packs.

Boosting system performance and cutting power consumption is a common design goal, but getting there needn't involve as many trade-offs as it used to. Because now, TI's BiCMOS and Advanced CMOS Logic (ACL) families combine the speed and drive you need with low-power operation and enhanced signal integrity. We want to prove it to you with our free Performance Data-Packs.

On your screen, see how our BiCMOS chips stack up

Our BiCMOS technology calculation software tool (BCT Calc) makes performance evaluation simple. Just place the disk into your TI or IBM®-compatible PC with Lotus® and enter the performance parameters you want to check out. You'll see exactly how TI's high-performance BiCMOS logic stacks up against other available bipolar and CMOS devices. Call or use the return card today.



LOW-POWER LOGIC

TI's BiCMOS logic: Use it to cut power without compromising performance

By combining bipolar and CMOS technologies, TI BiCMOS gives you the best of everything.

Switching speeds are comparable to advanced bipolar devices. You get the 48/64-mA drive current needed for high-capacitive loads and backplanes. This meets the drive requirements of industry-standard buses such as Multibus® and VMEbus™.

Yet TI's BiCMOS family can reduce disabled currents as much as 95% and active currents as much as 50% compared to bipolar equivalents. As a result, total system power savings can be more than 25%.

TTL I/O provide enhanced signal integrity, power-down backplane interface, and backplane-level standards.

There are more than 60 members in the BiCMOS family, including 8-, 9-, and 10-bit latches, buffers, drivers, and transceivers—whatever you need to make your bus-interface design a high-performance reality.

Again, check it all out for yourself with our BiCMOS Performance Data-Pack.

TI's EPIC ACL logic family: Use it to keep performance up and squelch "ground bounce"

This is the first advanced CMOS logic family designed to improve system performance while reducing the simultaneous switching noise or "ground bounce."

Performance is comparable to advanced bipolar devices, supporting frequencies up to 125 MHz and providing the 24-mA output capable of driving 50-ohm transmission lines. It's a perfect match for core and local bus interface.

The family is fabricated using TI's EPIC™ one-micron CMOS process, so power consumption is the lowest of any CMOS family, essentially zero standby.

Noise levels are as much as 50% lower compared to conventional advanced CMOS logic. That's because TI's family has two distinctions going for it: Innovative packaging and a circuit-design technique called OEC™ (Output Edge Control) that smooths the sharp edges of the output waveform which are a major cause of simultaneous switching noise.

A unique pinout arrangement creates a "flow-through" architecture. This simplifies board design and can save up to 32% in board space because you don't need passive components to control noise as you usually do with end-pin devices.

TI's more-than-300-member family includes versions compatible with CMOS and TTL voltage levels. Simulation models are available for both BiCMOS and ACL devices.

Call 1-800-232-3200, Inquiry 3004, for your free Performance Data-Packs

A call or a card will start your BiCMOS Performance Data-Pack on its way to you. Included are our performance calculation software and our BiCMOS data book and product bulletin.

Our ACL family Performance Data-Pack includes:

- TI *ACL Designer's Handbook* that describes methods for handling the technical issues facing advanced-logic design engineers.

- TI *ACL Data Book* that contains detailed specifications and applications information on family members.
- TI *ACL Qualification Data* that provides reliability and characterization data, die photos, and application derating factors.

It's all free and it's all yours by making a call or by completing the return card, today.

TEXAS INSTRUMENTS

MaxChassis.

A New VME Enclosure with Benefits That Really Stack Up:

40 Slot Capacity. Big systems in less space. In its maximum configuration, MaxChassis has *two* 20-slot VME card cages and two power supplies—two complete 20-slot VME systems in a single package only 14″ high, 26″ deep. One takes cards from the front, the other from the rear.

Match your needs exactly. There are 12, 20, and 32-slot systems, too. Tabletop or rack mount. The 12 and 20 slot models are only 20″ deep for VME or Multibus II, but you can get triple height (9U) cages and card depths to 400mm. There are three power supply choices from 400 to 800 Watts.

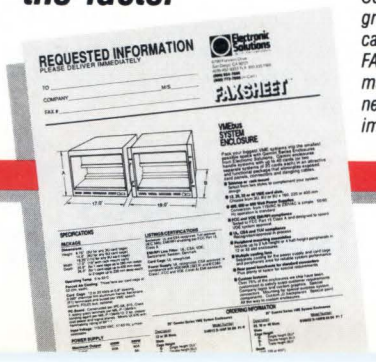
Ready to play. All MaxChassis come fully wired, complete with high-performance VME or Multibus backplanes. Just add your cards.

Disk drive modularity. The 12 and 32-slot models have slide-in peripheral mounting assemblies that hold up to four half-height drives. No brackets to design, no harnessing to make.

RFI tight. There's a front cover panel that holds RFI in (and out) so your system will be looked on approvingly by the FCC. The cover panel covers all those cables and connectors on the card fronts, so everyone else will look on your system approvingly, too.

So before you stack this magazine, phone for our MaxChassis facts right now. And ask for our complete catalog of VME, Multibus and Multibus II system packaging.

We'll FAX you the facts.



Want the latest data in a hurry? Nothing is faster than Electronic Solutions' new "FAX the FACTS" program. If you have a FAX machine, just call our "800" number, give us your FAX number and type of FAX machine, and the information you need from us. We'll FAX it to you immediately.

ZERO **Electronic Solutions**
UNIT OF ZERO CORPORATION

6790 Flanders Drive, San Diego, CA 92121 · (619) 452-9333 Telex II(TWX): 910-335-1169

Call Toll Free: (800)854-7086 In Calif: **(800)772-7086**

CIRCLE NO 86

Power-factor controller boosts power utilization and reduces line noise

To obtain the maximum amount of usable power from the ac lines, your current demand should be sinusoidal and in phase with the line voltage. Power supplies without power-factor correction, however, draw current from the ac lines in pulses, using only about 70% of the power available. The ML4812 power-factor controller eases the design of dc power supplies that exhibit the ideal current demand and allows 99% utilization of available power.

The power-factor controller uses a current multiplier, operating with the line voltage and the error voltage as operands, to force the input-current waveform to match the input-voltage waveform. The device switches input current not required by the load into an external inductor, where the unused power is stored in a magnetic field. The device can tap this field energy as needed to fill in when the input current is insufficient. The switching between energy sources allows the power-factor controller to maintain a steady 1A output at 380V dc.

Because the input current of the power-factor controller is sinusoidal, the power supply is prevented from introducing any noise back into the ac power source. In addition, the current multiplier is immune to the effects of ground noise. Both features aid in meeting strict European electromagnetic-interference limits for conducted emissions.

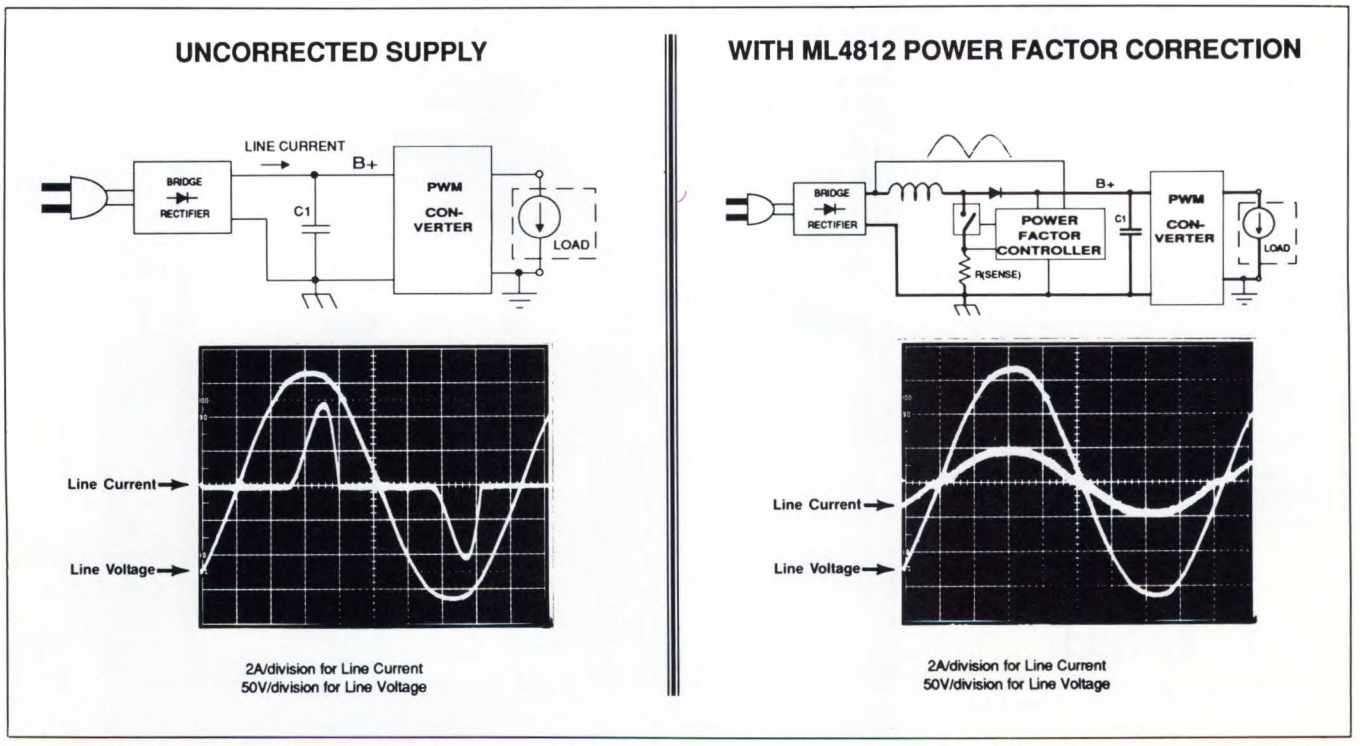
Another feature of the power-factor controller provides overvoltage protection to prevent output runaway when the load is removed. To simplify the start-up, the controller has an undervoltage lockout with 7V hysteresis. Furthermore, the ML4812 provides a 5V dc reference signal accurate to ±0.5% and offers programmable ramp compensation that provides stability when the device's switching circuits exceed 50% duty cycle.

The ML4812 operates over an input-voltage range of 90 to 265V ac. This wide input-voltage range allows you to build a supply that operates at nearly any standard line voltage without needing jumpers or switches to reconfigure the supply. The device comes in either a 16-pin DIP or a 20-pin plastic chip carrier. The price is $5.95 (100).

—Richard A Quinnell

Micro Linear Corp, 2092 Concourse Dr, San Jose, CA 95131. Phone (408) 433-5200.

Circle No 433



Using the ML4812 power-factor controller *in your power-supply design, you can utilize as much as 99% of the available power from your wall socket. The device forces the supply's input current to match the shape and phase of the input voltage.*

ECL SPARC chip set operates at 80 MHz

The B5000 SPARC microprocessor is true to its ECL heritage. The 32-bit device operates with clocks as fast as 80 MHz and boasts a performance rating as high as 65 MIPS. Together with the B5100 floating-point controller, two B5210 register files, and the B5110/5120 floating-point chip set, the B5000 offers mainframe performance that fits into an office environment.

The B5000 chip set uses the standard SPARC binary interface but offers several enhancements, including a 5-stage pipeline, cache sizes to 512k bytes, instruction prefetch with a 4-word queue, and a double-word-wide interface between the processor and cache memory.

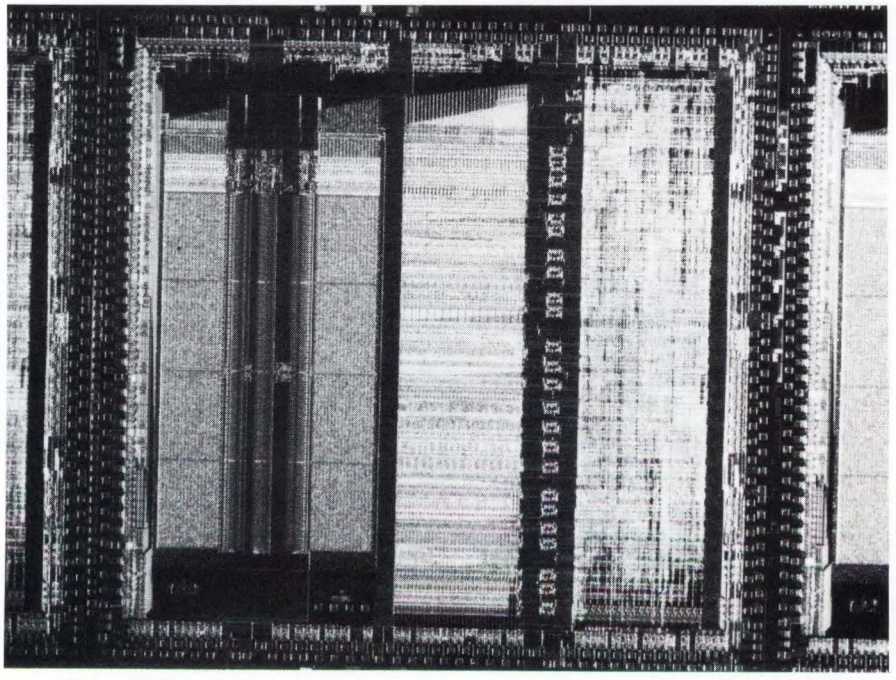
The extra-wide interface path allows the processor to fetch one of the following combinations: instructions and data together, two instructions, or two data words. The processor can fetch a branch instruction and its destination address in the same cycle, for example, or take in double-precision data in a single cycle. This flexible cache interface allows the B5000 to achieve 1.2 cycles per instruction.

The chip set also offers enhanced system integrity when used in a multitasking application. If a parity error is detected during operation, the system enters a synchronous trap. This function allows the operating system an opportunity to determine which process has suffered the error and to abort only that process. The system will continue to operate for the other processes.

The 6-chip set costs $3300/set (100).—***Richard A Quinnell***

Bipolar Integrated Technology Inc, 1050 NW Compton Dr, Beaverton, OR 97006. Phone (503) 629-5490. FAX 503-690-1498.

Circle No 432



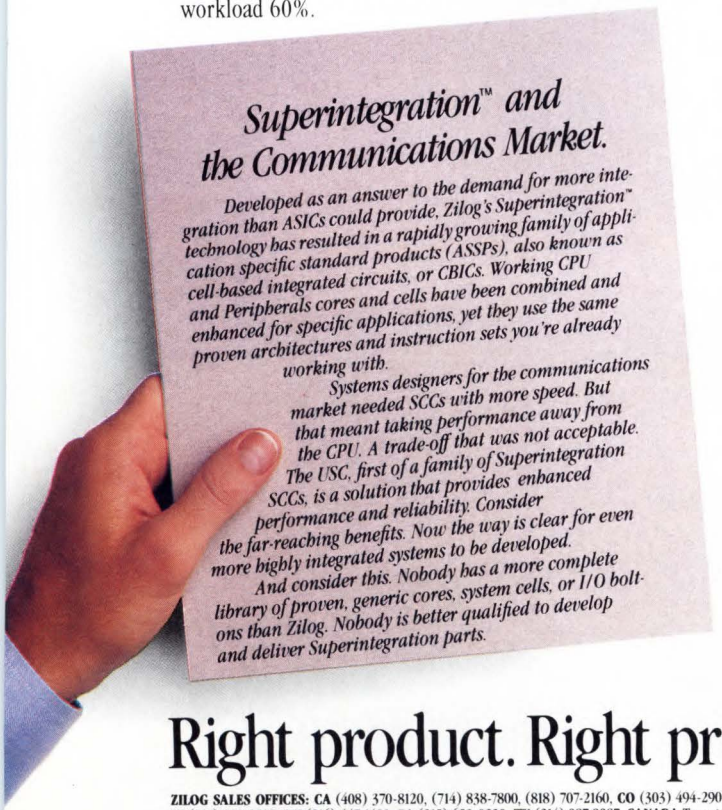
This ECL SPARC microprocessor *operates with clock rates as high as 80 MHz. The processor achieves 1.2 cycles per instruction and processing rates as high as 65 MIPS.*

Z I L O G

USC

The next standard.
A new generation of high performance SCCs.

Zilog's universal serial communication controller, the USC (Z16C30™), provides higher throughput than any general purpose SCC. And it does it while reducing the CPU workload 60%.



More speed.

The USC is four times faster than any general purpose SCC. You get guaranteed data rates of 10 Mbits/sec. But speed is not the only USC advantage.

More CPU power.

The USC requires less attention from the system CPU. That means more power for the system. The USC's lower overhead is due to easy initialization, auto-sequencing word transfers from deep FIFOs, fly-by DMA control, and reduced latency from an efficient, chained interrupt structure.

More flexibility.

You've got two completely independent channels, as well as multi-protocol capability. Because the USC has two BRGs per channel you can transmit and receive at two different bit rates. And the USC's universal bus interface means you can cut the cost of GLU logic and expensive board real estate.

More performance.

CMOS and Superintegration™ bring more CPU power and higher data throughput. The USC carries a 12.5 MByte/sec bus bandwidth punch. Straight DMA connect and 32-byte FIFOs make the USC's systems simple, elegant and fast. Very fast.

More reliability.

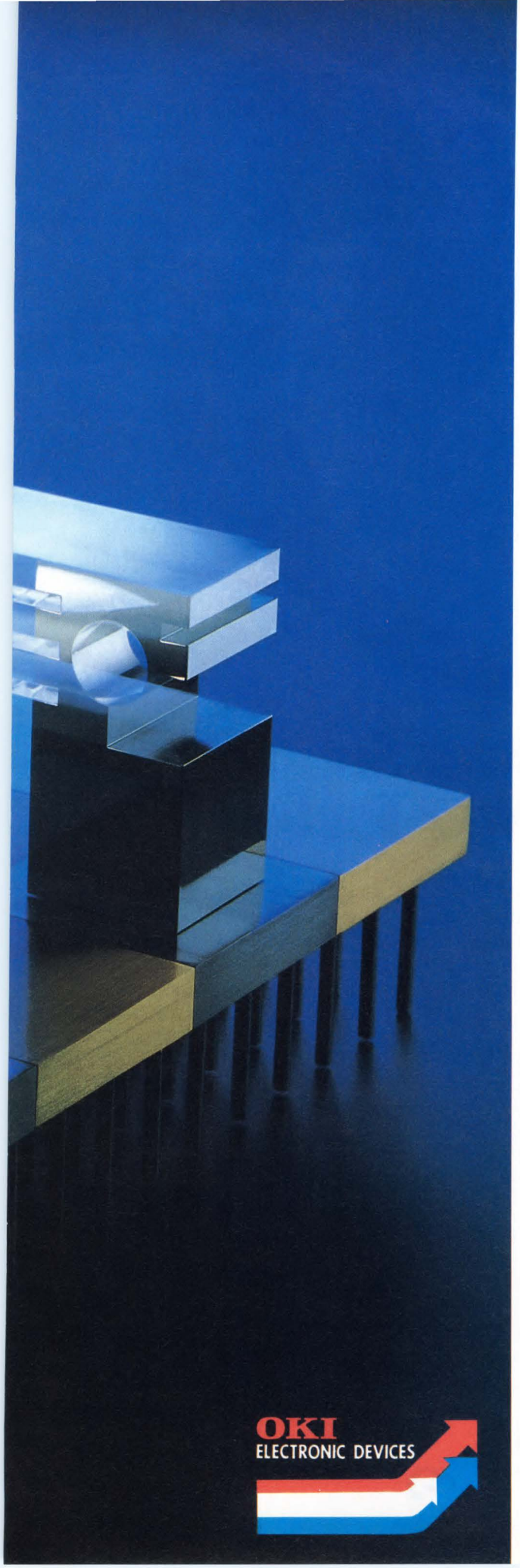
With the USC you get Zilog's proven quality and reliability. Unique built-in testability features allow access to nodes and registers for testing program functionality in real time. Find out more about the USC or any of Zilog's growing family of Superintegration products. Contact your local Zilog sales office or your authorized distributor today. Zilog, Inc., 210 Hacienda Ave., Campbell, CA 95008, (408) 370-8000.

Right product. Right price. Right away. **Zilog**

ZILOG SALES OFFICES: CA (408) 370-8120, (714) 838-7800, (818) 707-2160, **CO** (303) 494-2905, **FL** (813) 585-2533, **GA** (404)923-8500, **IL** (312) 517-8080, **MA** (617) 273-4222, **MN** (612) 831-7611, **NJ** (201) 288-3737, **OH** (216) 447-1480, **PA** (215) 653-0230, **TX** (214) 987-9987, **CANADA** Toronto (416) 673-0634, **ENGLAND** Maidenhead (44) (628) 39200, **W. GERMANY** Munich (49) (89) 612-6046, **JAPAN** Tokyo (81) (3) 587-0528, **HONG KONG** Kowloon (852) (3) 723-8979, **KOREA** (82) (2) 552-5401, **TAIWAN** (886) (2) 741-3125, **SINGAPORE** 65-235 7155, **DISTRIBUTORS: U.S.** Anthem Electric, Bell Indus., Hall-Mark Elec., JAN Devices, Inc., Lionex Corp., Schweber Elec., Western Microtech. **CANADA** Future Elec., SEMAD, **LATIN AMERICA** Argentina—Yel.-(1) 46-2211, Brazil—Digibyte (011) 241-3611, Mexico—Semiconductores Profesionales (5) 536-1312.

CIRCLE NO 57


Make your best move.
An advanced ASIC family, flexibility and comprehensive technical support help you take your ASIC project in the right direction.



OKI SYSTEM TECHNOLOGIES.

With OKI SYSTEM TECHNOLOGIES we bring it all together, an advanced ASIC family, system-oriented flexibility and comprehensive technical support. Oki gives you a full range of solutions. And we do our best from start to finish to ensure they precisely match your design objectives and total system needs.

ASIC technology doesn't stand still

To cover today's wide range of needs, Oki has already introduced 1.2μ standard cells, 1.2μ high-speed gate arrays and 1.5μ Sea-of-Gates gate arrays. Because technology never stops, as the 1990s draw near Oki is readying a next-generation of CMOS ASIC families based on advanced 0.8μ technology.

High-performance fault coverage

The ultimate test of an ASIC design is final in-product operation. Oki is ready to help you pass that one the first time around.

Introducing Automatic Test Generation (ATG), a powerful system for automatic test program generation that achieves more than 95% fault coverage with little loss of space or performance. You'll find ATG running on mainframes at Oki design centers.

Meeting customers more than half way

Total customer satisfaction is at the core of OKI SYSTEM TECHNOLOGIES. That's why we not only maintain large teams of field engineers, but staff and operate design centers across the U.S., Europe, Asia and Japan. Oki provides total project assistance, from ASIC design, testing, packaging and manufacturing to system components and modules. And, of course, technology assistance is available at any development stage.

Oki Electric Industry Co., Ltd.
Electronic Devices Group
Overseas Marketing Group
7-5-25 Nishishinjuku, Shinjuku-ku,
Tokyo 160, Japan
■Tel:3-5386-8100 ■Fax:3-5386-8110
■Telex:J27662 OKIDENED

Oki Electric Europe GmbH
Hellersbergstr. 2, D-4040 Neuss 1,
West Germany
■Tel:2101-15960 ■Fax:2101-103539
■Telex:8517427 OKI D

Oki Semiconductor Group
785 North Mary Avenue, Sunnyvale,
CA 94086, U.S.A.
■Tel:408-720-1900 ■Fax:408-720-1918
■Telex:296687 OKI SUVL

Oki Electronics (Hong Kong) Ltd.
Suite 1801-4, Tower 1
China, Hong Kong City, 33 Canton Road.,
T.S.T. KLN, Hong Kong
■Tel:3-7362336 ■Fax:3-7362395
■Telex:45999 OKI HK HX

OKI
Oki Electric Industry Co., Ltd.
Tokyo, Japan

CIRCLE NO 58

.99

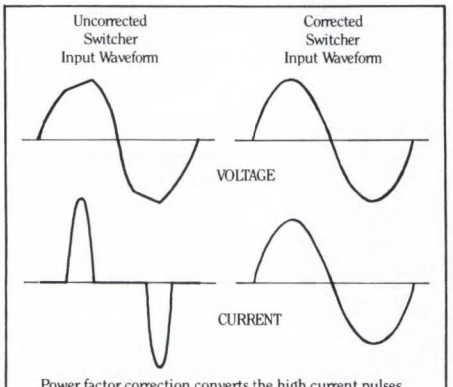
Only Pioneer Power Supplies Deliver .99 Power Factor

That's the typical power factor on Pioneer supplies with the power factor option. That means only Pioneer can give you 1000 watts of DC power from a standard UL 115 VAC, 15 amp wall plug. That's 300 more watts of usable power for system peripherals and accessories.

115/230 volt input strapping is eliminated. You can operate over a continuous range from 90-264 VAC.

You'll also get the added benefits of improved hold-up performance, reduced line harmonics between 10 and 150 kHz, and no AC line frequency sensitivity.

We offer the broadest high power line in the industry. From 250 to 2000 watts, single or multiple output, AC/DC or DC/DC. Standard units are certified to UL, CSA and IEC safety to Class I SELV levels and meet VDE and FCC conducted and radiated EMI specs.



Power factor correction converts the high current pulses characteristically drawn by a switcher into a sinusoidal waveform, in-phase with the line voltage.

With all options you might need, including built-in Single-Channel Battery Backup, Single-Wire Load Sharing, "connectorized" modules for hot-changing, or any of three dozen more.

No matter how tough your specs, chances are excellent that Pioneer has built one like it. Why not? We've shipped over 300,000 high power switchers. Worldwide.

And reliability? All supplies are 100% tested and given a 48-hour, full-power burn-in. That's how we achieve MTBFs up to 250,000 hrs.

So if you'd like to turn up the output power on your next supply by over 30%, call us at **800-233-1745.** In Calif., **800-848-1745.** Or write 1745 Berkeley Street, Santa Monica, CA 90404. FAX: (213) 453-3929. We're the only ones with .99.

Pioneer Magnetics

CIRCLE NO 59

WORLD CLASS

Power, approvals and cooling — Condor's new "PAC" Series enclosed switching power supplies have it all!

Want to save a lot of time on your next project? Just bolt a "PAC" Series power supply in place, plug into its mating amp connector and you're ready to go!

All "PAC" models feature fans for system cooling, and inside the system, they mount to an outside surface and include on/off switches, IEC 380 AC input plugs and air exhausts, all on that surface. Best of all, they automatically switch from 115 to 230VAC!

"PAC" Series features:

- 17 models, 4 power levels — 85 to 185 watts
- Multi-output — up to 5 outputs
- Fully protected— factory-set current limit, built-in OVP and reverse voltage protection
- Full load burn-in and 2-year warranty
- Powerfail signal at 150W and 185W levels
- High peak current disk drive outputs as well as closely regulated 3-terminal outputs
- Extremely versatile output configurations for tough applications
- Isolated outputs can be used for positive or negative sources or in series with other outputs
- Pass vibration and shock per MIL-STD 810D

The entire "PAC" Series is fully approved by CSA, UL, and TUV/VDE, and tested for compliance with VDE 0871 Level B and FCC Class B.

Why not try Condor's "PAC" Series power supplies for yourself? Call us today for a **free** 30-day evaluation unit!

Send for our free catalog!

250 power supplies!
Switchers and linears!
Open frame and enclosed!
Custom capability!

CONDOR INC.
DC POWER SUPPLIES

2311 Statham Parkway, Oxnard, CA 93030
(805) 486-4565 • TWX: 910-333-0681
FAX: (805) 487-8911
CALL TOLL-FREE: 1-800-235-5929 (outside CA)

CIRCLE NO 60

Modern dc power systems overcome component failures and ac outages

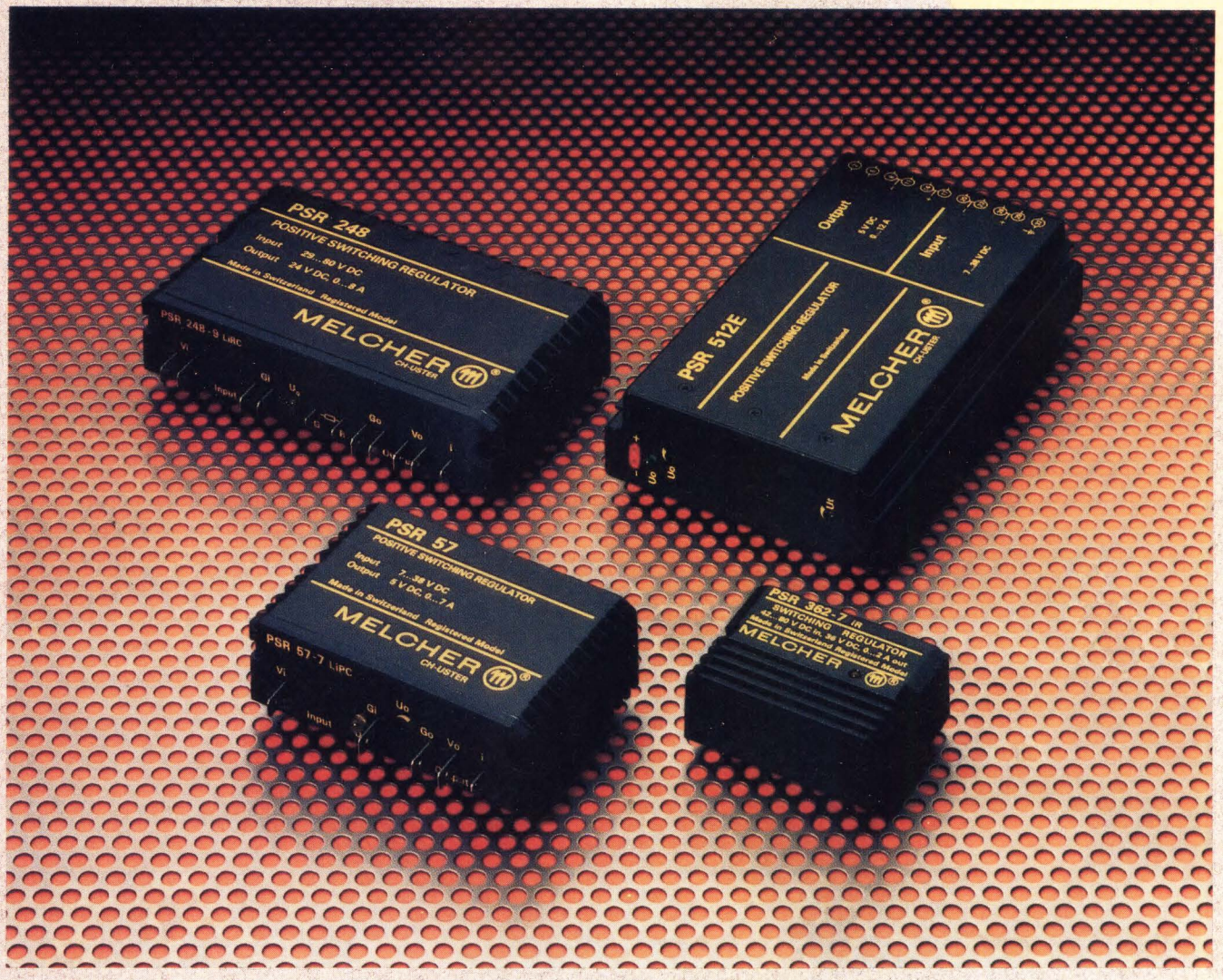
Redundancy and the use of backup power supplies aren't just for military and aerospace applications anymore. Through these techniques, commercial electronic systems—such as computers and automatic test equipment—continue to perform under conditions that would have shut down older products.

Dan Strassberg,
Associate Editor

You might think the electronic industry would have reached a consensus long ago on the most reliable and cost-effective approach to designing power systems for medium- and large-scale electronic products—such as workstations, superminicomputers, automatic test systems, and telecommunications equipment. But there is little agreement among power-system designers, even though their discipline is decades old. In fact, there are nearly as many design philosophies as there are designers and vendors—and the power-supply business is legendary for its large number of vendors.

Nevertheless, an approach that some vendors call "distributed power" is gaining adherents among power-system designers. This scheme uses so-called "bulk" supplies to convert ac-line voltage to a dc voltage that is higher than that required by most of the circuits in the system. In systems that require immunity from short-duration ac power outages, batteries provide backup for the bulk supplies. To convert the bulk voltage to voltage levels the system components can use, dc/dc converters mount on or near the printed-circuit cards that contain the system's analog and digital circuits.

A second technique sometimes called "m-out-of-n redundancy" is often combined with distributed power. In systems that employ this redundant approach, the designers connect the outputs of n power sup-



DC/DC converters that maintain full ratings to 70°C (Melcher Inc)

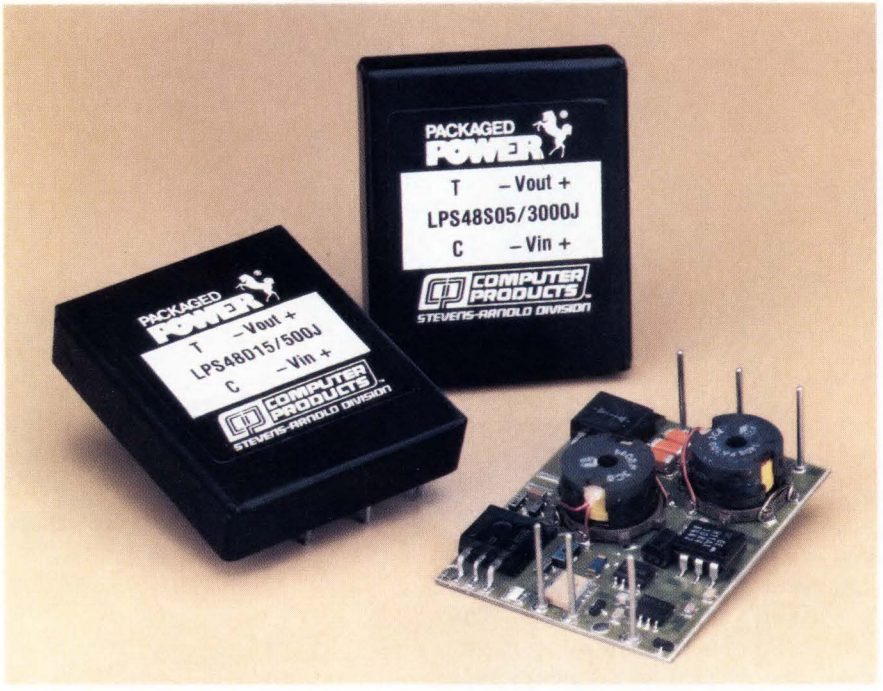
plies in parallel—usually through isolation diodes. The system can derive all of its output power from m of these supplies, where m is smaller than n and is usually equal to n−1. As many as n−m supplies can fail; in that event, the system issues a warning to the operator but continues to function as though nothing had gone wrong.

Life-cycle cost is lowest

Using distributed power and m-out-of-n redundancy won't yield a system with the lowest possible initial cost, smallest size, or highest efficiency. Power-system designers who espouse these approaches argue, however, that the size and efficiency penalties are almost always unimportant, and that over its life, a system that uses these techniques can cost considerably less than a comparable product designed with a classical dc power system. The reason for this lower life-cycle cost, they say, is that in a system that has a classical power architecture, failure of one supply usually puts the entire system "off the air." Down time of large systems can be extremely expensive, particularly in systems involved in a production process (for example, testing systems for pc boards or ICs). In systems used for on-line transaction processing—such as the computers used in stock exchanges and in tracking airline reservations—unscheduled down time incurs costs so large that nothing less than 100% availability is acceptable.

Over its life, a system that uses redundancy can cost much less than a similar product designed with a classical dc power system.

Bear in mind, though, that when you design a power system, it's very easy to wind up with a product that incurs all of the initial cost penalties associated with high reliability, yet is not reliable. You are most likely to run into this sad state of affairs if you adopt the classical attitude toward power-system design; that is, treating the power system as an afterthought, failing to allow enough time to evaluate vendors and products, and assuming that the job is so trivial that it doesn't require the effort of experienced, well-qualified personnel. In particular, if after completing a prototype, you abdicate responsibility for writing purchase specifications and qualifying alternate sources, turning the job over to someone whose only purpose is to find the lowest cost suppliers, you may end up turning a reliable design into an unreliable one.



Wide-input-range, pc-board-mounted, 15W dc/dc converters (Computer Products/ Stevens Arnold)

More than 1000 vendors sell standard and semicustom power supplies in the United States. As you can well imagine, not one of these companies boasts that it provides *un*reliable power supplies. The power-supply business is extremely competitive, so you should be skeptical of any vendor that offers what seems to be a true equivalent to another company's product at a dramatically lower price. Although it isn't universally true, usually you get what you pay for. Investigate the two designs as thoroughly as you can by evaluating the performance of several units and by satisfying yourself that the supplies use truly equivalent components and construction. Look for evidence of vendors cutting corners to meet a price objective.

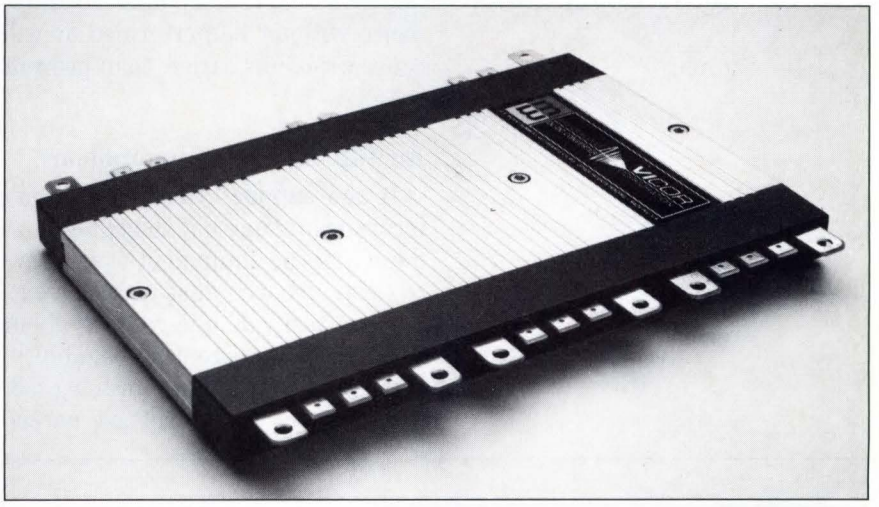
It also pays to be skeptical of MTBF (mean time between failures) figures. Many vendors refuse to publish MTBF estimates, though they will quote figures privately if you apply pressure. Here again, there is no unanimity among vendors. Some highly respected suppliers *do* publish MTBF estimates, but the majority of power-supply companies will tell you that MTBF calculations for non-MIL-spec power supplies have become a joke, and that for a power supply that uses commercial-grade components, you can calculate any MTBF that makes you feel happy. The reason for this situation is that MIL Handbook 217E, which forms the basis of the MTBF calculations, lists MTBF figures only for MIL-qualified components. Commercial power supplies don't use such components, so vendors must make assumptions about the reliability of the commercial components their supplies actually use. These assumptions can form the basis of exaggerated MTBF claims.

The MTBF figures derived from a vendor's warranty claims are also not good predictors of reliability. First of all, most supplies are installed in OEM equipment, so installing replacements for failed power supplies is not the power-supply vendor's responsibility. Replacing supplies may be the respon-

sibility of the system vendor's field-service organization, a third-party field-service organization, or the end user of the equipment. Consequently, most failed power supplies never find their way back to the supply vendor. Second, the power-supply vendor usually has no way of knowing about a failed supply's operating conditions or how much use the unit actually saw. A vendor can make wildly optimistic calculations of what's called "demonstrated MTBF" by assuming that every failed supply is returned, and that, since the original shipment to the system vendor, all of the failed supplies were run at 100% of their ratings 100% of the time.

Electrolytics get a bad rap

In calculating a supply's MTBF, it's easy to assume that any supply that uses wet-electrolyte, aluminum electrolytic capacitors will be less reliable than an equivalent supply that does not use them. These capacitors are the only electronic (as opposed to electromechanical) power-supply components *known* to have a finite life. Indeed, some companies that make dc/dc converters without these capacitors claim the products have MTBFs in the neighborhood of 40 years. Competitors question the assumptions used in the 40-year MTBF calculations, pointing out that even if you validate an MTBF value by running several hundred converters for a year, you can't predict what the failure experience will be over 40 years—nobody has manufactured such a product for more than about five years. Furthermore, the lifetime of a good-quality, wet-electrolyte, aluminum electrolytic capacitor is approximately 20 years, so it's not necessarily correct to assume that failures of such capacitors will represent the dominant failure mode in a supply that uses them.



High-power-density, triple-output dc/dc converter (Vicor Corp)

Another point to consider when you evaluate published MTBF values is whether the supply in question incorporates a fan. In one technique that's sometimes used for calculating the MTBF of fan-cooled supplies, you exclude the fan from the calculation, because including it would produce an unacceptable MTBF estimate. The justification for the exclusion is that you should replace fans after approximately three or four years of continuous operation. If you replace the fans at this interval during scheduled maintenance, they won't fail and won't cause the supplies that use them to fail. Unfortunately, though, in some fan-cooled supplies, the fans are mounted in such a way that you must disassemble the en-

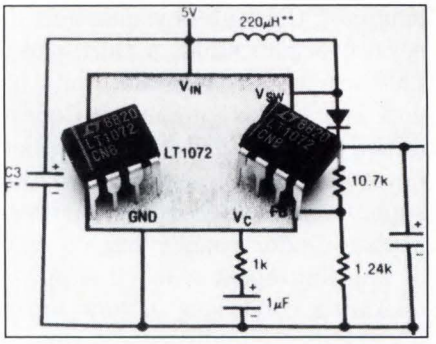
Hermetically sealed, thick-film hybrid dc/dc converter (Lambda Electronics)

In many transaction-processing systems, unscheduled down time incurs costs so large that nothing less than 100% availability is acceptable.

tire supply to extricate the fan. Furthermore, unless you provide for easy fan replacement during your design process, you may have to disassemble your product substantially to get at the power supply. Such situations increase the likelihood that scheduled maintenance will not be performed or will cause problems rather than prevent them.

Air filters can create problems

If the supplies themselves don't incorporate fans, but the equipment does, and the equipment uses filters to keep airborne dust particles out, you can easily delude yourself about the system's potential reliability. Filters can quickly become clogged, and users of equipment are notoriously negligent about cleaning and replacing air filters. If the system continues to operate when the filters are clogged, and the power supplies are therefore forced to operate with significantly less airflow than the MTBF calculations assumed, the supplies will fail prematurely. Because of the possibility of failures associated with restricted airflow, you should consider using airflow sensors as well as fans with built-in rotation-speed sensors. By monitoring the sensor outputs, you can warn a system operator of trouble that will eventually disrupt the system's function.

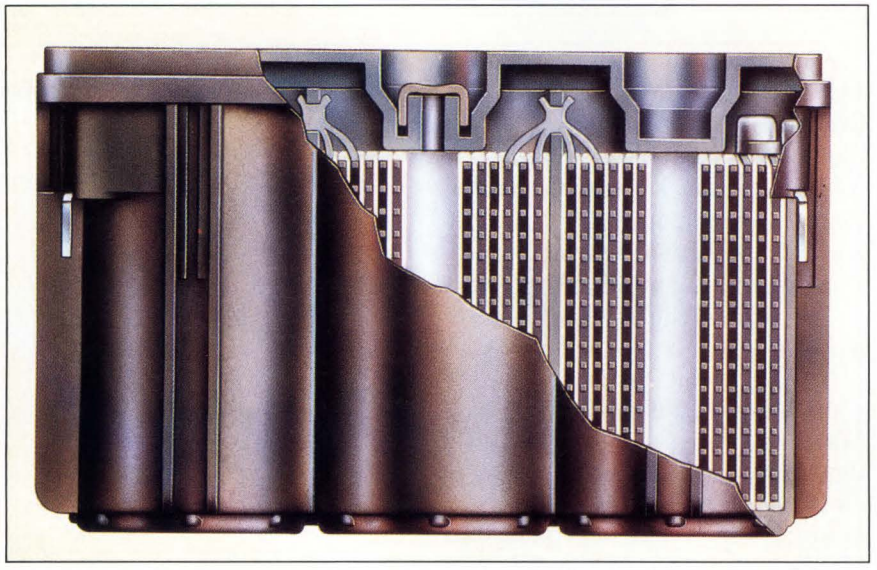


Low-power, switched-capacitor IC dc/dc converters (Linear Technology Corp)

You should also carefully consider the type of fans your system uses. Power-supply vendors generally agree that at the high temperatures frequently encountered in and around power supplies, ball-bearing fans are more reliable than those that use sleeve bearings.

Even if you design with heat sinks instead of fans, you can create reliability problems. The ratings of many pc-board-mounted dc/dc converters are based on case temperature. To operate such devices at more than a small fraction of their published ratings, you must either force a substantial amount of air past them or attach sizable heat sinks. The heat sinks' mass can create mechanical resonances that are stimulated by vibration during shipment. The result can be excessive physical stress on the components within the converter or on the points where the converter is soldered to the pc board on which you mount it. This stress can cause the converters to be "dead on arrival" or to fail prematurely. To prevent such problems, make the heat sink large enough to overhang the converter, and mechanically secure the heat sink to your board in addition to thermally coupling it to the converter.

Calculating MTBF values and keeping power supplies cool aren't the only controversial issues associ-



Internal construction of a sealed lead-acid battery (Gates Energy Products)

ated with power-supply reliability. Different vendors have different philosophies about how to connect the outputs of multiple supplies in parallel, but most vendors agree that, for maximum reliability, you should use isolation diodes as shown in **Fig 1**.

Today, most new system designs employ switching-regulated power supplies. The output stage of a switcher usually consists of a rectifier and a filter. When a rectifier fails, it usually behaves as a short circuit. Therefore, if you directly parallel the outputs of a number of switching supplies without using isolation diodes, and the output rectifier in one of the supplies fails in short-circuit mode, the entire group of supplies ceases to function. Nevertheless, isolation diodes exact a penalty on efficiency because they exhibit a forward voltage drop. The lower the supplies' output voltage, the greater the penalty on overall power-system efficiency. Some vendors incorporate the isolation diodes within their supplies; other vendors leave it to you to provide the diodes and an adequate heat sink for them.

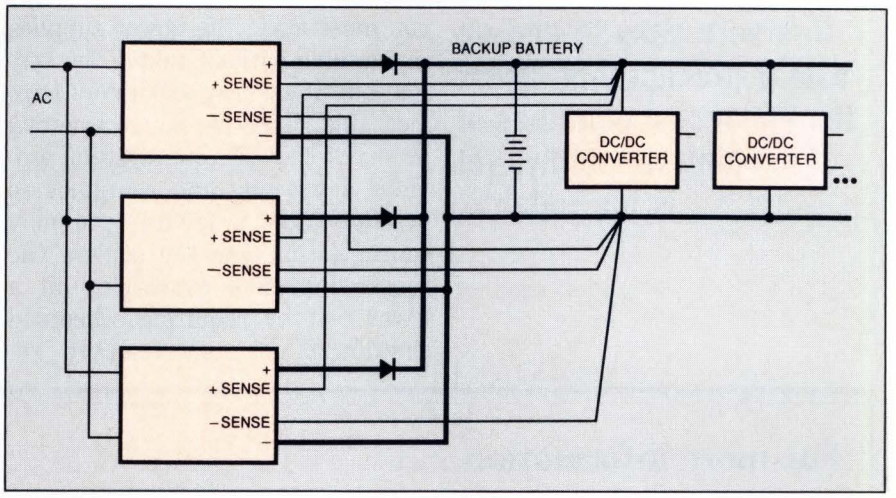


Fig 1—A distributed power system can consist of several redundant bulk supplies whose outputs are paralleled through isolation diodes and optionally backed up by batteries. In this configuration, the bulk supplies' force and sense terminals are connected near the load, which consists of dc/dc converters on or near the boards that contain the system logic.

Where to sense?

Some vendors recommend that you use remote sensing; that is, for a group of supplies that produce a positive voltage, you connect the positive sense terminals of all the paralleled supplies at a single point on the load side of the isolation diodes. Other vendors insist that remote sensing is likely to degrade the dynamic performance of the supplies to an unacceptable degree. These vendors recommend that you use local sensing—connecting each supply's sense terminals directly to its own output—on the supply side of the isolation diodes. Regardless of the sensing scheme, when you parallel supplies you must set each supply's current limit at or below the rated value. When the load is light, the supply with the highest output voltage supplies the entire load until that supply reaches its current limit. At this point, the output voltage drops slightly, and the supply with the next highest output voltage assumes additional loads. This process continues until the load current reaches its maximum value. In a system with one more supply than is required to furnish the maximum load current, the supply with the lowest output voltage never provides any load current unless another supply fails.

In another scheme for paralleling supply outputs, used by Powertec, supplies operate in what the company refers to as "current mode." Each supply has a special terminal that you use when you connect the outputs of multiple supplies. A 1-wire "bus" interconnects this terminal on all supplies whose outputs are paralleled. The supplies need not have identical current ratings. The output voltage of the group equals that of the supply whose output is highest. All supplies in the group share the load in proportion to their ratings. Hence, if you parallel one 20A supply and two 10A units, and if the total load is 20A, the 20A unit will furnish 10A and each of the 10A-rated units will furnish 5A.

If your goal is 100% system availability, you need to decide whether

It is very easy to end up with a product that incurs the initial cost penalties of high reliability, yet is not reliable.

you must make the power supplies replaceable without taking the system out of service. Designers *have* met this objective in commercial products, but if your system provides a warning and continues to function after a failure, you may conclude that you can achieve the required system availability at a lower cost by requiring scheduled shutdowns for power-supply replacement. Either way, you need supplies that individually provide a "power-good" indication. The indication should appear on the supply itself (probably in the form of an LED) to make it easier to spot a defective unit, and it should also appear as a logic level that the system can monitor.

If you plan to replace supplies with the system in service, you'll

For more information . . .

For more information on power supplies, dc/dc converters, batteries, and high-current connectors such as those described in this article, circle the appropriate numbers on the Information Retrieval Service card or use EDN's Express Request service. When you contact any of the following vendors directly, please let them know you read about them in EDN.

Because there are so many vendors of products of the types described in this article, this list is by necessity only a partial one. A good place to start a search for additional vendors is in the advertisements in *EDN Magazine Edition* and *EDN News Edition.*

Abbot Transistor Laboratories
2727 S La Cienega Blvd
Los Angeles, CA 90034
(213) 936-8185
TLX 691398
Circle No 374

ACDC Electronics
401 Jones Rd
Oceanside, CA 92054
(619) 757-1880
TLX 350227
Circle No 375

Acme Electric Corp
20 Water St
Cuba, NY 14727
(716) 968-2400
FAX 716-968-3948
Circle No 376

Acopian
Box 638
Easton, PA 18044
(215) 258-5441
FAX 215-258-2842
Circle No 377

Arnold Magnetics
4000 Via Pescador
Camarillo, CA 93010
(805) 484-4221
TWX 910-343-6468
Circle No 378

Astec USA Ltd
Box 732
Santa Clara, CA 95051
(408) 748-1200
TLX 4745018
Circle No 379

Astrosystems Inc
6 Nevada Dr
Lake Success, NY 11042
(516) 328-1600
Circle No 380

China Storage Battery Co Ltd
1204 7th St
Fort Worth, TX, 76102
(800) 327-2872
in TX, (817) 332-1309
FAX 817-332-6036
Circle No 381

Computer Product Inc/Power Conversion
3785 Spinnaker Ct
Fremont, CA 94538
(415) 657-9837
FAX 415-683-6452
Circle No 382

Computer Products Inc/Stevens-Arnold
7 Elkins St
Boston, MA 02127
(617) 268-1170
FAX 617-268-0300
Circle No 383

Condor Inc
2311 Statham Pkwy
Oxnard, CA 93033
(805) 486-4565
FAX 805-487-8911
Circle No 384

Converter Concepts Inc
Industrial Pkwy
Pardeeville, WI 53954
(608) 429-2144
FAX 608-429-9241
Circle No 385

Datapower Inc
3545 Cadillac Ave
Costa Mesa, CA 92626
(714) 754-4400
FAX 714-754-5407
Circle No 386

Deltron Inc
Box 1369
North Wales, PA 19464
(215) 699-9261
FAX 215-699-2310
Circle No 387

Elcon Products International Co
42700 Lawrence Pl
Fremont, CA 94538
(415) 490 4200
Circle No 388

Electronic Measurements
405 Essex Rd
Neptune, NJ 07753
(201) 922-9300
TLX 132424
Circle No 389

Ericsson Components Inc
403 International Pkwy
Suite 500
Richardson, TX 75081
(214) 480-8300
Circle No 390

Gates Energy Products
Box 861
Gainesville, FL 32602
(904) 462-2570
Circle No 391

Harris Semiconductor
Box 883
Melbourne, FL 32901
(305) 724-7400
TWX 510-959-6259
Circle No 392

Hypertronics Corp
16 Brent Dr
Hudson, MA 01749
(800) 225-9228
in MA, (508) 568-0451
FAX 508-568-0680
Circle No 393

International Power Devices
155 N Beacon St
Brighton, MA 02135
(617) 782-3331
FAX 617-782-7416
Circle No 394

Jeta Power Systems Inc
2675 Junipero
Signal Hill, CA 90806
(213) 427-0095
FAX 213-426-2417
Circle No 395

KEC Electronics Inc
20617 Western Ave
Torrance, CA 90501
(213) 320-3902
FAX 213-618-1197
Circle No 396

Kepco Inc
131-38 Sanford Ave
Flushing, NY 11352
(718) 461-7000
TWX 710-582-2631
Circle No 397

probably want supplies that you can remotely shut down. You can obtain connectors from Elcon and Hypertronics that let you unplug a supply producing currents in excess of 100A—usually only if the output voltage is approximately 5V or less. However, the personnel replacing the supplies will be much less apprehensive if the supply is off when they unplug it. Simply placing a switch in series with the ac line isn't a good way to shut down high-power supplies. A supply with a 1500W output operating at 80% efficiency and an 80% power factor from a 208V 60-Hz source draws an input current greater than 11A. It takes a fairly large switch to interrupt such a current in a 208V circuit repeatedly and reliably. Instead, many switching power supplies al-

Lambda Electronics
515 Broad Hollow Rd
Melville, NY 11747
(800) 526-2324
FAX 516-293-0519
Circle No 398

Linear Technology Corp
1630 McCarthy Blvd
Milpitas, CA 95035
(408) 432-1900
FAX 408-434-0507
Circle No 399

Lite-on Corp
4951 Airport Pkwy, Station 570
Dallas, TX 75248
(214) 239-3565
FAX 214-385-0145
Circle No 400

Melcher Inc
200 Butterfield Dr
Ashland, MA 01721
(508) 881-4715
FAX (508) 879-8669
Circle No 401

NCR Power Systems
3200 Lake Emma Rd
Lake Mary, FL 32746
(800) 327-7612
in FL, (407) 323-9250
TWX 810-856-0290
Circle No 402

Onan Power/Electronics
4801 W 81st St
Minneapolis, MN 55437
(612) 921-5600
FAX 612-921-5627
Circle No 403

Panasonic Industrial Co
Box 1511
Secaucus, NJ 07094
(201) 348-5266
FAX 201-392-4782
Circle No 404

Pioneer Magnetics
1745 Berkeley St
Santa Monica, CA 90404
(213) 829-6751
FAX 213-453-3929
Circle No 405

Power One
740 Calle Plano
Camarillo, CA 93010
(805) 987-8741
FAX 805-388-0476
Circle No 406

Power-sonic Corp
Box 542
Redwood City, CA 94063
(415) 364-5001
FAX 415-366-3662
Circle No 407

Power Systems Inc
45 Griffin Rd S
Bloomfield, CT 06002
(203) 726-1300
Circle No 408

Powertec
20550 Nordhoff St
Chatsworth, CA 91311
(818) 882-0004
FAX 818-998-4225
Circle No 409

Qualidyne Systems Inc
3055 Del Sol Blvd
San Diego, CA 92154
(619) 575-1100
FAX 619-429-1011
Circle No 410

Rantec
9401 Oso Ave
Chatsworth, CA 91311
(818) 885-8223
FAX 818-993-7780
Circle No 411

RO Associates
Box 61419
Sunnyvale, CA 94088
(408) 744-1450
FAX 408-744-1521
Circle No 412

Shindengen America Inc
2649 Townsgate Rd, Suite 200
Westlake Village, CA 91361
(805) 373-1130
FAX (805) 373-3710
Circle No 413

Sonnenschein Batteries Inc
Box 339
Cheshire, CT 06410
(800) 437-9348
in CT, (203) 271-0091
Circle No 414

Sorenson Co
5555 N Elston Ave
Chicago, IL 60630
(312) 775-0843
FAX 312-775-7432
Circle No 415

Switching Power Inc
3601 Veterans Hwy
Ronkonkoma, NY 11779
(516) 981-7231
FAX 516-981-7266
Circle No 416

Todd Products Corp
50 Emjay Blvd
Brentwood, NY 11717
(516) 231-3366
TWX 510-227-4905
Circle No 417

Toko America Inc
1250 Feehanville Dr
Mt Prospect, IL 60056
(312) 297-0070
FAX 312-699-7684
Circle No 418

Tri-mag Inc
8210 W Doe Ave
Visalia, CA 93921
(209) 651-2222
FAX 209-651-0188
Circle No 419

Vicor Corp
23 Frontage Rd
Andover, MA 01810
(508) 470-2900
FAX 508-380-5144
Circle No 420

Westcor Corp
485-100 Alberto Way
Los Gatos, CA 95032
(408) 395-7050
FAX 408-395-1518
Circle No 421

Xentek Inc
760 Shadow Ridge Dr
Vista, CA 92083
(619) 727-0940
FAX 619-727-8926
Circle No 422

Yuasa Battery (America) Inc
Box 3748
Santa Fe Springs, CA 90670
(213) 949-4266
FAX 213-949-5527
Circle No 423

Zenith Components Group
1000 Milwaukee Ave
Glenview, IL 60025
(312) 391-7733
FAX 312-391-7532
Circle No 424

VOTE...

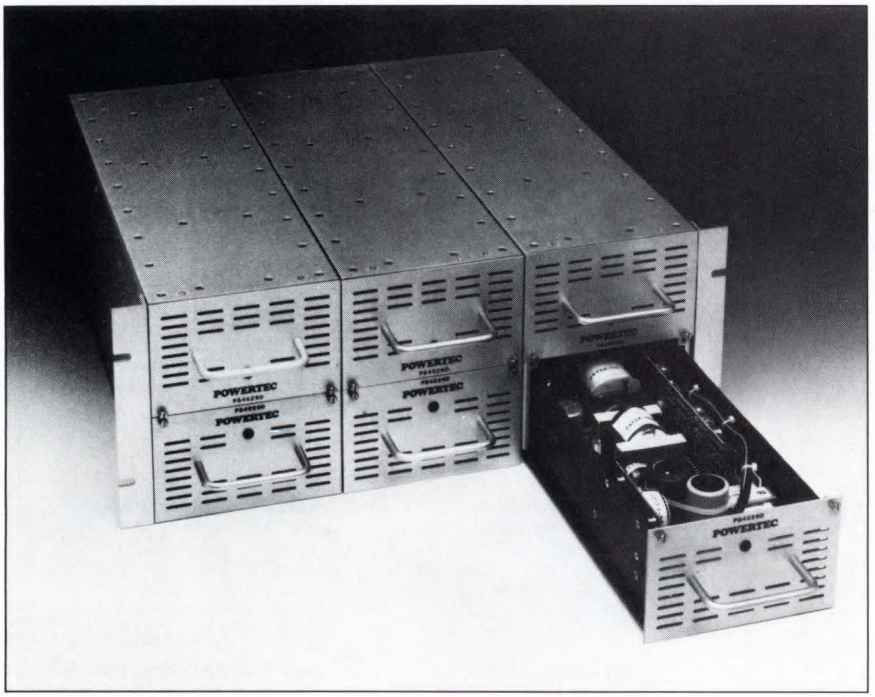
Please also use the Information Retrieval Service card to rate this article (circle one):

High Interest 512
Medium Interest 513
Low Interest 514

MTBF calculations for non-MIL-spec power supplies have become a joke; for a supply that uses commercial components, you can calculate any MTBF value you wish.

low you to use a logic-level signal to force a shutdown.

Supply-output wiring provides one of the few potential savings in the initial cost of distributed power systems. In systems made up of multiple cabinets, particularly those that use ECL, a major cost is the large bus bars and cables required to carry the output from supplies that produce hundreds of amperes at logic-supply voltages. The size of this wiring is determined by the allowable IR drop and the resulting voltage regulation at the point of load, not by the permissible I^2R losses. In a distributed power system, you send a substantially higher voltage, generally 28V or more, to dc/dc converters on or near the pc boards that contain the system logic ICs.



A redundant, fault-tolerant power system with hot plug-in capability (Powertec)

Distribute power to reduce wiring

Suppose that instead of distributing 5.2V at 300A, you distribute 28V. To supply the same power, the current drops to only 55.7A. You might at first think you could decrease the cross-sectional area of the distribution wiring by a factor of $300 \div 55.7 = 5.38$, but in fact, you can decrease the wire size by a much greater factor. First of all, the dc/dc converters can withstand a much wider input-voltage range *as a percentage of their nominal input voltage* than the logic can. Thus, at the expense of a small drop in efficiency, the wire cross-section can drop by a factor significantly larger than $(28 \div 5.2)^2 = 29$. Of course, you have to find a place to put the dc/dc converters. If you put them on the logic boards, either the board size must increase or fewer ICs will fit on each board. As an alternative, you can mount boards containing only dc/dc converters close to the logic. If you have modest power needs and don't need the transformer input-output isolation provided by many dc/dc converters, you can use switched-capacitor dc/dc converters, some of which are ICs packaged in 8-pin DIPs.

You can carry the use of high distribution voltages much further. Distributing a voltage higher than 28V allows still greater savings in wiring cost; indeed, several military airborne systems will use 270V dc, and telecommunications systems have long used a nominal 48V dc. However, choosing 28V dc or a value close to it lets you satisfy two requirements: First, safety agencies such as Underwriters Laboratories place a limit of 30V rms or 42.4V dc, the so-called SELV (safety extra-low voltage) limit, on the value of voltages accessible to service personnel who are not specially trained in high-voltage hazards. Once you've constrained the voltage to a value below 42.4V dc, your next problem is to select *the* value that gives you the widest possible selection of vendors and models. The distribution voltage that satisfies these two requirements is 28V or a value very close to it.

A 28V distribution voltage has further advantages if you need battery backup to ride through brief

GENERAL DYNAMICS LAND SYSTEMS

Generations from now, when today's state-of-the-art fighting systems have taken their place in armament history books, today's Abbott power supplies will still be operating reliably.

Outfitted for Enhanced Reliability, for example, our new 60 Watt triple-output switching DC-DC converter achieves an MTBF rating up to 600,000 hours; more than 68 years. A single-output model is rated even longer.*

Yet this compact package is fully self contained. It meets the tough EMI limits of MIL-STD-461C. And the punishing environmental specs of MIL-STD-810C and MIL-S-901C.

While the BC60 is brand new, this is no "developmental" power supply. Its topology is identical to our field proven BC100 and BC200 models. Its design integrity is verified through rigorous ESS testing.

We're delivering power supplies for projects critical to America's defense, including MILSTAR, the EH101 helicopter, the TOW missile, INEWS and the F/A-18 Hornet.

For a copy of our 1988 Military Power Supply Product Guide, write us at 2721 S. La Cienega Boulevard, Los Angeles, CA 90034. (800) 556-1234 XT9; CA (800) 441-2345 XT9.

*MTBF FIGURES CALCULATED PER MIL-HDBK-217E GROUND.

Our power supply is built to outlast the tank.

Versatile new 60 Watt switcher measures 5 x 4 x 1.5 inches. Provides outputs of 5, 12, 15, 24 or 28 V dc, from inputs of 18 to 36 V dc. Operating temperature from −55°C to +100°C. Overvoltage protection & short circuit protection standard.

abbott

WHEN RELIABILITY IS IMPERATIVE.™

CIRCLE NO 61

To minimize problems related to fans and clogged air filters, try using both airflow sensors and fans with built-in rotation-speed sensors.

ac power outages. Lead-acid batteries are the most convenient type for standby applications (so-called "float-charge" service), because the primary alternative, nickel-cadmium (NiCd) batteries, require more elaborate charging circuits to deliver their potentially long life in float-charge service. On the other hand, in standby applications, you can simply connect lead-acid batteries in parallel with the output of your bulk supplies.

Although the precise value depends on the vendor, the optimum voltage for float charging a single 2V-nominal-voltage, lead-acid cell is approximately 2.35V. Thus the proper voltage for float charging batteries with a 24V nominal output is almost exactly 28V. You shouldn't use loosely regulated supplies to float charge the lead-acid batteries used for backup in electronic equipment. Charging them to a lower voltage significantly diminishes the energy they store; charging them to a higher voltage for an extended period of time can damage them.

Lead-acid batteries for constant-voltage charging (Panasonic Industrial Co)

C/20 is the key

Vendors rate the capacity of lead-acid batteries at a so-called C/20 discharge rate. That is, when fully charged and in good condition, a battery rated at 10 ampere-hours (10 Ahr) delivers at least 10 Ahr if the discharge current is $^{10}/_{20}$A (0.5A). For higher-rate discharges, you reduce the ampere-hour capacity. You can safely draw currents in excess of 50A from a lead-acid battery rated at 10 Ahr, depleting a fully charged battery in approximately three minutes. As the battery supplies energy to a load, its terminal voltage declines. If you use a 24V nominal battery voltage, you'll probably want to shut down the system when the battery voltage drops to approximately 20 or 21V. Below this point, drain on the battery causes a precipitous decline in its output voltage and possible damage to the battery itself. Most 28V-input dc/dc converters are designed with battery-backup applications in mind, so their input range usually includes 20 or 21V.

If a 10-Ahr battery has a nominal voltage of 24V at a current of 50A, it delivers in excess of 1 kW (but only about 50 watt-hours). You would construct such a battery by series connecting a pair of 12V batteries, each consisting internally of six 10-Ahr cells in series. Battery prices depend strongly on the quantity ordered, but in moderate quantity, you'll probably pay about $30 each for 12V 10-Ahr batteries. Provided that the ambient temperature is not excessive, in float-charge service these batteries have a life expectancy of more than five years and require no maintenance. Some vendors say you can expect an 8-year battery life.

The shape of the bulk supply's V-I characteristic is an important consideration in selecting a bulk supply to use with backup batteries. It's very common for supplies to have "foldback" current limiting, as shown in **Fig 2a**. However, this characteristic is inappropriate when a supply is used with backup batteries. When ac power returns after

Normally, when you parallel supplies, the supply with the lowest output voltage never supplies any load current unless another supply fails.

an outage, if the bulk supply can't simultaneously charge the battery *and* power the load because of a foldback characteristic, you'll discover that the reliable power system you paid for isn't reliable after all. Instead, you should use a supply with a current-limiting characteristic like that shown in **Fig 2b.**

New peripherals ease shutdowns

If an ac power outage lasts so long that the system can't ride it through, the system's most important function during the outage is to save its status so that it can "return to the air" gracefully when power returns. A few years ago, systems that could benefit from high-reliability power subsystems usually used ac-powered, mass-storage peripherals (for example, hard disks and tape drives). Many systems still use such peripherals, but if the peripherals are to operate during an ac outage, an ac-in/ac-out uninterruptable power supply (UPS) must provide their power. Nowadays, however, large-capacity hard-disk drives are normally dc powered, so in a system that uses distributed power with battery backup, the disk drives can operate during an ac outage. Therefore, you won't have a big problem storing an image of several megabytes of dynamic RAM on the system's hard disk when ac power is off.

As mentioned earlier, redundancy and the use of both bulk supplies and dc/dc converters don't result in a power system with the lowest possible initial cost. Furthermore, the costs of properly designing a cooling system and system packaging for service accessibility further increase the initial cost of providing a reliable power system. Therefore, although power-supply vendors often quote prices below $0.50/W for switching supplies, your *installed* cost for a distributed power system that employs redundancy will almost certainly exceed

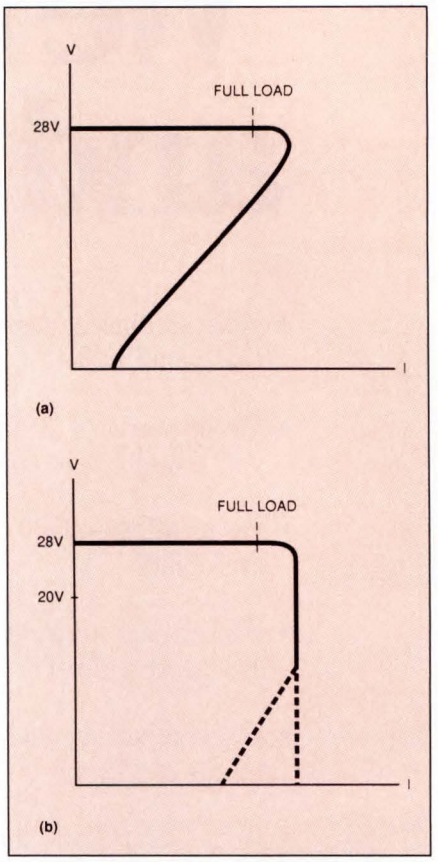
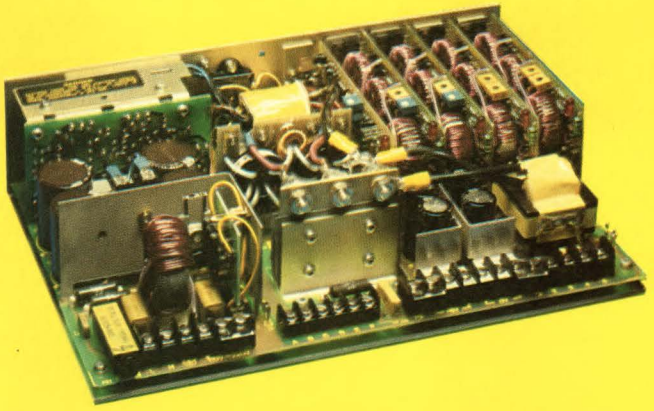


Fig 2—A foldback output characteristic (a) doesn't work when your power supply must supply a load while simultaneously recharging backup batteries. A supply output that current limits, at least at voltages higher than that at which the system shuts down because of low battery voltage **(b)**, is required so that the system will function when ac line voltage returns.

$1/W, and may easily be several times that figure. Nevertheless, in an era when field-service costs often run to hundreds of dollars per hour (if you include travel-related costs), and your customers' costs for a down system may represent thousands of dollars per hour, the added initial costs of providing a reliable power system seem small indeed. If you do the design job correctly, you can regard the initial cost as an investment that will produce an excellent return over the life of your product. EDN

Article Interest Quotient
(Circle One)
High 512 Medium 513 Low 514

The latest Advance



New Powerflex 350-watt 5-output switching power supply

Go ahead. Design your microprocessor based equipment any way you want, and don't worry about the power supply. Whatever voltages you require, from 2V to 50V in either polarity, the Powerflex 350 switching power supply can provide them.

Because it's modular, we can easily configure the P350 for up to five outputs in standard or special voltages. And if your design changes, you can easily change outputs without changing your physical dimensions.

Just 2.9″ x 7.5″ x 11.8″, this high efficiency (75% at full load) 350-watt power supply takes both 110V and 220V inputs. Overvoltage and overcurrent protection on outputs is standard, along with margin testing (4.750V — 5.250V) on the main +5V 50A output. An optional signals board provides TTL compatibility.

The magnetic amplifier and soft switching technique assure high reliability and enable regulated auxiliary outputs to function without any minimum load on the main +5V output. Filtering is to VDE 0871, Curve A. The P350 is UL listed, CSA certified and meets other VDE, EC and FCC requirements.

Compare the calculated MTBF of over 52,000 hours with other power supplies in its class. There's no compromise on quality when you build around the P350 from Advance.

Contact your Advance Power Supplies representative for complete data on the P350 and other open and closed frame units from 25 to 1000 watts. Or call 1-216-349-0755 for more information.

Advance Power Supplies
32111 Aurora Road
Solon, OH 44139

ADVANCE POWER SUPPLIES

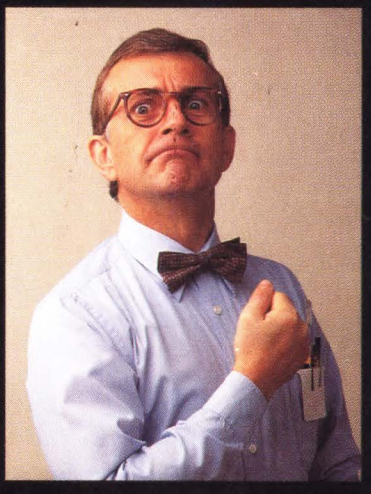
CIRCLE NO 63

703-001-1

The power supplies created for people who can't stand rejection.

When only the most reliable power supplies will do, choose Panasonic® Switching Power Supplies. Thanks to the fact that all of the critical components are made by Matsushita Electric, our parent company, you can count on an acceptance rate of 99% and a typical MTBF of 160,000 hours*. They're everything you need:

- 60 models to choose from
- Single or dual input models
- Single or multiple output models
- 5V – 24V at 0.5 – 30 Amps
- Switching frequencies from 40 kHz to 100 kHz
- Open and closed frame construction
- Inexpensive and versatile

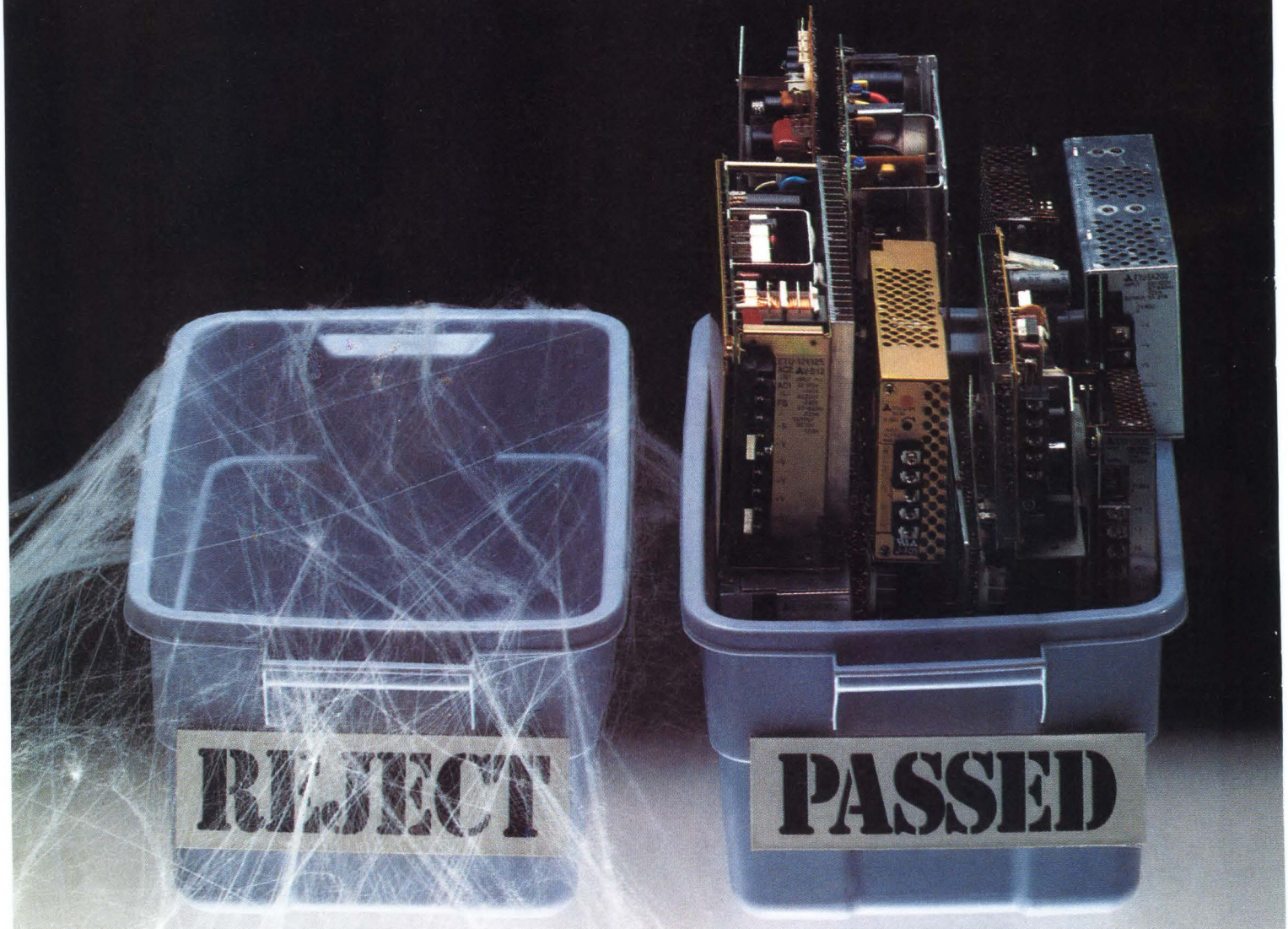


- 0° – 50°C typical operating temperature
- FCC Class A & B and VDE Class B noise regulation
- UL recognized, CSA certified and approved by TUV (for VDE 0806)
- LED power on signal light on some models
- Remote sense (150 watt units) on some models

Panasonic. Switch to our power supplies and you'll never switch again.

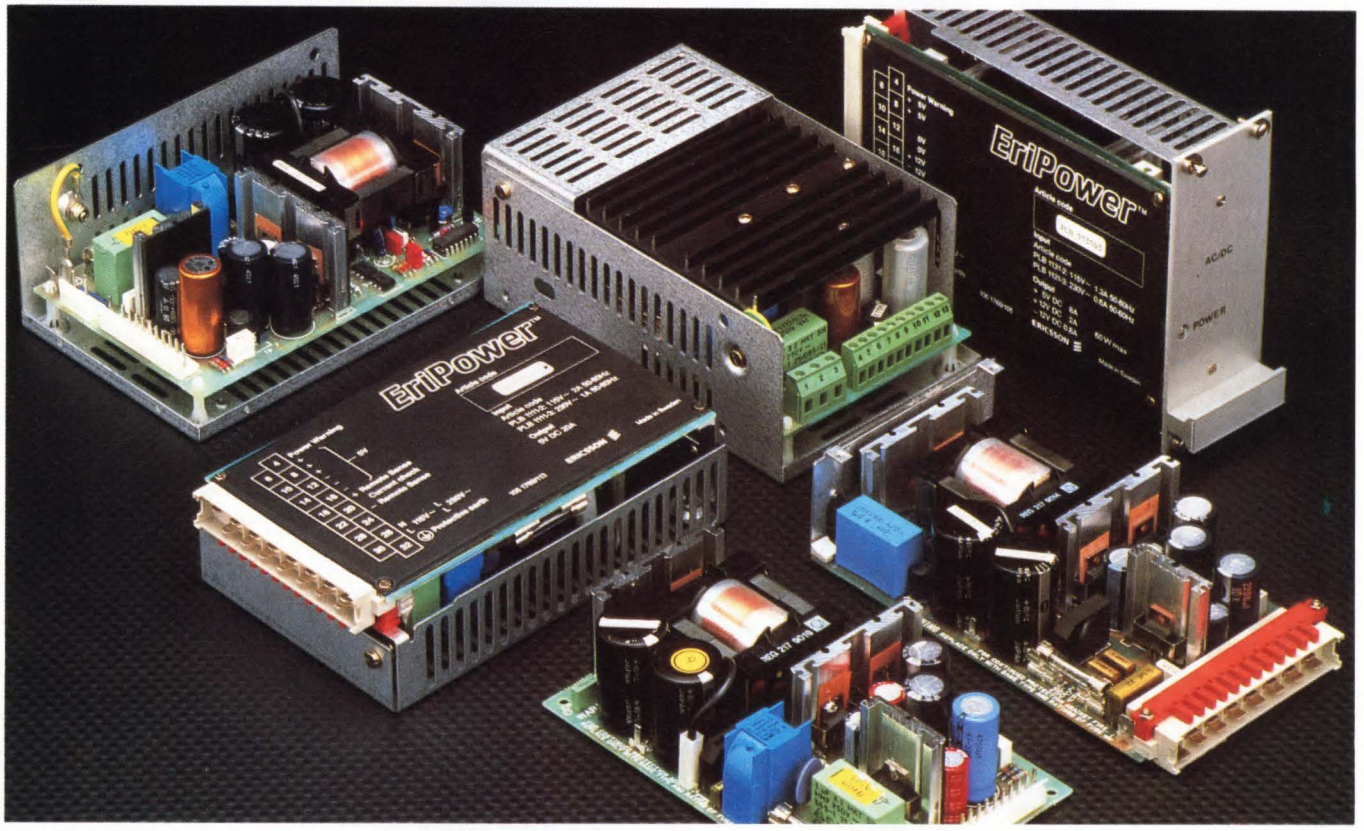
For more information, contact: Panasonic Industrial Company, ECD Division, Two Panasonic Way, Secaucus, NJ 07094. (201) 392-4290.

*As calculated to MIL-Spec 217D.



Panasonic
Industrial Company

These six power supplies are all the same



They're all reliable, with an MTBF of over 300,000 hours. They're all very compact and between 78% and 85% efficient. And, they all meet internationally recognized standards including VDE, IEC, UL, CSA, BS and FCC with respect to safety and RFI.

The differences you see are purely in mechanical construction. The options mean there's a PLB series AC/DC power supply to suit almost every application, whether you need rack or chassis mounting.

These new 60 to 100 Watt SMPS use highly developed flyback technology to minimize component count and maximize efficiency. As a result, they're up to 50% smaller than comparable power supplies.

You can choose from single, dual or triple output versions and all units are user selectable 115/230 VAC. The output voltages, in combinations of ±5, ±12, ±15, 24 or 48 VDC, can be adjusted by ±5% with a potentiometer on the PCB. Standard features include comprehensive protection circuitry, together with a power warning signal.

EriPower™
The Reliable Source

In short, the PLB is smaller, more efficient, more reliable and more flexible than other power supplies in its class. But then, you would never expect anything less from Ericsson, would you?

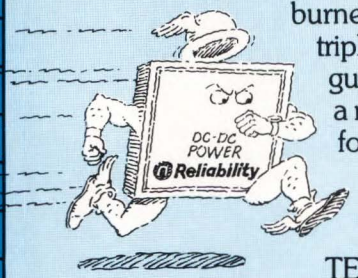
Rifa Inc
P.O. Box 853904, Richardson, Texas 75085-3904
Tel: (214) 480-8300
Telex: 735389 ERICS RCHN
Fax: (214) 680-1059

Ericsson Components AB
Power Products, S-164 81 Stockholm, Sweden
Tel: +46 8 757 4011
Telex: 10948 POWERI S
Fax: +46 8 757 4884

ERICSSON

WE CAN SERVICE YOU FASTER THAN THE COMPETITION...

because Reliability Incorporated assures fast delivery of the DC/DC converters you need. This combined with the fact that they are 100% burned-in and triple tested guarantees you a reliable source for your design needs. Our 5 Watt and 25 Watt TELCOM-PAC® DC/DC converters are short circuit protected and input/output isolated with no derating to 71°C. And, these are only two examples from our product line of over 150 one to 25 Watt DC/DC converters.



So don't be kept waiting. Call our Power Sources Division today at **(713)492-0550.**

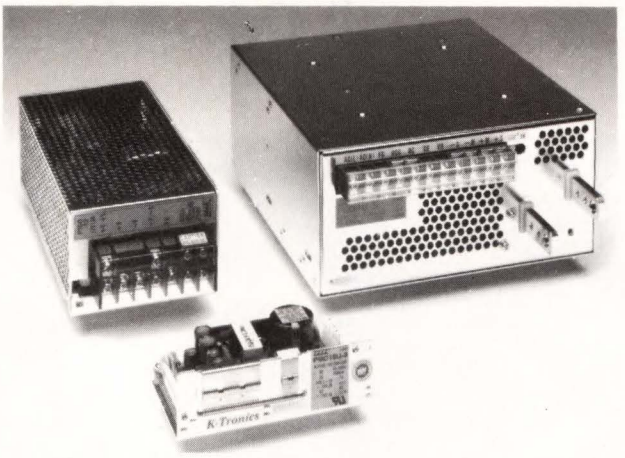
Quality *is* Reliability
A Zero-Defects Company

Reliability Incorporated U.S.A.
P.O. Box 218370
Houston, Texas 77218
Phone: (713)492-0550
Fax: (713)492-0615

Reliability®

CIRCLE NO 6

ELCO P Series Worldwide Input Power Supplies



- o 15 watt to 1500 watt models, single output
- o PMC versions; multiple outputs; 15 watts up to 100 watts
- o UL, CSA & TUV approved, or pending
- o High Efficiency—up to 4.2 watts per cubic inch on P1500
- o Molex or screw terminals (most models)
- o Meets FCC & VDE EMI requirements; high MTBF
- o Smaller than industry standard footprints

For information contact:
K-Tronics, a division of K.T. Electronics.
341 Cobalt Way, #206, Sunnyvale, CA 94086
Phone 800 888-ELCO; FAX 408 732-5049

ELCO

CIRCLE NO 7

DC-DC CONVERTERS
To 25 Watts — From ERG — *Your DC PowerHouse!*

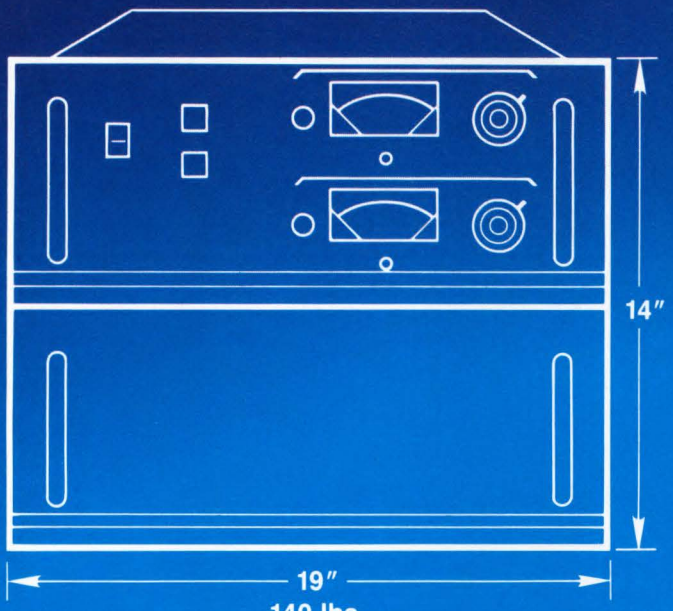
- **ERG DC-DC CONVERTERS.** Inputs from 5 to 48 VDC. Outputs from 5 VDC to 1500 VDC. Single, dual, center-tap (+/–) outputs. Regulated and unregulated. **Ask about our New Step-Down converters for battery-powered logic and other applications!**
- **SMART FORCE™ INVERTERS FOR EL LAMPS!** Smart Force DC-AC Inverters extend the useful life of Electroluminescent lamps. Power EL to backlight LCDs and membrane switches, and more! **Ask about our New miniaturized P Package Inverters!**

Call today for complete product information and pricing:

Endicott Research Group, Inc.
2601 Wayne Street P.O. Box 269 Endicott, NY 13760
® 607-754-9187 TWX 510-252-0155
FAX: 607-754-9255
©1986 ERG, Inc.

CIRCLE NO 8

Glassman HV supplies like to be compared!



All Glassman HV supplies are better by design, offering a combination of performance, size, and weight that beats the competition hands-down. Consider the new PK Series. . .

Nearest Competitor	PK Series
3 KW, 14" high	4 KW, 10.5" high
0.63 W/in.^{3}	1.2 W/in.^{3}
21.4 W/lb.	61.5 W/lb.
140 lbs.	70 lbs.

But numbers are not the whole story. For example, only the PK Series shows you at a glance its complete status. Indicators signal power on, HV on, standby, safety interlock, external trip, polarity, remote/local control, regulating mode (voltage or current), output voltage and current. . .even a bargraph trend indicator for pulsed load applications is standard.

Glassman's pulse width modulated circuitry delivers regulation better than 0.01%, low ripple, fast transient response, and full load efficiency greater than 85%. . . all with lower parts count for greater reliability. And Glassman's unique air insulation offers field-proven serviceability while it contributes to reduced weight.

Call or write for full information. Compare the PK Series to any others. . .we're confident you will decide that Glassman is the true innovator in high voltage power supply technology.

Glassman High Voltage, Inc.
Route 22 (East)
Salem Industrial Park, PO Box 551
Whitehouse Station, NJ 08889
Telephone (201) 534-9007
TWX 710-480-2839
FAX: (201) 534-5672

GLASSMAN HIGH VOLTAGE INC.

CIRCLE NO 66

Don't leave a void in your specifications.

Designing a new, portable electronic device is a meticulous, painstaking procedure. But in the end, one simple fact remains. The performance of the final product is only as good as the battery inside it.

To make sure your product performs up to your customer's expectations, specify the alkaline battery brand preferred by more U.S. consumers — DURACELL®.

Duracell's quality reputation and high level of consumer awareness (99%) are just two reasons why leading electronics manufacturers around the world specify DURACELL alkaline batteries for their equipment.*

And in 1989, we've improved DURACELL alkaline batteries once again to provide an increased service life of up to 20%. So your product will operate at peak performance for longer than ever before.

Free design literature.

Fill the void in your specifications with DURACELL batteries. Call or write today for our new technical literature on our improved alkaline batteries. Duracell's experienced OEM battery engineers can provide immediate assistance with your questions or problems. And, make your designs more powerful.

DURACELL INC.

New Products and Technology Division
OEM Sales and Marketing
Berkshire Industrial Park
Bethel, CT 06801
Toll-free: 1-800-422-9001 ext. 427
Facsimile: 203-791-3273

**Source: Research 100, Jan. 1989. Total brand awareness*

CIRCLE NO 67

Wideband ac power sources deliver a 70 to 82% efficiency

The Titan Series of wideband ac power sources consists of the MAC-01, MAC-02, and MAC-03 mainframes, as well as the MOS-01 manual oscillator module and the EIM-01 external input module. By employing patented switch-mode, thick-film, power-hybrid circuitry, the sources realize a 70 to 82% power-transfer efficiency across the full output range. They can deliver a stable voltage and current output into any reactive load that has a leading or lagging power factor of 0 to 1.

The mainframes have output capabilities of 1000, 500, and 165 VA, respectively. They have both a 0 to 130 and a 0 to 260V rms output range, which you select via the front-panel switch. The output currents for the two output ranges are 8 and 4, 4 and 2, and 1.4 and 0.7A for the MAC-01, MAC-02, and MAC-03, respectively.

Although the mainframes' full-output range is 45 Hz to 15 kHz, their usable frequency range extends to 20 kHz. The units' harmonic distortion is <1% from 45 Hz to 3 kHz and <3% from 3 to 20 kHz. Their output noise is 60 dB below the full-rated output, and their gain stability is ±0.25% over 72 hours when the line and load regulation and the temperature are constant.

The MOS-01 module plugs into the mainframes and serves as a general-purpose sine-wave oscillator and a digital-readout monitoring system. The module operates over a 20-Hz to 20-kHz frequency range in three switch-selectable, 1-decade scales—20 to 200 Hz, 0.2 to 2 kHz, and 2 to 20 kHz. The EIM-01 external input module safely isolates and inputs an external drive signal into the power mainframes.

The MAC-01, MAC-02, and MAC-03 come in gold, irridite-plated, steel main chassis and cost $1950, $1250, and $889. The MOS-1 and EIM-01 modules are priced at $349 and $59, respectively. All items in the series include a 1-year warranty.

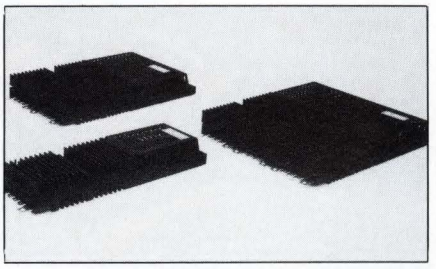
Compact Power Co, 17282 Orange Dr, Yorba Linda, CA 92686. Phone (714) 996-5826.

Circle No 439

AC/DC switchers feature flat profile and pack 7W per cubic inch

The FlatPAC family of user-definable off-line switching power supplies includes single-, double-, and triple-output models. The units share a flat package profile—1.37-in. high by 8.6-in. long—and come in widths of 2.5, 4.9, and 7.4 in., which correspond to output power ratings of 200, 400, and 600W. In full-power configurations, the power density is 7W per cubic inch.

The standard output voltages are 5, 12, 15, 24, and 48V and are externally trimmable to +10% and −100%. The three different packages provide one, two, or three user-definable power cells. You can specify each power cell to be an independent isolated output with a power rating of 50, 75, 100, 150, or 200W, or you can combine the cells to form higher power outputs.



For example, you can configure a 3-cell, 600W unit as three totally isolated 200W outputs, or as two isolated outputs of 400W and 200W, or as a single output supply capable of delivering 600W. Similarly, you can specify a 2-cell unit as either a single 400W supply or as a dual supply with 200W for each output. The single unit provides a single 200W output.

The units feature remote sensing and overvoltage and overcurrent protection. They also meet Class A interference specs, and conform to UL, CSA, and TUV safety requirements. In OEM quantities, the supplies are priced as low as $0.85/W.

Vicor Corp, 23 Frontage Rd, Andover, MA 01810. Phone (508) 470-2900. FAX 508-475-6715.

Circle No 440

DC/DC converters feature 2:1 input range in 15 and 30W models

The Wide Range Series of dc/dc converters includes 26 models that feature input ranges of 9 to 18V or 18 to 36V at power ratings of either 15 or 30W. Single-, dual- and triple-output models are available in combinations of 5, 12, 15, −12, and −15V. The converters come in two packages, measuring 3×2.56×0.83 in. and 4.56×2.56×0.83 in.

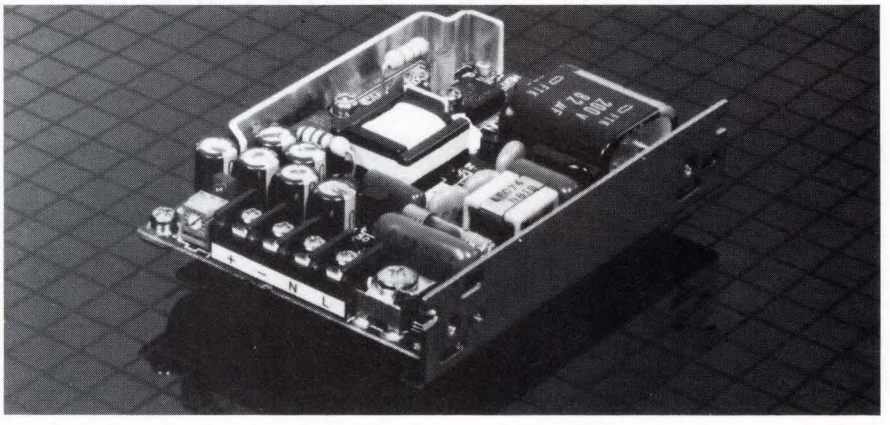
The units operate at a switching frequency of 100 kHz, and their efficiencies range from 75 to 84%. The converters operate over a temperature range of −25 to +71°C without derating the outputs.

The converters' standard features include automatic voltage and current limiting on all outputs, a TTL-compatible control input for remote on/off control, input filtering, 6-sided shielding, and a minimum isolation voltage of 500V dc. The 30W models also provide remote-sense inputs to compensate for lead-resistance voltage drops. Prices start at $107.

Datel Inc, 11 Cabot Blvd, Mansfield, MA 02048. Phone (508) 339-3000. FAX 508-339-6356.

Circle No 441

AC/DC switchers deliver 15, 25, and 50W in slim package



The FAW International series and the FAK North American series of ac-to-dc switchers are available in three power levels: 15, 25 and 50W. The open-frame FAK supplies are 0.78 in. high; the optional-enclosure versions are 0.9 in. high. The widths of the FAK supplies range from 2.76 to 3.75 in.; the lengths range from 3.74 to 5.12 in. The International series features an input range of 85 to 264V and has UL, CSA, and TUV approvals; the North American series features an input range of 85 to 135V and has UL and CSA approvals. Four output voltages—5, 12, 15, and 24V—are available at each power level.

All of the units feature a power-OK LED, a soft-start circuit, and a built-in EMI filter. The FAW models operate at 120 to 130 kHz, and the FAK models operate at frequencies as high as 260 kHz. Single-unit prices for the 15, 25, and 50W units are as follows: FAW series, $55, $85, $110; FAK series, $55, $75, $85.

Kepco Inc, 131-38 Sanford Ave, Flushing, NY 11352. Phone (718) 461-7000. FAX 718-767-1102.

Circle No 442

POWER PLUS SAFETY.

The Maxell Super Lithium Battery.* Good for a decade, these lithium thionyl chloride batteries are hermetically sealed for super safety plus long shelf and service life. And at 3.6 volts, they supply the high energy density you're looking for. Specify Maxell Super Lithium Batteries for critical applications where a safe battery is imperative.

Specify Maxell Super Lithium Batteries for quality and a name you can trust. When you need power and you need it safe, look for Maxell.

maxell®

Maxell Corp. of America
22-08 Route 208
Fair Lawn, NJ 07410

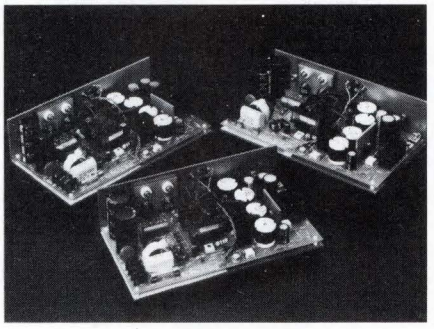
*Recognized under the Component Program of Underwriters Laboratories.

CIRCLE NO 68

220W switching power supply features low ac-line leakage

The MDT-224 is a standard quad-output, 220W switcher and meets the stringent requirements for medical electronics equipment. Specifically, the supply meets the UL554 and IEC601 specifications for patient monitoring equipment in a 9×5×2.5-in. package. The MDT-224 provides 30A of 5V for logic and memory and peak currents as high as 12A for motor starting. The unit includes two auxiliary outputs of ±12V or ±15V at 1.5A.

To meet the medical-application requirements, the MDT-224 features low-leakage RFI filters and line-transient-suppression circuitry to survive the line-voltage transients found in hospital environments.



The user-selectable ac input is either 90 to 132V ac or 180 to 264V ac at line frequencies of 47 to 63 Hz. The supply's line and load regulation is ±1% over the ac input range and over a 0 to 100% load change. Ripple is less than 0.2% rms, and noise is either 1% p-p or 100 mV, whichever is greater. The output voltage returns to within 1% of its specified rating in less than 500 μsec for a 50% load change. The peak transient does not exceed 5%. All outputs are protected against overload and short-circuit conditions; the supply recovers automatically upon removal of a fault. The overvoltage-protection trip point is factory set so that the 5V output can't exceed 6.8V. The supply's typical efficiency is 75%, and its MIL-HDBK-217 calculated MTBF is over 100,000 hours. The MDT-224 costs $265 (100); delivery is six weeks ARO.

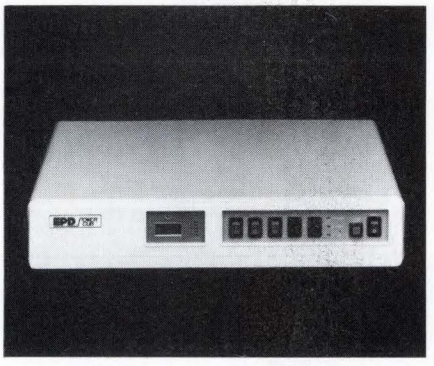
Todd Products Corp, 50 Emjay Blvd, Brentwood, NY 11717. Phone (516) 231-3366. TWX 510-227-4905.

Circle No 443

Slim, uninterruptible power supplies protect personal-computer data

Designed specifically for personal computers, Power Cub power supplies provide immediate and complete protection of data from blackouts, brownouts, voltage transients, and noise interference. The units contain a battery-powered inverter that supplies electrical power to your system when utility power is not available.

The PC-300 has a power rating of 300 VA and provides 12 minutes of backup when under an average load and 29 minutes of backup under a half load. The PC-550 has a power rating of 550 VA and provides 10 minutes of backup under an average load and 15 minutes under a half load. The transfer time from the ac line to the internal battery is 2 msec typ. The two models are housed in slim cabinets. The PC-300 measures 16.54×3.19×14.96 in.; the PC-550 measures 16.54×3.56×17.25 in. They weigh 30 and 36.4 lbs, respectively.



Individual power switches for all of the system's peripherals are mounted on the units' front panel for easy access. Other features include a front-panel lamp for keyboard illumination during power failure, LED indicators for mode operation, load-level and overload indicators, and telephone-line transient protection for modems. The PC-300 and PC-550 sell for $609 and $799, respectively.

General Power Corp, Box 65008, Anaheim, CA 92805. Phone (800) 854-3469; in CA, (800) 824-8912.

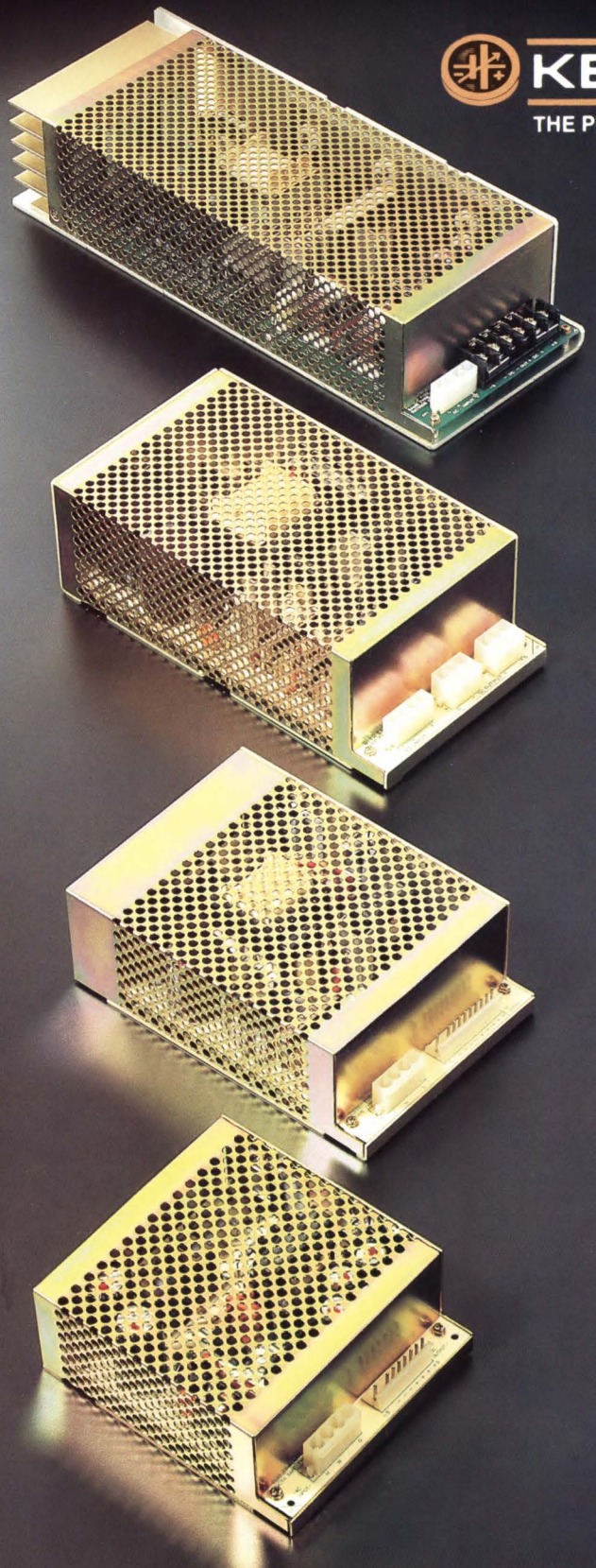
Circle No 444

146-1662

30 to 240 WATTS

5 TO 24 VOLTS d-c
6 TO 48 AMPS
(more with paralleling)
RUGGED, RELIABLE,
SAFETY-APPROVED

KEPCO®
THE POWER SUPPLIER™



KEPCO SERIES ERX™ SINGLE-OUTPUT L-CHASSIS SWITCHING POWER SUPPLIES

TEAR ON DOTTED LINE TO REMOVE AND SAVE.

ERX MODEL TABLE

115/230V a-c input

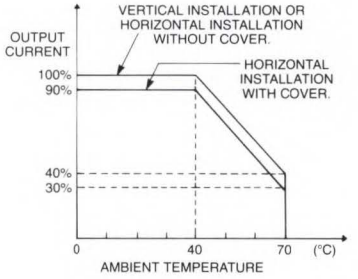
SPECIFICATION	OUTPUT VOLTAGE		OVP SETTING	OUTPUT CURRENT				CURRENT LIMIT (RECTANGULAR FIXED)	RIPPLE				NOISE (SPIKE)	EFFICIENCY
Unit	Volts		Volts	Amps				Amps	mV				mV	Percent
Condition	Factory set,(1)	Adjustment range	Nom. input 25°C	40°C	50°C	60°C	71°C	25°C nom input	p-p Source typ	p-p Source max	p-p Switching typ	p-p Switching max	d-c to 50MHz p-p	typ
30 WATT MODELS	Size: 2.17″Hx4.84″Wx5.51″D Net weight: 1.5 lb. Optional cover: CA 15													
ERX 5-6	5	4.5- 5.5	5.8~ 6.9	6.0	4.8	3.6	2.4	6.3- 7.8	5	10	40	70	150	68%
ERX 12-2.5	12	10.8-13.2	13.7~15.7	2.5	2.0	1.5	1.0	2.6- 3.3	20	40	40	80	300	
ERX 15-2	15	13.5-16.5	17.0~19.0	2.0	1.6	1.2	0.8	2.1- 2.6	20	40	40	80	300	
ERX 24-1.3	24	21.6-26.4	27.9~30.5	1.3	1.0	0.8	0.5	1.4- 1.7	30	50	40	100	400	
60 WATT MODELS	Size: 2.36″Hx4.84″Wx7.09″D Net weight: 1.5 lb. Optional cover: CA 16													
ERX 5-12	5	4.0- 5.5	5.8~ 6.9	12.0	9.6	7.2	4.8	12.6-15.6	5	10	30	50	150	72%
ERX 12-5	12	8.4-13.2	13.7~15.7	5.0	4.0	3.0	2.0	5.2- 6.5	20	40	40	80	300	
ERX 15-4	15	10.5-16.5	17.0~19.0	4.0	3.2	2.4	1.6	4.2- 5.2	20	40	40	80	300	
ERX 24-2.5	24	16.8-26.4	27.9~30.5	2.5	2.0	1.5	1.0	2.6- 3.3	30	50	40	100	400	
120 WATT MODELS	Size: 2.76″Hx4.84″Wx8.90″D Net weight: 3.1 lb. Optional cover: CA 17													
ERX 5-24	5	4.0- 5.5	5.8~ 6.9	24.0	19.2	14.4	9.6	25.2-31.2	5	10	40	70	150	74%
ERX 12-10	12	8.4-13.2	13.7~15.7	10.0	8.0	6.0	4.0	10.5-13.0	20	40	40	80	300	
ERX 15-8	15	10.5-16.5	17.0~19.0	8.0	6.4	4.8	3.2	8.4-10.4	20	40	40	80	300	
ERX 24-5	24	16.8-26.4	27.9~30.5	5.0	4.0	3.0	2.0	5.2- 6.5	30	50	40	100	400	
240 WATT MODELS	Size: 2.76″Hx4.84″Wx12.91″D Net weight: 5.5 lb. Optional cover: CA 18													
ERX 5-48	5	4.0- 5.5	5.8~ 6.9	48.0	38.4	28.8	19.2	50.4-52.8	5	10	50	90	150	80%
ERX 12-20	12	8.4-13.2	13.7~15.7	20.0	16.0	12.0	8.0	21.0-22.0	20	50	50	100	300	
ERX 15-16	15	10.5-16.5	17.0~19.0	16.0	12.8	9.6	6.4	16.8-17.6	20	50	50	100	300	
ERX 24-10	24	16.8-26.4	27.9~30.5	10.0	8.0	6.0	4.0	11.2-12.0	30	60	50	120	400	

(1) Nominal input, maximum load, 25°C

ERX GENERAL SPECIFICATIONS

SPECIFICATION		RATING/DESCRIPTION	CONDITION
Temperature		0-71°C (see model table)	Operating
		−40 to +75°C	Storage
Humidity		95% RH	Non-condensing Operating and storage
Shock		20g, 3 axes (11msec ±5msec pulse duration)	Non-operating 3 shocks each axis
Vibration		5-10Hz: 10mm amplitude, 3 axes	Non-operating 1 hour each axis mounted by base
		10-55Hz: 2g, 3 axes	
Isolation	Output to case	500V d-c, 100MΩ	25°C, 65% RH
Withstand voltage	Input to output	3.75KV a-c for 1 minute	20°C, 65% RH Y capacitor removed
	Input to case	1.25KV a-c for 1 minute	25°C, 65% RH
Safety		UL 478 recognized, CSA C22.2-154 certified; VDE 0806/IEC 380 approved by TÜV Rheinland	
Type of construction		PC card, L-chassis	
Enclosure		Steel	Optional
Cooling		Convection	

UL RECOGNIZED CSA CERTIFIED TÜV APPROVED



OUTPUT RATING VS. TEMPERATURE

For complete specifications send for ERX Brochure 146-1641 or complete catalog 146-1605

KEPCO®
THE POWER SUPPLIER™

KEPCO, INC. • 131-38 SANFORD AVENUE • FLUSHING, NY 11352 USA • (718) 461-7000 • FAX: (718) 767-1102 • Easylink (TWX): 710-582-2631

BERTAN

High Voltage... Custom/OEM!

Bertan Associates is uniquely qualified to produce custom high voltage power supplies and systems for demanding OEM applications.

Our professional engineering staff and modern manufacturing facility, equipped with the most advanced design and analytical tools, will tailor a high voltage power supply or system to your specific needs.

Call our applications engineers for information on how we can meet your requirements.

Capabilities Include

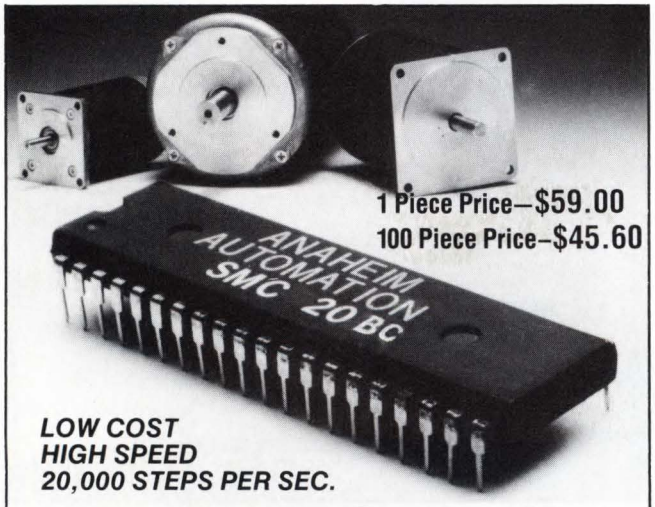
- ***AC to DC / DC to DC***
- ***Single/Multiple Outputs***
- ***Linears/Switchers***
- ***Custom Interfacing***
- ***UL/CSA/VDE***
- ***IEEE-488 Control***
- ***Programmable***
- ***Quantity 10 to 10,000***

Also send for new free color catalog.

Phone **(516) 433-3110**
TWX 510-221-2144
FAX 516-935-1766
121 New South Rd., Hicksville, NY 11801

BERTAN High Voltage

CIRCLE NO 9



LOW COST
HIGH SPEED
20,000 STEPS PER SEC.

Step Motor Controller

New SMC20BC CMOS Step Motor Controller outputs a pulse signal for each step to be taken, and allows programming of direction, base and maximum rates, separate acceleration and deceleration slopes, and distance to be traveled in incremental or absolute position. • An internal buffer can be used to store command sequences for execution of routines on a stand alone basis. Limit switch, Jog and three programmable inputs and outputs are provided to make complex operations possible. The controller communicates through an 8-bit data bus in either ASCII or binary data formats.

ANAHEIM AUTOMATION

910 E. Orangefair Lane, Anaheim, CA 92801
(714) 992-6990 Telex: 2978217 MCI FAX: 714-992-0471

83-1R

CIRCLE NO 10

POWER

When your products depend on reliable power, depend on DATEL. With 20 years experience in the design and manufacture of power products, DATEL's complete line offers

- 1W to 30W DC/DC Converters
- Single, dual, triple and high voltage outputs
- PC or chassis mounting
- Wide range inputs
- Outstanding regulation, accuracy and low noise
- Line operated supplies, Switching supplies
- Miniature packages

Call or write for DATEL's new brochure detailing more than 140 power products.

DATEL

INNOVATION AND EXCELLENCE IN PRECISION DATA ACQUISITION
DATEL, Inc., 11 Cabot Boulevard, Mansfield, MA 02048 (508)339-3000

CIRCLE NO 11

SAFT BATTERIES. ONE FOR ALL. ALL FROM ONE.

Powering the portable electronics of the 80's has been a major problem for product design engineers. And the 90's will be even more challenging. But there is a one source supplier who can meet almost any portable power design challenge. With the industry's broadest line of Nicad® batteries and a variety of lithium chemistries, SAFT allows today's design engineer to design portability into a broad spectrum of electronics, from simple toys to sophisticated computers. And, best of all, this full range of portable power is available from a single source–one order, one shipment, one invoice.

For more information on our complete line of Nicad batteries, contact SAFT America Inc., Portable Battery Division, 711 Industrial Boulevard, Valdosta, Georgia 31601, or call (912) 247-2331. For information on our variety of lithium chemistries, contact SAFT America Inc., Advanced Battery Systems Division, 107 Beaver Court, Cockeysville, Maryland 21030, or call (301) 771-3200.

SAFT

CIRCLE NO 69

Power Sources

DC/DC CONVERTER

The LT1026 dc/dc converter transforms a single-level input into a dual, higher-voltage output. The device uses bipolar switched-capacitor technology, negating the need for internal inductors. The converter has a 4 to 10V input range and will output voltages as high as ±18V. The maximum output current is 20 mA. The unit requires only 1-μF charge pump capacitors. The converter comes in a plastic or ceramic DIP, a TO-5 metal can, and an 8-pin miniature DIP. An LT1026 in a miniature DIP, $2.10 (100).

Linear Technology Corp, 1630 McCarthy Blvd, Milpitas, CA 95035. Phone (408) 432-1900. FAX 408-434-0507.

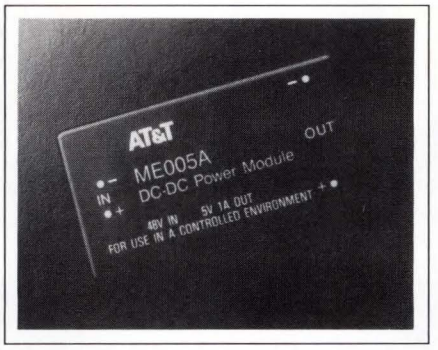
Circle No 526

3-PHASE SWITCHERS

The Case 36 line of 3-phase-input switch-mode power supplies includes six different models with output voltages from 2 to 48V dc and power ratings as high as 3000W. Models are available with 2, 5, 12, 15, 24, and 48V outputs. All the models are powered from a 208V, 3-phase input with a frequency between 50 and 400 Hz. The Case 36 package measures 5×8×13.75 in. The line regulation is 1% with a 15% line change. The load regulation is 1% with the remote sense connected. A thermostat shuts down the power supply whenever the safe operating temperature is exceeded. Output inhibit, output current monitoring, dc power good, and a reverse-air-flow fan connection are available as options. $1895. Delivery, eight to 10 weeks ARO.

Qualidyne Systems Inc, 3055 Del Sol Blvd, San Diego, CA 92154. Phone (619) 575-1100. FAX 619-429-1011.

Circle No 527



POWER MODULES

ME005A, ME005BK, and ME025ABK power modules operate from a nominal 48V dc input and meet FCC Class A requirements. The ME005A provides a regulated 5V output rating; the ME005BK module outputs ±12V. Both these models have a 5W power rating. Model 025ABK delivers 25W from three outputs—5 and ±12V. The ME005A and the ME005BK modules measure 2×1.1×0.46 in.; the dimensions of the ME025ABK are 4.26×2.58×0.5 in. ME005A, $57; ME025ABK, $162.34.

AT&T Microelectronics, Dept 51AL230230, 555 Union Blvd, Allentown, PA 18103. Phone (800) 372-2447.

Circle No 528

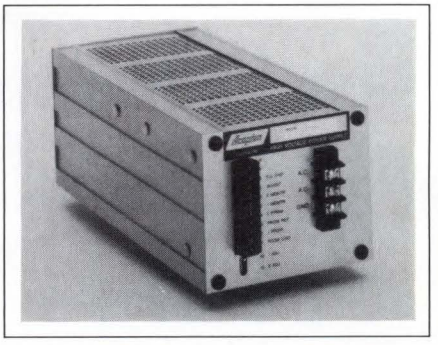
UPSs

By utilizing thyristor switching techniques, the Power Lab H0 Series off-line uninterruptible power supplies can commutate between their line input supply and their internal lead-acid batteries in <10 nsec. This switching speed gives them a performance comparable to on-line uninterruptible supplies. Targeted at users of personal computers and LANs, the series includes supplies with output ratings of 300, 600, 1000, and 1500 VA. They incorporate common-mode-rejection filters to smooth out harmonic fluctuations in the line input supply, and they provide full protection against voltage spikes, voltage sags and surges, brown-outs, and black-outs.

Depending on the connected load, the internal batteries provide between 10 and 30 minutes of back-up power. A software option, which operates under MS-DOS, provides an onscreen window that indicates line input interruptions and the amount of battery back-up time remaining. When only one minute of battery back-up remains, the software automatically closes and saves to disk any open files in the personal computer. £395 to £1200.

Ondyne (UK) Ltd, Unit 4, Davenport Gate, W Portway Industrial Estate, Andover, Hampshire SP10 3SQ. Phone (0264) 66688. FAX 0264-66601.

Circle No 529



POWER SUPPLIES

This line of high-voltage power supplies provides outputs with ranges from 0-1000V at 30 mA to 0-30,000V at 1 mA. Standard features include constant-voltage and constant-current crossover, a provision for output inhibiting and programming of both voltage and current, and arc/short-circuit protection. The line and load regulations are ±0.05% each; ripple is 0.05% p-p. The ac-

THE **SMALL** AND THE **MIGHTY**

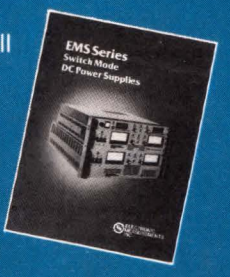
HIGH POWER SWITCHERS...FROM EM

Lighter...Smaller...More Powerful...
for single and three phase applications where high efficiency, precise regulation and a high degree of packaging density are required.

The EMS Series incorporates the best of customer tested and application proven features:

- 1kW, 1Ø; 2.5kW, 1Ø and 3Ø in one unit; 5kW, 3Ø
- Highest power per cubic inch for wide range, rack mount, CV/CC power supplies in the industry
- Common programming with TCR, EMHP, ATR and HCR Series
- 650 microsecond transient response time
- Built in OVP and thermal protections ...and much, much more

Want all the details on the small and the mighty? Write or call for the latest Tech Bulletin on the EMS Series of DC Power Supplies.



ELECTRONIC MEASUREMENTS INC.

405 Essex Road, Neptune, NJ 07753
CALL **TOLL FREE 800-631-4298*** ● Telex: 132-424 ● Fax (201) 922-9334
*Except in New Jersey, Alaska, Hawaii and Canada call (201) 922-9300.

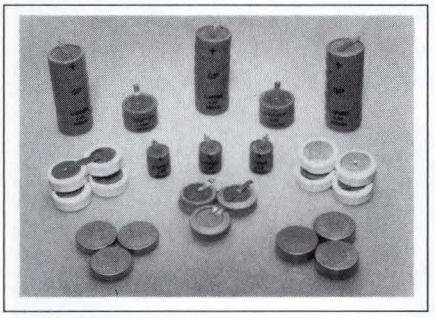
CIRCLE NO 70

Power Sources

input supply can run from 105 to 125V or from 210 to 250V ac inputs. A dc-input unit can run from 21.6 to 32V dc inputs. The output connection is a flying lead. All other connections are on a pluggable terminal block. $490 to $890.

Acopian, Box 638, Easton, PA 18044. Phone (800) 523-9478.

Circle No 530



NiCd BATTERIES

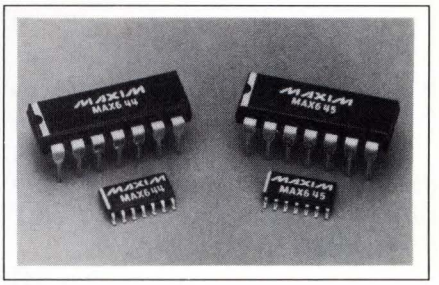
The PS-B60, PS-B100, PS-B170, and PS-B280 nickel cadmium button cells deliver 1.2V at 60, 100, 170, and 280 mAhr, respectively. The batteries have a service life of 500 to 2000 charge/discharge cycles. At 20°C and after 12 months of storage, the cells retain 40% of their nominal capacity. You can purchase single cells, or you can configure multiple cells into stacks or nestle them side by side. The terminal options include pc-board-mount pins, solder tabs, and wire leads. $0.85 to $1.20 (100).

Power-Sonic Corp, Box 5242, Redwood City, CA 94063. Phone (415) 364-5001. FAX 415-366-3662. TLX 348400.

Circle No 531

BOOST CONVERTERS

The MAX644 and MAX645 boost converters supply regulated 5V when the available input voltage is very low, such as 1.3V from a single-cell battery. The MAX644 is guaranteed to start up at 1.15V and to continue to operate below 1V as the battery discharges. The MAX645 is optimized for slightly



higher inputs, such as two alkaline cells or one lithium cell. The converters can supply 30 to 500 mA of output current, and the typical conversion efficiency is 80%.

A number of features that minimize external components in battery-powered applications include an 80-μA quiescent-current standby mode in which the converters can still supply low currents; a battery comparator output that goes low when the input battery voltage drops below 1.15V; a control input that allows you to select either standby or high-power mode; and a power-ready output that goes high when the 5V output has reached its proper output level after power-up or termination of standby. The devices are available in both commercial- and military-temperature ranges. From $3.34 (1000).

Maxim Integrated Products, 120 San Gabriel Dr, Sunnyvale, CA 94086. Phone (408) 737-7600.

Circle No 532

DC/DC CONVERTER

Suitable for use in ISDN equipment, the 48 ITS 1-05-40-T dc/dc converter allows you to generate the 40V required for the ISDN S-bus, and the 5V supply required by interface logic, from the voltage on the ISDN U-bus. The converter's isolated 5V and 40V outputs can deliver an output power of 1W, and you can adjust the 40V output to provide higher or lower voltages if required. The units achieve a typical efficiency of 80% over their entire input voltage range and require no derating over their operating

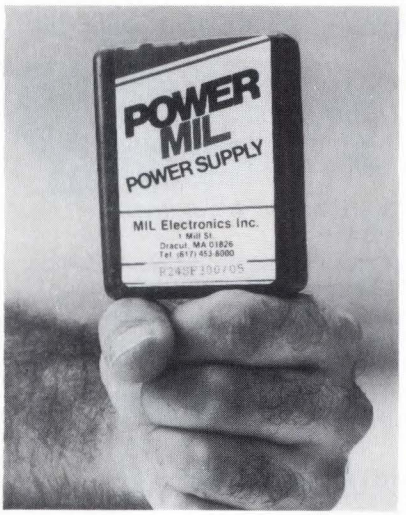
temperature range of −25 to +71°C. They are packaged in pc-board 40-pin DIP cases. SFr 85 (100).

Melcher AG, Ackerstrasse 56, 8610 Uster, Switzerland. Phone (01) 944-8111. TLX 828554. FAX 01-940-9858.

Circle No 533

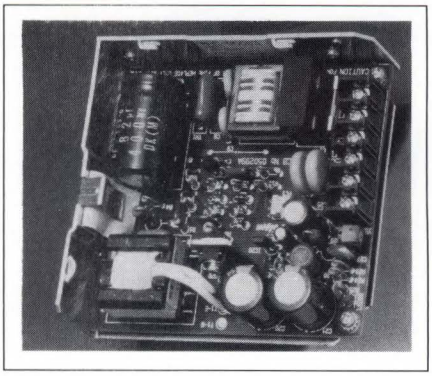
DC/DC CONVERTERS

Suited to high-energy applications, R-Series 15W dc/dc converters accept inputs of 10 to 40V dc. Single-output models provide from 30 to 1800V dc and dual-output versions generate outputs from ±15 to ±900V dc. All units are housed in a 2.5×3.02-in. package that features short-circuit protection. The converters have a built-in pi filter and a 75% typ efficiency rating. Switching frequency is 60 kHz and input-to-output isolation is equal to the output voltage plus 500V. Other specifications include a $1\times10^9\Omega$ min resistance, 50-pF I/O capacitance, and 3% line and load regulation. Single-output models, $185 (100).



MIL Electronics Inc, 1 Mill St, Dracut, MA 01826. Phone (508) 453-8000.

Circle No 534



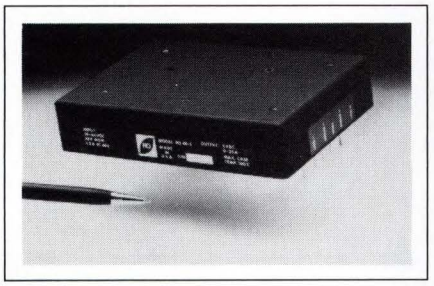
SWITCHING SUPPLY

The MRE Series of 15 and 30W single-output switching power supplies accept any input voltage from 85 to 264V ac without the need for jumper wires or a switch. Supplies with output voltages of 5, 12, 15, and 24V are available. The units operate at switching frequencies of 50 to 300 kHz with typical efficiencies

of 70%. The line regulation is 0.4% max, and the load regulation is 0.8%, no load to full load. The units feature internal filters that meet the Class B EMI limits of FCC and VDE 0871. The supplies have UL, CSA, and TUV approval. The MRE 15 measures 3.9×3.86×1.26 in.; the MRE 30 is 6.14×3.86 ×1.26 in. MRE 15, $28; MRE 30, $43.

Volgen America Inc, 39650 Liberty St, Fremont, CA 94538. Phone (415) 498-5950. FAX 415-498-5954.

Circle No 535



DC/DC CONVERTERS

Units in the RO Series single-output dc/dc converters can produce outputs of 125 to 150W at 20°C without the need for a heat sink or a fan. Housed in a 0.98×3.4×4.85-in. package, the converters feature a 2.5°C/W case to ambient thermal resistance. Converter outputs equal 5V at 25A, 12V at 12A, 15V at 10A, 24V at 6A, and 28V at 5A. The converters feature true N+1 redundancy with current-sharing, paralleling, and hot plug-in capability. Nonshutdown overvoltage protection, logic on/off, short-circuit protection, and overtemperature protection are standard on all units. The converters comply with MIL STD 810D, UL, CSA, and VDE requirements. The converters operate with inputs of 36 to 66V in the RO 48 Series or 200 to 400V in the RO 300 Series. $249. Delivery, stock to 60 days ARO.

RO Associates Inc, 246 Caspian Dr, Sunnyvale, CA 94088. Phone (408) 744-1450. FAX 408-744-1521.

Circle No 536

POWER SUPPLIES

The NFS350 Series open-frame switchers accept any input voltage from 85 to 264V ac without the need for jumper wires or a switch. The NFS350-7625 model has outputs of 5.1, ±12, and a floating output that you can adjust from 4½ to 16½V and reference as either positive or negative. A second model, the NFS350-7626, offers outputs of 5.1, ±12, and a floating output that you can adjust from 15 to 30V and reference as either positive or negative. Total output power at an ambient temperature of 50°C is 350W with forced-air cooling of 30 cfm. The supplies' typical efficiency is 70%.

It seems that every custom power supply project starts with inflexible performance specifications, impractical space limitations, and unrealistic completion schedules.

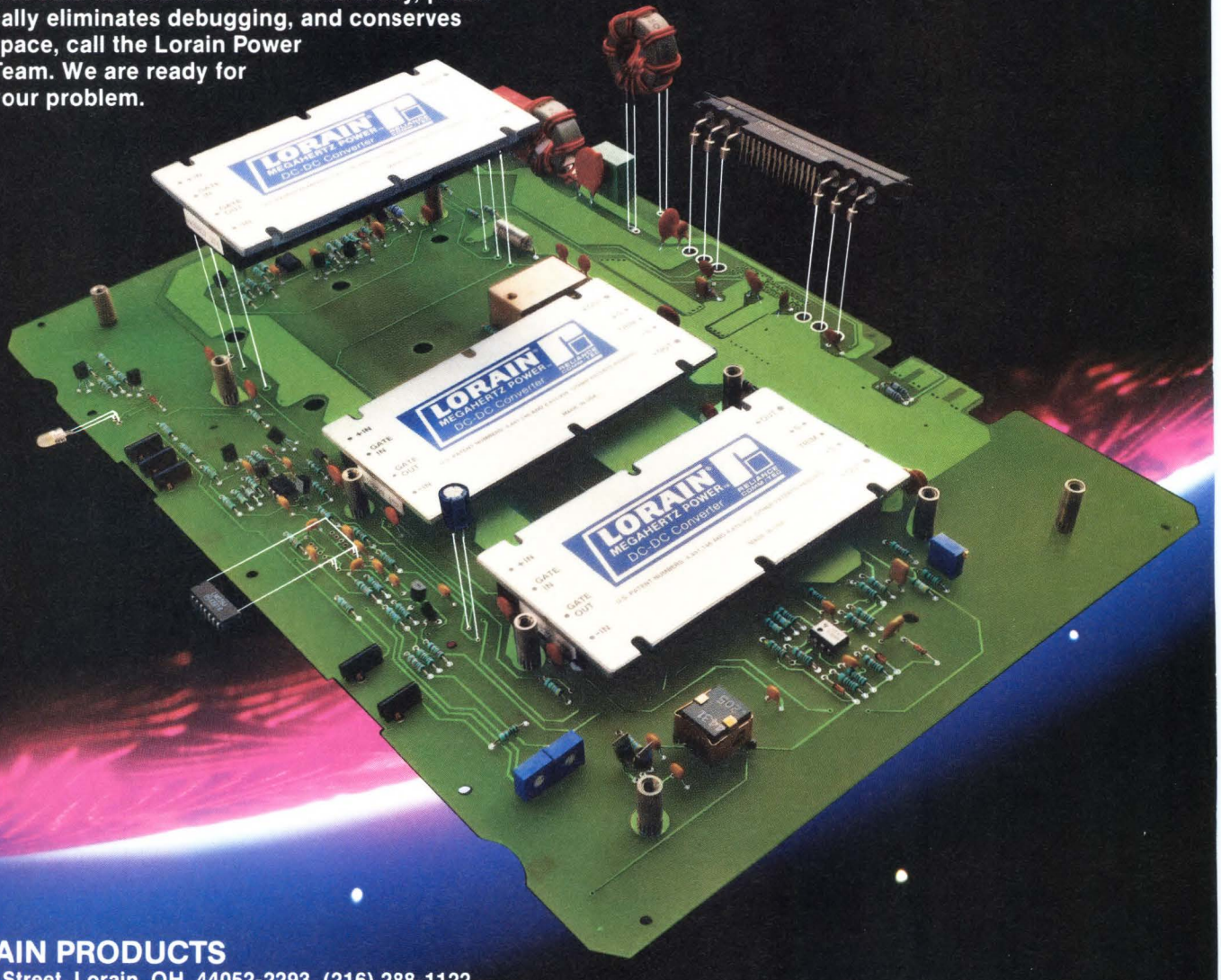
That is why Lorain custom power supplies start with Lorain Megahertz Power Modules. These compact, field proven modules contain a patented megahertz technology that provides exceptional power density, extremely high operating efficiency, quiet operation, and agency compliance. There are over 170 master and booster modules to accurately meet your system requirements.

To these, we add custom circuitry to match your input and output specifications; design-in visuals, forced load sharing, and other peripheral components; even allow for future expansion capabilities with additional plug-in booster modules.

If you are looking for a custom power solution that cuts turnaround time dramatically, practically eliminates debugging, and conserves space, call the Lorain Power Team. We are ready for your problem.

The Flexible, Practical, Realistic solution to custom power

Custom Lorain® Megahertz Power™ Supplies



LORAIN PRODUCTS
1122 F Street, Lorain, OH 44052-2293, (216) 288-1122

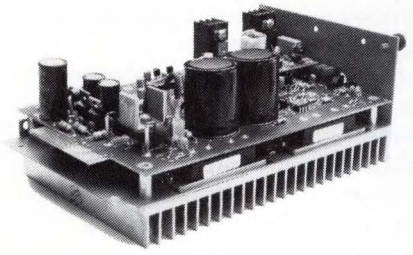
RELIANCE COMM/TEC, CANADA
St. Thomas, ONT., (519) 631-0780

RELIANCE COMM/TEC

CIRCLE NO 72

Power Sources

MHz MEETS POWER ENHANCEMENT CHALLENGE



A major manufacturer of digital communication systems required a drop-in replacement AC/DC power unit for an existing multiplexer. The new power system specifications demanded increased reliability, added circuit features, international agency approval, and Bellcore quality compliance.

Design specs included:
- Input: 120/240VAC
- Outputs: +5 VDC, +12VDC, -12 VDC
- Current Limiting
- Alarm Window Detectors
- Forced Load Sharing
- N+1 Redundancy

All this and more had to fit in the same space configuration as the old power system. Lorain® Megahertz Power™ zero current switching technology provided the space needed for the additional circuit features required.

Lorain response — A dedicated Lorain Power Team worked closely with the OEM in the development and manufacture of the improved power system. This team dedication and Lorain Megahertz Power Modules made it possible to ship completed power units to the OEM six weeks after the final specifications were received.

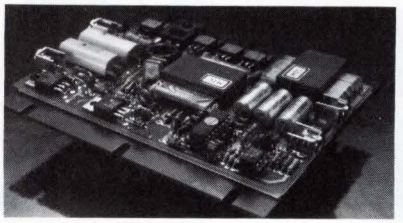
Lorain can make it happen for you — Take the hassle out of the power supply requirements. Put Lorain Megahertz Power to work for you today. Lorain understands power...talk to us. Write or call Lorain Products, 1122 F Street, Lorain, OH 44052, Phone (216) 288-1122.

CIRCLE NO 14

The NFS350 Series supplies are UL-, CSA-, and VDE-approved, and their built-in line filter reduces conducted noise below FCC limit B and VDE limit A. $319 (100).

Computer Products/Boschert, 3797 Spinnaker Ct, Fremont, CA 94538. Phone (415) 657-6700.

Circle No 537



CONVERTER KIT

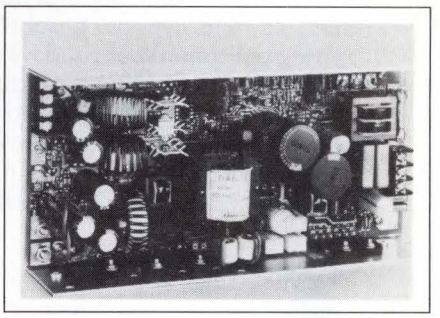
This kit enables designers to gain hands-on experience with resonant mode technology; it provides all the parts necessary to build a 5V, 20A resonant-mode dc/dc converter. The kit includes a pc board, a GP605 resonant mode controller IC, magnetics, power MOSFETS, all other necessary components, and a troubleshooting manual. The converter's performance features include a 36 to 60V dc input range, a switching frequency of 500 kHz, an efficiency of 80%, a line regulation of ±0.1%, a load regulation of ±0.5%, and an output ripple of 50 mV p-p. The unit measures 5.25×3.5×0.625-in. $150.

Gennum Corp, Box 489, Station A, Burlington, Ontario, Canada L7R 3Y3. Phone (416) 632-2996. FAX 416-632-2055. TLX 0618525.

Circle No 538

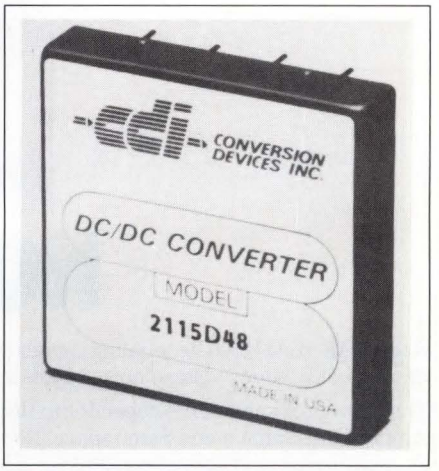
POWER SUPPLIES

V225 and V325 quad-output switching power supplies have power ratings of 225 and 325W and provide main outputs of 5V at 30A and 5V at 45A, respectively. Specifications include an 80% efficiency rating, 1% or 100-mV p-p ripple and noise, and a 0 to 50°C operating range. Cooling requirements equal 30 cfm for V225 units and 60 cfm for V325 devices. All supplies feature a 20-msec holdup time and include overload, reverse voltage, and ac-undervoltage protection. Overvoltage protection is standard on the main outputs and optional on auxiliary outputs. Other options include power-fail monitoring, thermal shutdown, and logic inhibit. The supplies meet UL, CSA, IEC, and VDE safety standards and FCC/VDE emission requirements. V225, $177; V325, $231 (OEM qty).



Deltron Inc, Box 1369, Wissahickon Ave, North Wales, PA 19454. Phone (215) 699-9261. TWX 510-661-8061.

Circle No 539



DC/DC CONVERTERS

Series 2100 20W dc/dc converters are available in single-, dual-, and triple-output versions. The units offer a 13.3W/in.^{3} power density, an 87% efficiency, and 50-mV p-p output noise. Input-to-output isolation of 500V dc min allows the outputs to float with respect to the inputs.

Continuous 6-sided shielding minimizes EMI/RFI problems. Converters are available with input ranges of 9 to 18, 18 to 36, and 36 to 72V. Standard outputs are 5, 12, 15, ±12, ±15, 5/±12, and 5/±15V. Line regulation equals 0.5%; load regulation measures 0.2% for single-output models and 1% for dual-output versions. Operation range spans −25 to +71°C. From $129.

Conversion Devices Inc, 101 Tosca Dr, Stoughton, MA 02072. Phone (617) 341-3266.

Circle No 540

CRT SUPPLIES

L- and M-series CRT power supplies are available with positive or negative outputs in the range 1 to 30 kV; an optional first anode output is available, if required. All the outputs are protected against short circuits. The supplies require a 24V dc input. L-series units have an output ripple of 500 ppm maximum, and M-series supplies have an output ripple of 50 ppm. The M-series supplies also have a remote control option that allows you to control the output voltage with a 0 to 10V analog input. Linearity between the control input and the output is ±1%. An optional adapter allows you to power the supplies from a line input. The series is available in commercial and military grade versions. L-series, £150 to £200; M-series, £190 to £340.

Wallis Hivolt Ltd, Dominion Way, Worthing, West Sussex BN14 8NW, UK. Phone (0903) 211241. FAX 0903-208017.

Circle No 541

POWER SUPPLIES

Units in the 29D5 Series switching power supplies provide five isolated outputs ranging from 5 to 48V and a 300W total power rating at 50°C. The main output is rated for 5V at 40A. Outputs 2, 3, and 4 provide 12 or 15V at 3 or 5A. The semiregulated output 5 can be either 12, 24, or 48V at 6, 4, or 2A, respectively. Line regulation for the field-selectable 90 to 132V ac or 180 to 264V ac inputs equals 0.2%. Load regulation for inputs 1 through 4 also equals 0.2%. Output ripple and noise is 1% p-p. When equipped with an optional filter, the supplies meet the requirements of FCC 20780 Class A and VDE 0871 Class A EMI specifications. $389.

Powertec, 20550 Nordhoff St, Chatsworth, CA 91311. Phone (818) 882-0004. TLX 277483.

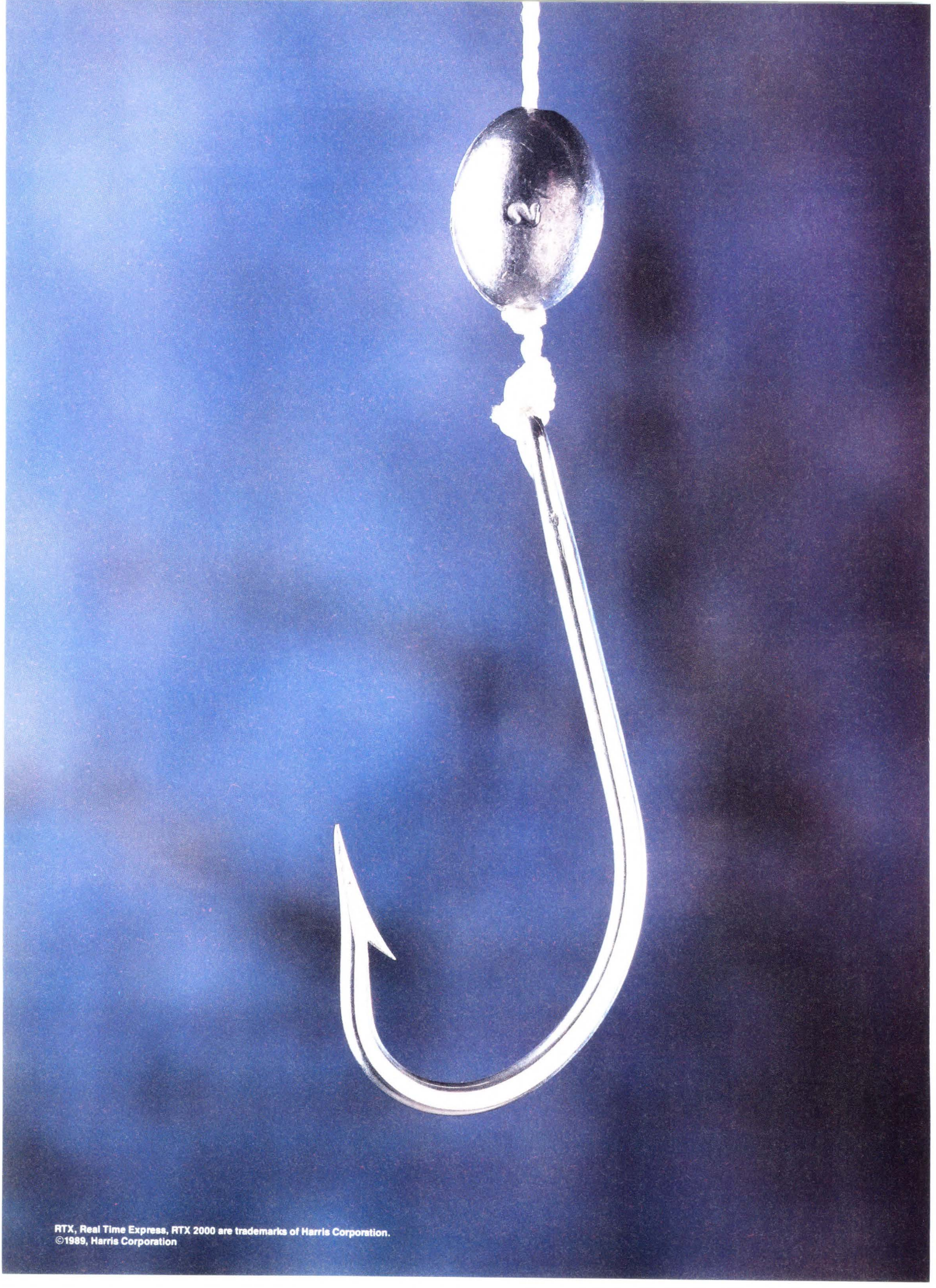
Circle No 542

LITHIUM BATTERY

The CR123A user-replaceable manganese dioxide/lithium battery has a built-in positive-temperature-coefficient device. The battery measures 17.1×34.5mm and weighs only 16g. The battery's nominal voltage is 3V, and its nominal capacity is 1300 mAhr. The battery can operate over a temperature range of −20 to +60°C. $5.40

Panasonic Industrial Co, 2 Panasonic Way, Secaucus, NJ 07094. Phone (201) 348-7000.

Circle No 543



Don't swallow that line about what a RISC processor can do for your real-time system.

Harris RTX 2000™: Superior Performance, Dramatic Cost Savings.

They dangle a RISC chip in front of you and tell you how well it performs in real-time systems. Bite... and you'll regret it.

Real Time Needs Speed, Response And Predictability.

Our unique RTX 2000 does away with the caches and pipelines that cause erratic execution speeds and response times in RISC processors. In fact, in an asynchronous interrupt driven environment, the RTX 2000 is so agile and predictable, it can outperform RISC processors by up to 10x. And its 16-bit architecture is a better fit for the majority of real-time applications.

Consider Form-Factor And Low Power.

With 84 pins, our RTX 2000 package is about half the size of many conventional RISC machines. In many cases, RISC chips require support circuits to reach their promised performance benchmarks. Not the RTX. And consider power use. The RTX 2000™ uses a mere 7 mA/MHz at full speed: about 1/6 the power consumption of basic RISC chips. That power and space savings is critical when sealed enclosures, high-density packaging and battery operation are considerations. And systems that run cooler, run more reliably.

Faster Development, Reduced System Cost.

Complex RISC hardware and software development can take months to master. You'll reach production-ready status much sooner in our highly integrated development environment with programming in a structured high-level language (C, Forth or Prolog).

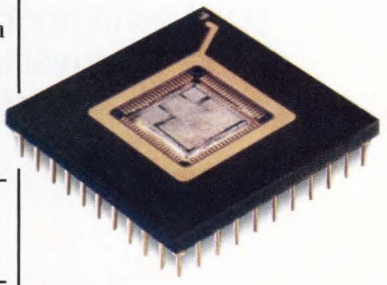
Cost savings come mainly from RTX 2000's low memory requirements. Memory can account for 80% or more of system cost, and RISC processors require massive amounts of high-speed memory. The RTX 2000 works with **4x to 6x less** program memory than RISC machines.

They Sample, We Deliver.

While RISC vendors continue shake-out sampling, we're delivering RTX 2000 chips now. In the quantities you need. With the support you need.

Don't ask RISC to do something it can't do. Design around a microcontroller optimized for real time. Reel in a winner: the Harris Real Time Express.™

Contact us for technical briefs or to register for our real-time design workshops. In U.S.: 1-800-4-HARRIS, Ext. 1291. In Canada: 1-800-344-2444, Ext. 1291.



What your vision of the future demands. Today.

HARRIS SEMICONDUCTOR

HARRIS · RCA · GE · INTERSIL

Specialized ICs drive flat-panel displays to new performance levels

The recent improvements in the size and image quality of flat-panel displays are, in large measure, the result of improved manufacturing techniques and the use of better materials. No less important, however, is the contribution made by innovative IC drivers that bring new levels of performance to these increasingly popular displays.

Dave Pryce,
Associate Editor

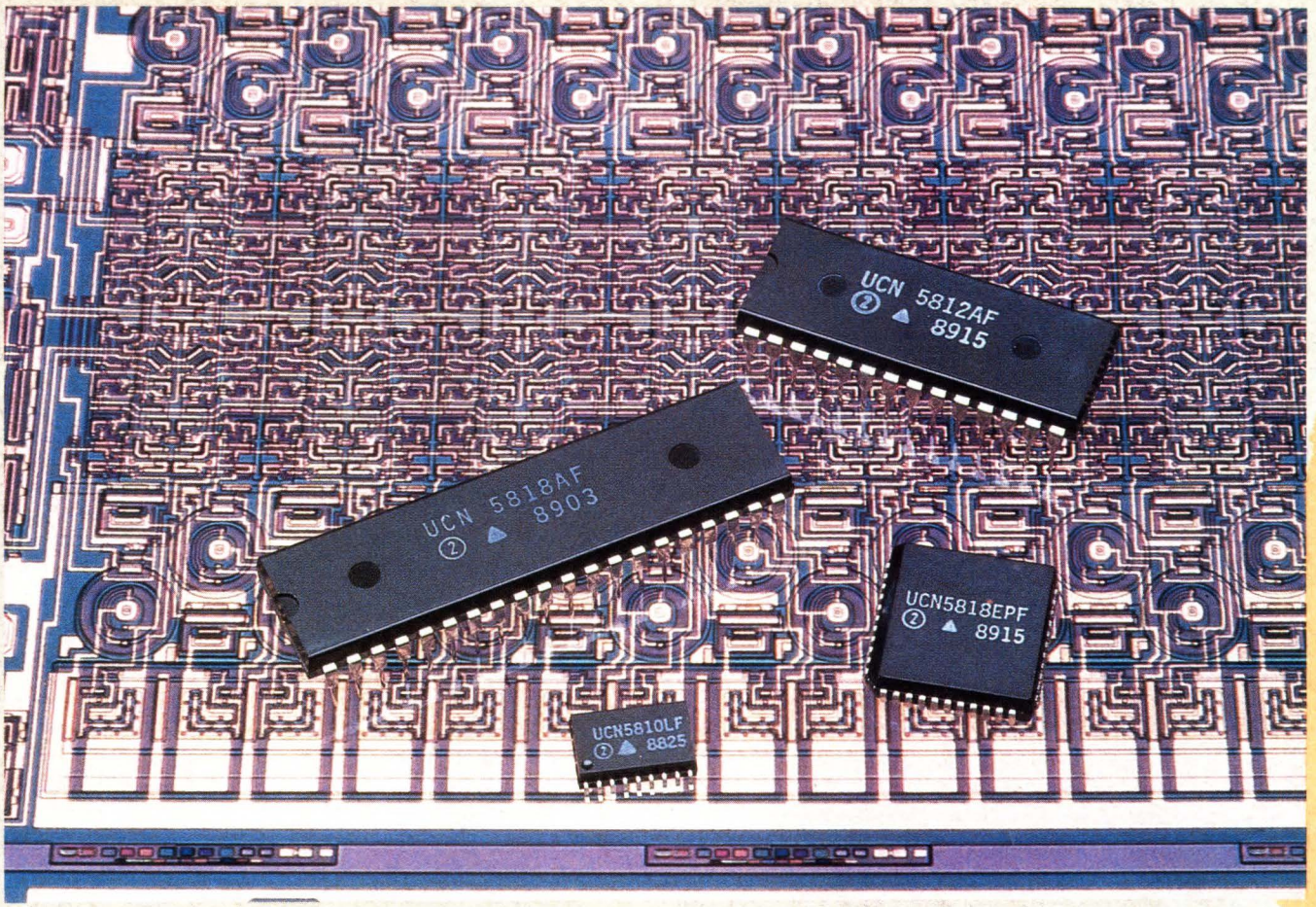
The evolution of flat-panel displays from laboratory curiosities to the large-screen commercial products of today is inextricably related to the development of suitable integrated circuits. Rather than using hundreds—or even thousands—of discrete transistors in a bulky and costly configuration, today's displays are driven by a handful of dedicated ICs. Moreover, as designers of flat-panel displays respond to demands for improved performance, greater reliability, and lower cost, IC manufacturers are responding with sophisticated high-performance chips and innovative packaging.

Perhaps nowhere are the benefits of these newer chips more apparent than in those used for electroluminescent (EL) displays where symmetric row drivers and gray-scale drivers are improving reliability and performance. One of the most important developments is the availability of symmetric row-driver chips for use with ac thin-film EL displays.

Until recently, asymmetric row drive, which requires a positive refresh pulse, was the industry standard. The sole purpose of the refresh pulse is to reverse the charge on the row capacitances so that the pixels will illuminate during the next frame. Because none of the refresh-pulse energy contributes to the display's light output, this energy is wasted. Moreover, because the *on* pixels are charged to a lower potential during the refresh pulse than during the write portion of the cycle, there is a net charge imbalance that can result in a latent-image effect (see **box**, "Display technologies and drive methods"). Although asymmetric drive is still used, designers are rapidly switching to ICs that provide symmetric drive.

Symmetry has its own rewards

With symmetric row drive, light is emitted during both the positive and negative row pulses. Instead of one refresh pulse that drives all rows positive, symmetric drive addresses each row separately. Dur-



VF drivers (Sprague Semiconductor)

ing the negative row pulse, the selected columns add to the magnitude of the row-driver voltage. During the positive row pulse, the selected columns subtract from the row-driver voltage. In other words, symmetric drive writes an entire frame in one polarity, then writes the next frame with the opposite polarity. The result of this symmetric drive is that there is no net charge imbalance—and consequently, no latent-image problem. Unlike asymmetric drive, which requires open-drain drivers, symmetric drive requires either 3-state drivers or complementary pairs of open-drain n- and p-channel drivers. Both drive methods require 225V-rated devices.

The SN75563A and SN75564A from Texas Instruments are representative of the newer breed of symmetric row-driver chips for use with EL displays. Packaged in 44-pin plastic leaded chip carriers, the devices are identical except that the output connections are reversed for ease in pc-board layout. The 34-channel devices (**Fig 1**) feature CMOS-compatible inputs and selectable open-source or open-drain outputs rated at 225V and ±70 mA. If the Positive Write input is high, the Q outputs act like open-source outputs; output data is not inverted with respect to input data. Conversely, if the Positive Write input is low, the Q outputs act like open-drain outputs, and output data is inverted with respect to input data.

During the typical operation of these row drivers, an external high-voltage switching circuit generates the composite V_{CC2} and ground signals. Serial data enters the shift register on the high-to-low transition of the clock input. A high Enable input turns on those outputs with a high in their associated register, thus connecting the corresponding row to V_{CC2} when Positive Write is high, or to ground when Positive Write is low. You can use the Serial Output from the shift register, which is not affected by the Enable or Positive Write inputs, to cascade additional devices. Unit pricing for the SN75563A or

Text continued on pg 106

Display technologies and drive methods

The major flat-panel technologies are electroluminescent (EL), plasma (PL), liquid crystal (LC), and vacuum fluorescent (VF). Because of similarities between some display technologies (EL and PL are good examples), you can frequently use the same driver IC for different displays.

Two common classifications exist for flat-panel displays: direct driven and matrix driven. In a direct-driven display, the panel elements are fixed; very little addressing is necessary (for example, in a watch's direct-driven display, addressing is only used to determine which numeric segments are turned *on*. The viewing area of a matrix-driven display is divided into intersecting rows and columns, and its addressing scheme is more complex.

In a typical matrix display, there are several hundred rows, each having several hundred columns. The picture elements (pixels) are the intersections of these rows and columns and are so closely spaced that the eye is not aware of the grain of the structure. The three most popular standards, which define the screen resolution by the number of columns times the number of rows, are

- CGA: 640×200 (2 colors) or 320×200 (4 colors)
- EGA: 640×350 (16 colors)
- VGA: 640×480 (16 colors) or 320×200 (256 colors).

Most displays have a glass face. In a 640×480 display, there are 640 vertically oriented conducting stripes (columns) placed on the inside of the front glass. The next layer of the panel, which is placed between the front glass and the back panel, contains the 480 horizontally oriented conducting stripes (rows). The column stripes on the front glass are made of either tin oxide or indium tin oxide, which are transparent conductors. Because you don't need to see through the row stripes, they are made of aluminum. The in-between material is the luminous medium: a solid (EL), a liquid (LC), or a gas (PL). A VF display, which works on the same basic principle as a triode vacuum tube, uses phosphor-coated anodes to radiate light.

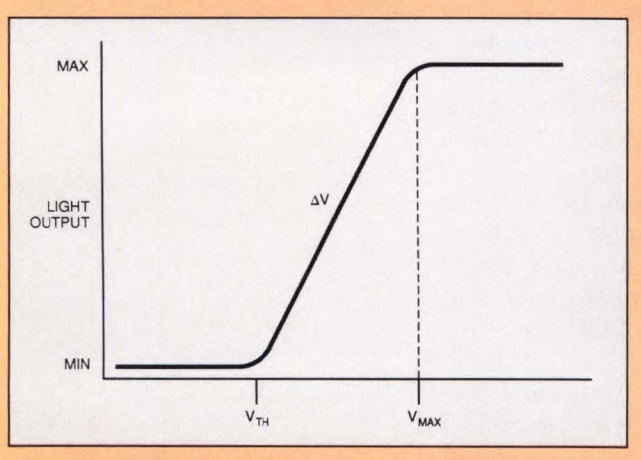


Fig A—The light output of a pixel depends on its driving voltage. The pixel needs a voltage, V_{TH}, to begin light emission. Above this threshold, light output increases to V_{MAX} and then levels off. The V_{TH} for the different display technologies varies considerably, from about a volt for some types of LCDs to several hundred volts for EL and plasma displays.

In dc displays, the emitting solid or gas makes contact with the pixel stripes; the driven load is largely resistive. In ac displays, the stripes have an insulating layer deposited on them—there is no actual conduction—and the load is capacitive. In VF displays, the load is capacitive until emission occurs, whereupon the load looks resistive. To a driver, a typical pixel exhibits the characteristics shown in **Fig A.**

A voltage, V_{TH}, begins light emission. Above this threshold, light output increases to a maximum (V_{MAX}) and then levels off. The typical V_{TH} for the different technologies varies considerably—from about a volt or so for some LCDs to several hundred volts for EL and PL displays.

The slope between V_{TH} and V_{MAX} is important; it must be stable or variations caused by temperature, for example, would cause changes in brightness. If the slope between V_{TH} and V_{MAX} is wide enough, there is the potential for generating intermediate levels of brightness, called gray scale. Gray-scale capability is essential for video images such as pictures, and nearly as important for graphics. Conventional alphanumeric data can get by with only two levels of brightness—dark and some level of bright.

The gray-scale potential depicted in **Fig A** is analog in nature. A pixel driven to V_{TH} produces no light output. Driving the pixel to as many intermediate levels as possible between V_{TH} and V_{MAX} produces a range of gray. When the slope of the curve is nearly vertical, analog-drive gray scale is not possible. However, if the display technology is fast enough, gray-scale generation is possible by subdividing the time a pixel is addressed into shorter bursts ranging from zero to several bursts. The eye integrates the total number of bursts into levels of brightness corresponding to the gray scale. Eight levels of brightness are achievable with some diplay technologies, and 16-level devices are now appearing on the market.

As mentioned, a display consists of rows of pixels, with each pixel in each row located in columns from left to right. The drivers are usually located on all sides of the panel, (**Fig B**), because leads from the IC packages are wider than the pixel spacings. Typically, half of the interlaced columns are driven from the left, the other half from the right. Such driver-

placement methods, caused by mechanical constraints, severely complicate the actual drive scheme and its timing.

The drivers themselves are usually serial-to-parallel converters with high-voltage outputs. The available data is displayed a line (row) at a time, and the total number of available lines constitutes a frame. The data enters a chain of column drivers until all of the columns for a row are filled. The data is then latched and the row driver is turned on, driving all the pixels in the row. Meanwhile, new column data is entering the drivers in order to proceed to the next row. Depending on the drive scheme, the exact sequence of row drive can vary; some schemes drive each row in turn, others drive the odd rows first and then the even rows.

An ac EL panel has a characteristic that causes repeated pulses of the same polarity to produce successively dimmer light pulses and rapid degradation of the EL material. Conversely, if the drive pulses alternate in polarity and are of equal amplitude, there is no diminution in light output. This effect has led to different drive schemes for EL displays. In one scheme, called asymmetric drive, all of the rows are sequentially written to the display in the same direction. At the end of the frame, a brief pulse of opposite polarity is emitted by all of the rows to refresh the display. The scanning of the display then proceeds to the next frame.

The problem with asymmetric drive is that each row has an indeterminate number of *on* pixels; a refresh pulse of average length can't exactly cancel the energy originally delivered to each row. As a result, some pixels may still be on if quasistatic images are displayed for long periods of time. The pattern seen is called a latent image and is similar to a burned-in image on a CRT. Newer drive methods address this problem with ICs that provide symmetric drive. However, not all EL panels are equally susceptible to latent imaging, or equally in need of symmetric drive.

The ac plasma display, which is capacitive in nature, requires an ac-waveform drive. The LCD also requires ac waveforms, which help to prevent long-term degradation to some types of liquid-crystal material. Thus, the need for symmetric drive can easily apply to more than one technology. Moreover, all display types find major use in video terminals and computer systems and must be able to handle video data rates and have fast frame speeds.

Acknowledgment

The author wishes to thank Andrew Wolff of Supertex, who provided most of the information contained in the ***box****, "Display technologies and drive methods." Thanks also to Steve Sutton of Texas Instruments, whose conference paper, "Recent developments and trends in thin-film electroluminescent display drivers," proved helpful in the discussion of symmetric row drivers. Thanks also to Dean Channing of Cherry Electrical Products, whose paper, "EL addressing technology" helped clarify the different methods for generating gray scale.*

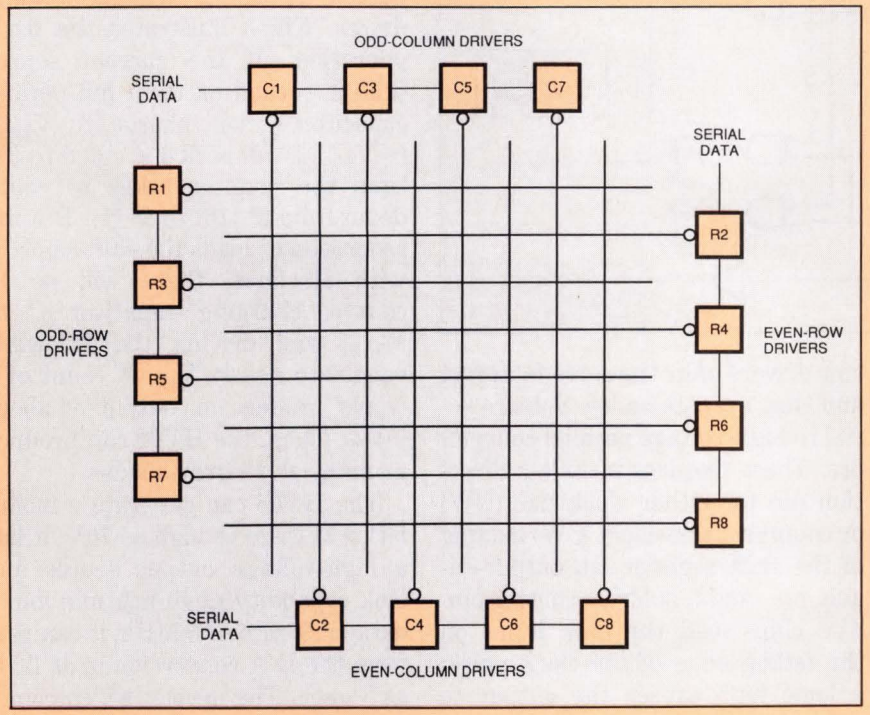


Fig B—In the typical display, half of the interlaced columns are driven from the left, the other half from the right. Drivers that are packaged in complementary left/right pinouts or have pin-selectable left/right drive capability can greatly simplify board layouts.

The development of symmetric row drivers has practically eliminated the latent-image problem with ac thin-film electroluminescent displays.

SN75564A is $11 (1000).

Although basically identical in function to the SN75563A/64A devices, Supertex Inc's HV09 (32 channels) and HV70 (34 channels) differ from the TI devices in that they use complementary n- and p-channel output drivers **(Fig 2)** rather than two n-channel drivers. The Supertex row drivers feature output-voltage ratings of 250V (HV09) and 230V (HV70). The source and sink current ratings are 200 and 70 mA, respectively. Like the TI devices, the Supertex chips come in 44-pin PLCC packages.

Both of the Supertex symmetric row drivers offer the same features, and they operate as low-voltage serial to high-voltage parallel converters. These features include a direction pin for either clockwise (CW) or counter-clockwise (CCW) loading of the shift register, an output-enable pin, and a polarity-control pin. The chips load the data input on the falling edge of the clock pulse; a logic high causes the output to swing to the supply voltage if the polarity pin is high, or to ground if the polarity pin is low. The shift register in the HV09 and HV70 is capable of speeds to 4 MHz. Although Supertex has not yet established firm pricing, estimated large-quantity unit costs are $0.20/channel for the HV09 and $0.10/channel for the HV70.

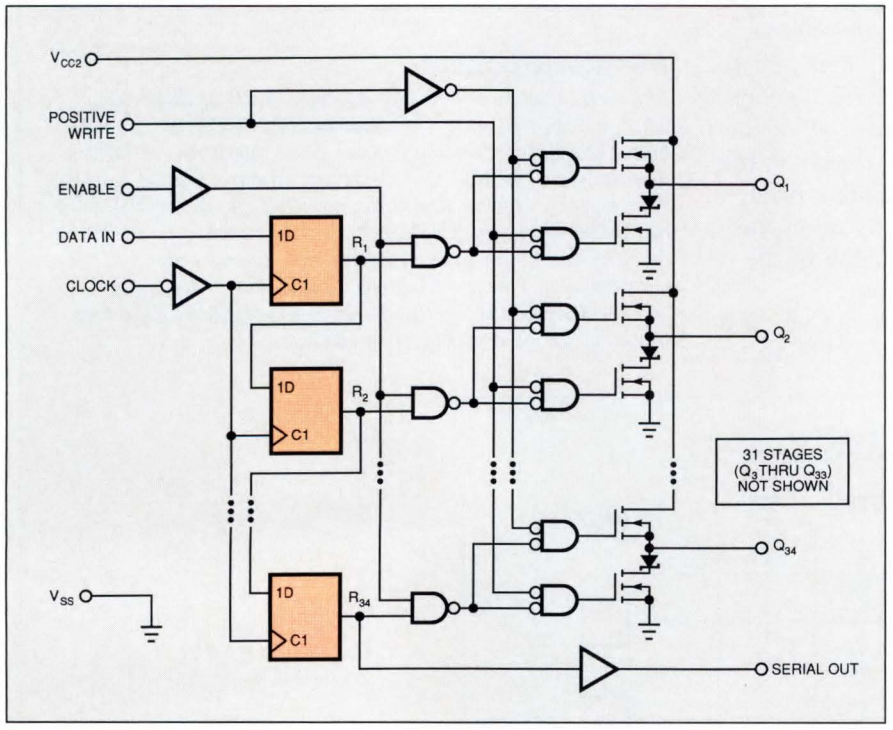


Fig 1—This symmetric row-driver chip set, the SN75563A/SN75564A from Texas Instruments, can help eliminate latent-images from electroluminescent displays. The device has 34 output channels rated at 225V and ±70 mA.

Gray-scale chips improve display

Another problem that designers of flat-panel displays and IC manufacturers have been struggling with is the generation of a gray scale for monochrome displays. Although shades of gray are not important for black-and-white text, they are of paramount concern when you need to reproduce pictures or color graphics on a monochrome display. There are two different methods currently used for generating a gray scale—the analog ramp and pulse-width modulation. Both methods modulate the column drivers in a flat-panel display.

One example of an IC that uses the analog-ramp method is the Supertex HV08 24-channel column driver. **Fig 3** illustrates the basic operation. If the current source (CS) is turned on for a full period, capacitor C will charge to V_{RAMP} ($\approx V_{PP}$). A full period is equal to the time the counter takes to count down from 2^4 (16) to 2^0 (1). If a microprocessor loads the shift register with all ones, there will be 16 counts, charging capacitor C to V_{RAMP} and driving the follower's output to nearly V_{PP}. A count of 8 would produce an output of about $\frac{1}{2}V_{PP}$. Thus, the HV08 can produce as many as 16 gray shades.

The HV08 can generate a modulation voltage as high as 70V; it has a high-voltage output source and sink capability of 40 mA min and a data-shift rate of 6 MHz; it can perform the D/A conversion in as little as 3 μsec. The device, which comes in a 44-pin PLCC, also provides a

shift-direction pin that lets you interchange the function of the shift-register data-input and -output pins. When the direction-pin input is high, data is shifted in a CW direction; when the input is low, data is shifted in a CCW direction. Supertex estimates large-quantity unit costs for the HV08 at \$0.20/channel.

Cherry Electrical Products (Waukegan, IL), uses the other method for generating gray shades—pulse-width modulation—in its EL panels. These displays use the Supertex HV77 64-channel serial-to-parallel converter as a column driver and a custom chip to generate the gray scale. Cherry apparently chose this approach for two reasons. First, at about \$0.10/channel, the combination is very cost-effective (the HV77 alone costs about \$0.05/channel in OEM quantities). Second, with pulse-width modulation, the operating point of the EL panel is always the same, a characteristic that Cherry feels is particularly important for its dc panels. The output of the gray-scale chip is the data input for the column driver and determines the width of the high-voltage pulse to the display. **Fig 4** shows the timing of the pulse-width-modulated signal, which can provide as many as 16 levels of brightness. The value of a 4-bit nibble from the gray-scale chip determines the number of periods the pulse remains on.

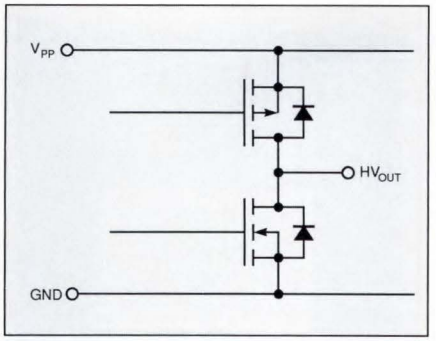


Fig 2—This output-stage configuration uses complementary n- and p-channel transistors. Such a configuration is typical of the HV09 and HV70 symmetric row-driver chips from Supertex.

Vacuum-fluorescent and liquid-crystal displays also benefit from higher-performance chips. For example, the Sprague Electric Semiconductor Group's UCN5810 (10-bit), UCN5812 (20-bit), and UCN5818 (32-bit) drivers are used with vacuum-fluorescent diplays. Fabricated in Sprague's BiMOS II process, these "smart-power" drivers **(Fig 5)** combine a low-power, high-speed shift register, data latches, and control circuitry with 10, 20, or 32 high-speed bipolar outputs that have active DMOS pull-down circuitry. The shift register and data latches allow direct interfacing with μP-based systems, and a CMOS serial-data output pin allows cascading of additional devices.

Along with the ability to sink 3.5 mA, the DMOS active pull-downs in these devices exhibit a maximum impedance of only 3 kΩ vs the 5-kΩ max impedance of competitive devices, a feature that provides faster, more positive blanking of the display digits and allows high refresh rates. This feature can eliminate interdigit "ghosting," in which a turned-off display character has insufficient time to extinguish completely before a new character fully turns on. Typically, these drivers can operate at 5 MHz with a 5V logic supply and at 7.5 MHz with a 12V supply. The drivers have output ratings of 60V at −40 mA and feature low logic-supply currents. The UCN5818, for example, has a maximum logic-supply current of 200 μA in both the on and off states—about one-tenth that of competitive devices, according to Sprague. The drivers come in a variety of package styles including DIP, PLCC, and SOIC. Prices start at \$1.60 (5810), \$2.68 (5812), and \$4.73 (5818) (100).

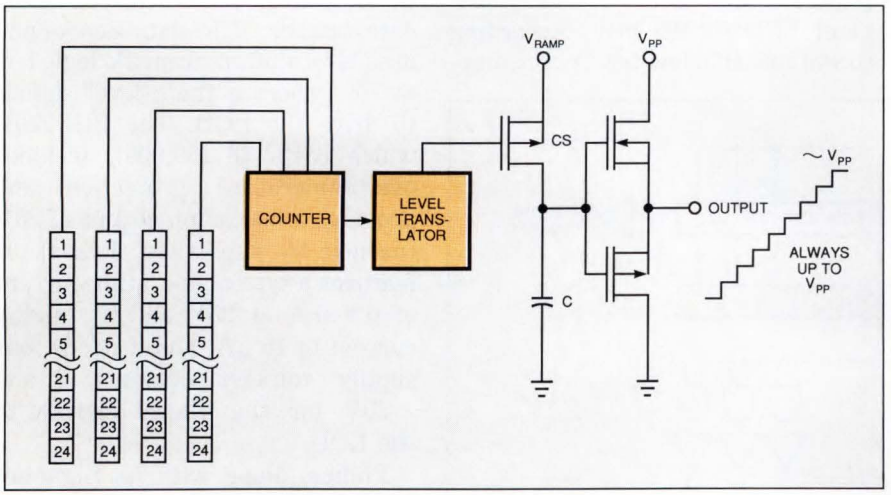


Fig 3—In this gray-scale column driver, the output is digitally ramped to a given level. The current source in this Supertex HV08 device charges the capacitor for a time set by the number of pulses in the counter, which is determined by the number of bits in the shift registers. With 4 bits in each shift-register, 16 output-voltage levels (gray shades) are available.

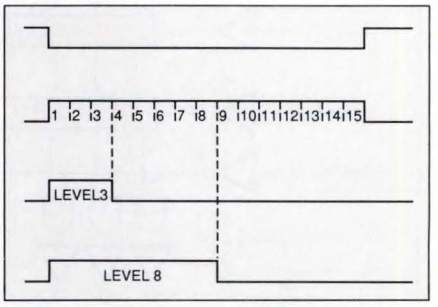
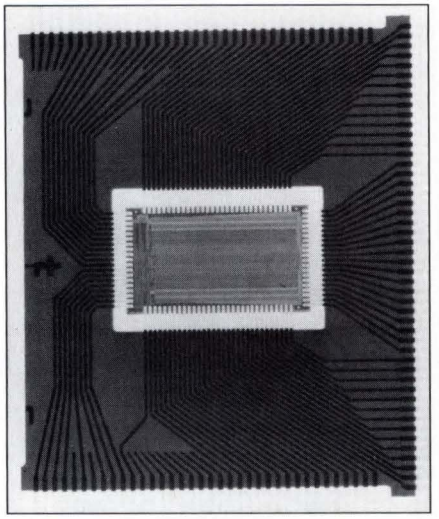


Fig 4—Another method for generating a gray scale uses pulse-width modulation. Depicted here are two different levels of gray (out of a total of 16), which are determined by the pulse width.

Two methods generate a gray scale for monochrome displays—the analog ramp and pulse-width modulation.



The PCF2201 row/column LCD driver in a tape-automated-bonding (TAB) package (Philips Components)

Another device that is extending the performance boundaries for flat-panel displays—in this case LCDs—also extends the packaging boundaries. The PCF2201 LCD driver from Philips is encapsulated in a 120-pin tape-automated bonding (TAB) package that keeps all of the wiring on a single plane, thereby eliminating the need for costly, double-sided substrates. Implemented in a CMOS p-well, polysilicon-gate process, the device cuts the typical power needed to drive a 640×400-pixel LCD to 100 mW. According to Philips, this low power consumption enables battery-operated equipment such as portable computers to work nearly twice as long without recharging than was heretofore possible.

The PCF2201 features a data-transfer rate of 16M bps and multiplex rates from 1:32 to 1:256; it drives both conventional twisted-nematic displays and the most recent SBE (super-twisted, birefringent-effect) LCDs. Controlled by any industry-standard LCD controller, you need only 21 PCF2201s to drive a 640×400-pixel SBE display. The IC converts display data into parallel LCD drive waveforms for as many as 81 rows or 80 columns. It also includes an electronically implemented left or right orientation, a feature that simplifies system design and reduces inventory requirements.

The IC accepts 4-bit parallel or serial data from an external alphanumeric graphics-controller chip. When used as a row driver, the PCF2201 serially clocks the scanned data through the 81 bidirectional shift-register cells to provide a selectable scan configuration. When used as a column driver, the shift registers hold column data until the next line is assembled in the data latches. The data conversion uses level shifters from 5V logic levels to generate the 4-level signals to drive the LCD. The PCF2201, which costs $6 (50,000), includes overtemperature protection and provides a maximum output of 25V (needed by supertwist LCDs). It features a typical operating current of 0.4 mA at 25V and a standby current of 15 μA, and it needs four supply voltages between 5 and −20V for the 4-level signals to the LCD.

Philips, along with its Signetics subsidiary, also offers several other driver chips for LCDs, including the PCF8578 row/column driver and the PCF8579 column driver. Com-

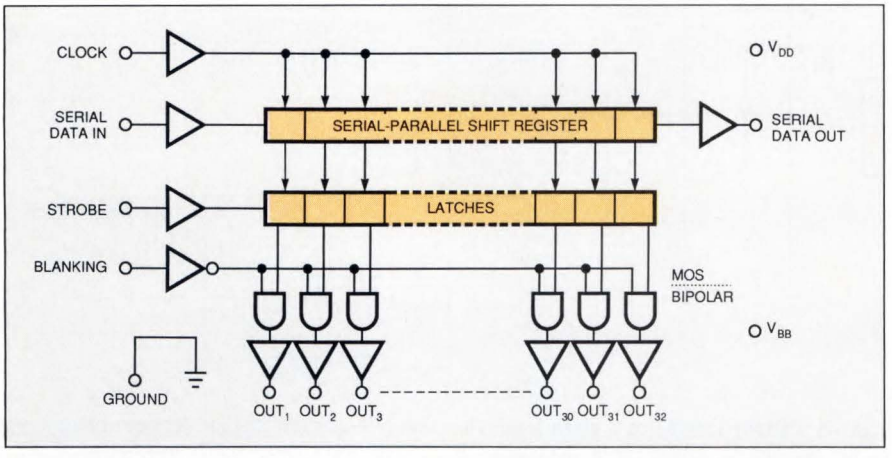


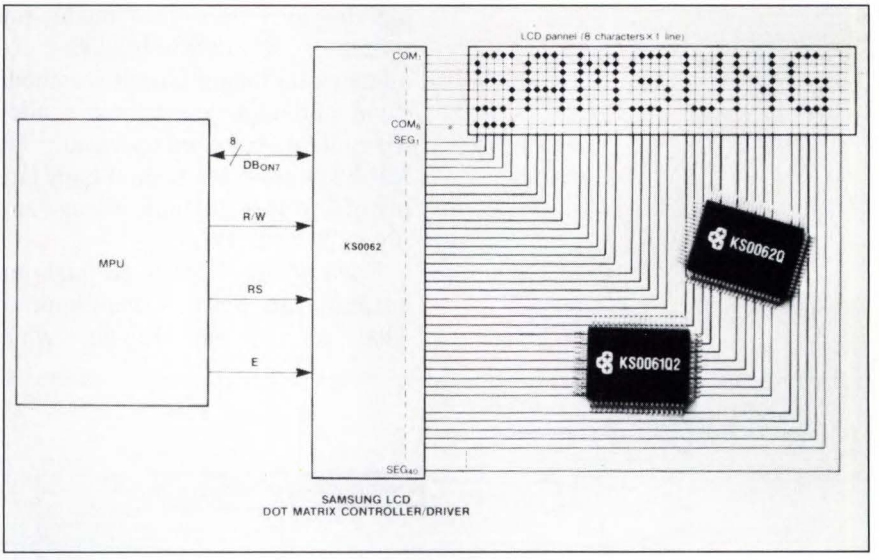
Fig 5—Designed primarily for use with vacuum-fluorescent displays, the UCN5818 from Sprague Semiconductor provides 32 outputs and features latched source drivers with active DMOS pull-downs.

patible with the I^2C bus (a 2-line bidirectional bus), these chips are suitable for medium-multiplex-rate, dot-matrix LCDs. The chip set typically consumes only 20 μA of current per chip—about one-twentieth that of competing chips, claims Philips. The chips can drive graphics or character diplays at multiplex rates between 1:8 and 1:32, and you can configure the chips to drive as few as 256 or as many as 40,960 dots. The chip set, which operates from supplies between 2.5 and 6V, is suitable for a variety of battery-powered equipment (in telecommunications and automotive applications, for example).

The PCF8578 row-and-column controller/driver has 40 outputs, which are suitable for driving a 5×8 dot-matrix character display. Standing alone, and depending on the multiplex rate, the device can drive as many as 384 dots in various combinations of rows and columns. The selectable multiplex rates enable the IC to drive between 8 rows of 32 pixels and 32 rows of 8 pixels. You can cascade the 8578 with one or more 8579 40-output column drivers for larger horizontal displays. The 8578 provides the clock signal and the display synchronization for the 8579. The 8578 works with as many as 32 cascaded 8579s, either as a row/column driver or as a row driver with as many as 32 output rows. The PCF8578 and PCF8579 come in a variety of packages, including a 56-pin minipack and a 64-lead tape-automated-bonding module. The devices cost from $2 to $5, depending on quantity.

High-voltage LCD drivers

Although the majority of flat-panel displays suit applications in the commercial and industrial markets, the military also uses a variety of display types, including LCDs. Military applications generally use dichroic LCDs, which provide superior contrast, wider viewing angles, higher speed at low temperatures, and less light bleed-through in darkness. However, dichroic LCDs require higher voltages to achieve these benefits. Moreover, to ensure device reliability in critical systems such as avionics displays, the military prefers to derate ICs by 50%. This supply-voltage derating provides an additional safety margin for protection against power-supply line transients. When given a choice, the military prefers to use a 100V device in a 50V application.



Dot-matrix controller/driver (Samsung Semiconductor)

Until recently, the available driver ICs topped out at about 32V, generally the maximum available from standard CMOS devices—and the voltage at which the advantages of dichroic LCDs begin. The MIC8031 from Micrel Semiconductor, however, has changed the ground rules. Fabricated with a low-voltage CMOS and high-voltage DMOS technology, the IC features a 100V rating and can drive dichroic displays at 35 to 60V and still maintain an extra margin of reliability.

The MIC8031 (**Fig 6**) operates as follows: The TTL/CMOS-compatible serial input sends data into a

Low-power LCD row/column drivers help reduce power drain for battery-operated equipment such as portable computers.

38-bit shift register, which, on command, loads a 38-bit latch register. The latch register controls the high-voltage output drivers, which can drive 30, 32, or 38 segments. An RC-controlled internal oscillator provides the backplane frequency or, in the case of multiple cascaded devices, the master chip's backplane frequency. The oscillator input automatically detects whether the chip is self-oscillating or being driven in the slave mode, and switches a divide-by-256, frequency-stabilizing circuit in or out. Load and chip-select inputs allow μP control of system operation. The MIC8031 operates from a logic supply of 5 to 15V; its high-voltage supply is 20 to 100V.

Each of the device's 38 push-pull outputs can drive a maximum of 4000 pF of capacitance, which makes the device suitable for use with other displays such as plasma, vacuum fluorescent, and ac electroluminescent. The MIC8031 comes in a 48-pin plastic DIP and a 44-pin ceramic LCC package for MIL-STD-883C operation. Pricing for commercial versions start at $27.90; military versions cost $54.50 (100).

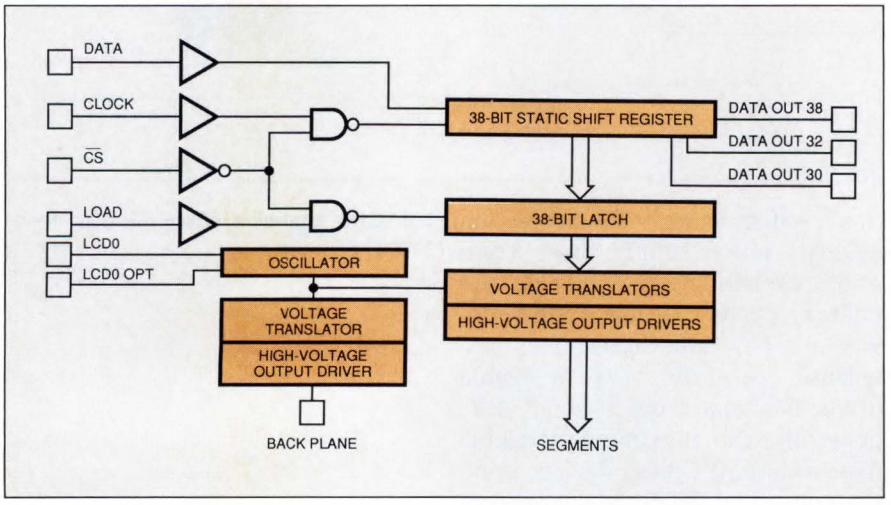


Fig 6—With 38 high-voltage outputs, the MIC8031 from Micrel Semiconductor can drive both dichroic and standard liquid-crystal displays. Because of its 100V rating, the device is particularly useful for driving dichroic LCDs in military applications.

A quartet of LCD drivers from Samsung Semiconductor includes two devices for use with character (alphanumeric) displays and two for use with graphics displays. The two character-display types are the KS0061, a 40-channel segment/common driver, and the KS0062 controller/driver.

The segment driver has two sets of 20-bit bidirectional shift registers, 20-bit data-latch circuits, and 20-bit driver circuits. A direct replacement for the comparable Hitachi driver, the KS0061 receives serial display data from the controller section of the KS0062, converts it into parallel data and supplies waveforms to the dot-matrix LCD panel. The data can drive a static or dynamic liquid crystal and is usable as a common driver or a segment driver.

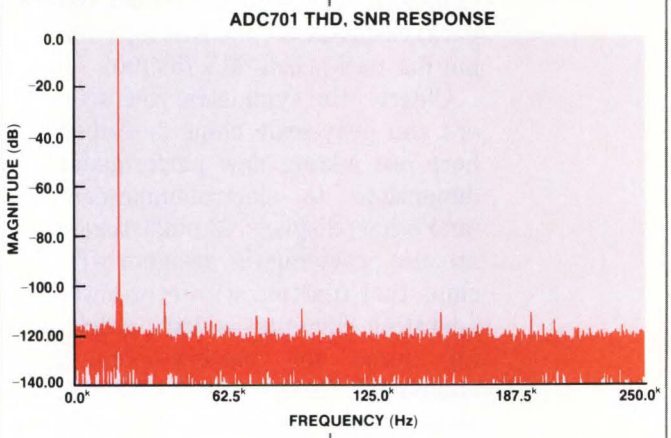
The more complex KS0062 controller/driver contains an on-chip character ROM and can provide multiplexed ac drive to the LCD. The chip also contains a display data RAM for 80 characters (80 × 8 bits). In addition to its drive capability, the KS0062 offloads a number of display housekeeping chores from the main processor. The KS0062 is a direct replacement for the comparable Hitachi device and interfaces with 4- or 8-bit μPs to drive a dot-matrix LCD that produces alphanumerics, characters, or symbols. The chip set can display as many as 80 characters simultaneously. The KS0061 (60-pin flat pack) costs $5.61; the KS0062 (80-pin flat pack) costs $11.25 (100).

The drivers for graphics displays are the KS0101 68-channel common driver and the KS0102 80-channel segment driver. The KS0101 contains 68-bit bidirectional shift registers, 68-bit level shifters and 68-bit 4-level drivers. Although the chip has a 68-channel output, you can drive a wider dot-matrix panel by paralleling devices.

The KS0102 contains 80-bit bidirectional shift registers, 80-bit data latches, 80-bit level shifters, and 80-

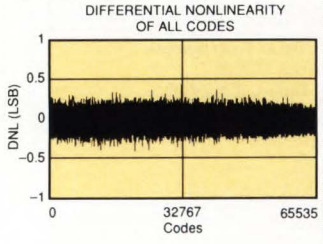
New 16-Bit, 500kHz Sampling A/D System

Advanced Signal Processing Solutions



Our new high performance analog-to-digital conversion system is specifically designed and tested to excel in demanding ATE, FFT spectrum analysis, imaging, professional audio, and other advanced signal processing applications.

The new system comprises a matched pair of hybrid components: the SHC702 sample/hold amplifier and the ADC701 16-bit A/D converter. The ADC uses three-step subranging for fast, accurate conversions.



Unmatched Spurious-Free Dynamic Range

Together, SHC702 and ADC701 form a very compact, fast, low-distortion system with exceptional spurious-free dynamic range and low power consumption. Features include:

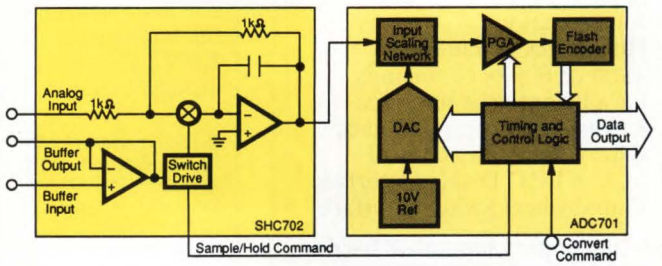
- 16-bit resolution
- DC to 500kHz conversion rate
- 107dB spurious-free dynamic range (20kHz)
- 0.00068% THD (20kHz), 0.0078% THD (199kHz)
- -81.4dBc IMD (195/200kHz)
- 93dB SNR (5kHz)
- ±0.002% FSR dynamic nonlinearity
- no missing codes guaranteed

Big Space Savings!

These new components employ our advanced monolithic technology to give you better performance and reliability than modular devices plus a lot more board space to work with. SHC702's 24-pin metal DIP measures only 1.4″ x 0.8″, and ADC701's 40-pin ceramic/metal DIP is only 2.1″ x 1.1″.

- 0/+5V, 0/+10V, -10/0V, ±5V, and ±10V input ranges
- CMOS/TTL compatible
- 2.8W combined power dissipation
- internal +10V reference
- ±10ppm/°C gain stability
- demonstration board and complete layout information available
- From $579* (ADC701 and SHC702)

Call 1-800-548-6132 toll-free for immediate assistance.



Burr-Brown Corp., P.O. Box 11400, Tucson, AZ 85734.

*U.S. unit prices, in 1000s.

BURR-BROWN®

The use of high-voltage (100V) drivers can improve the reliability of military equipment that uses dichroic LCDs operating at 35 to 45V.

bit 4-level drivers. The chip receives 4-bit parallel display data from the controller and then outputs the driving waveform to the dot-matrix LCD panel. A power-down function keeps the power consumption of this CMOS device to a minimum. The KS0101 (80-pin flat pack) costs $14.50; the KS0102 (100-pin flat pack) costs $15.75 (100).

Clearly, the symmetric row drivers and gray-scale chips described here are adding new performance dimensions to electroluminescent (and other) displays. Manufacturers are also providing the designer with chips that function with ever-lower operating currents—always a driving force for battery-operated equipment. Completing the picture, chips with selectable left-right drive are providing greater versatility and ease in board layouts, as are innovations such as tape-automated-bonding (TAB) packages.

EDN

Article Interest Quotient
(Circle One)
High 515 Medium 516 Low 517

For more information . . .

For more information on the display drivers discussed in this article, circle the appropriate numbers on the Information Retrieval Service card or use EDN's Express Request service. When you contact any of the following manufacturers directly, please let them know you saw their products in EDN.

Hitachi America Ltd
Semiconductor & IC Div
2000 Serra Point Pkwy
Brisbane, CA 94005
(415) 587-8300
Circle No 366

Micrel Semiconductor
1235 Midas Way
Sunnyvale, CA 94086
(408) 245-2500
Circle No 367

Philips Components
Box 218
5600 MD Eindhoven
The Netherlands
(040) 791111
Circle No 368

Samsung Semiconductor
3725 N First St
San Jose, CA 95134
(408) 434-5400
Circle No 369

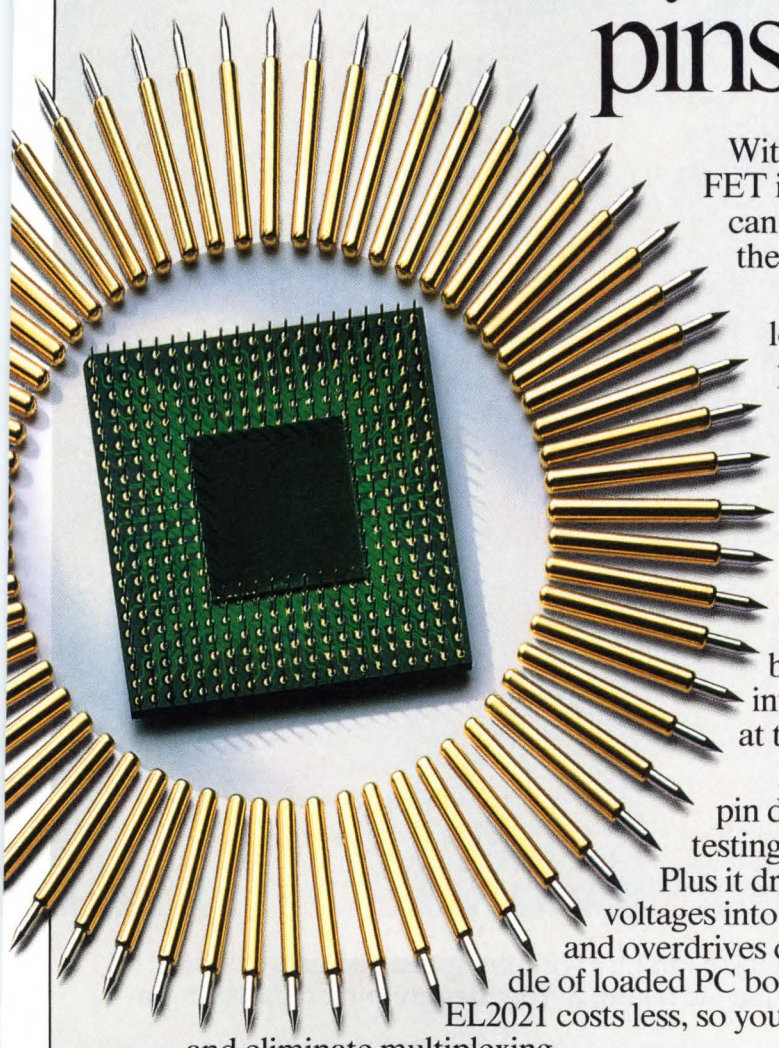
Signetics Corp
811 E Arques Ave
Sunnyvale, CA 94088
(408) 991-2000
Circle No 370

Sprague Semiconductor
115 Northeast Cutoff
Worcester, MA 01615
(508) 853-5000
Circle No 371

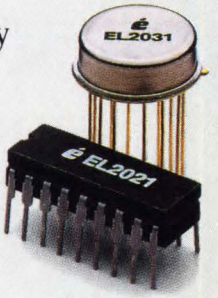
Supertex Inc
1225 Bordeaux Dr
Sunnyvale, CA 94088
(408) 744-0100
Circle No 372

Texas Instruments
Box 809066
Dallas, TX 75380
(800) 232-3200
Circle No 373

Thanks to Elantec, ATE design engineers are no longer kept waiting on pins and needles.



With Elantec pin drivers and FET input buffers, the ATE industry can stop sitting on the edge of their seats.



Whether it's for IC or loaded PC board testers, our parts are higher performing than the competition. Not to mention more affordable.

As are Elantec analog ICs for all applications—from ATE, video and LANs, to instrumentation, disk drives, and more.

One product that pins down the fastest logic devices is our FET input EL2031 buffer amplifier. It drives 7000V/μs signals into 100 ohm loads. Or buffers those signals at the pin receiver.

Another example is our EL2021 monolithic pin driver. It supports in-circuit and functional testing with a programmable slewrate to 250V/μs. Plus it drives externally programmed voltages into difficult and reactive loads and overdrives device outputs in the middle of loaded PC boards. Best of all, the EL2021 costs less, so you can afford a part per pin and eliminate multiplexing.

For all high-performance applications, look to the full family of Elantec high-speed analog products. Everything from amplifiers and buffers, to comparators and transistor arrays. Each backed by the industry's only two-for-one guarantee. Elantec, analog that's ahead of the times.

There's No Wait For A Selection Guide. For your free copy, circle the bingo number or write Elantec.

Because when it comes to designing PC board or IC testers, you'll never need to be needled again.

élantec
HIGH PERFORMANCE ANALOG INTEGRATED CIRCUITS

Elantec: 1996 Tarob Court, Milpitas, CA 95035. Telephone: (408) 945-1323, Fax: (408) 945-9305 © 1989 Elantec
European Sales: 87 Jermyn Street, London, SW1Y6JD, England. Tel: 44-1-839-3841, Telex: 917835, Fax: 44-1-930-0751

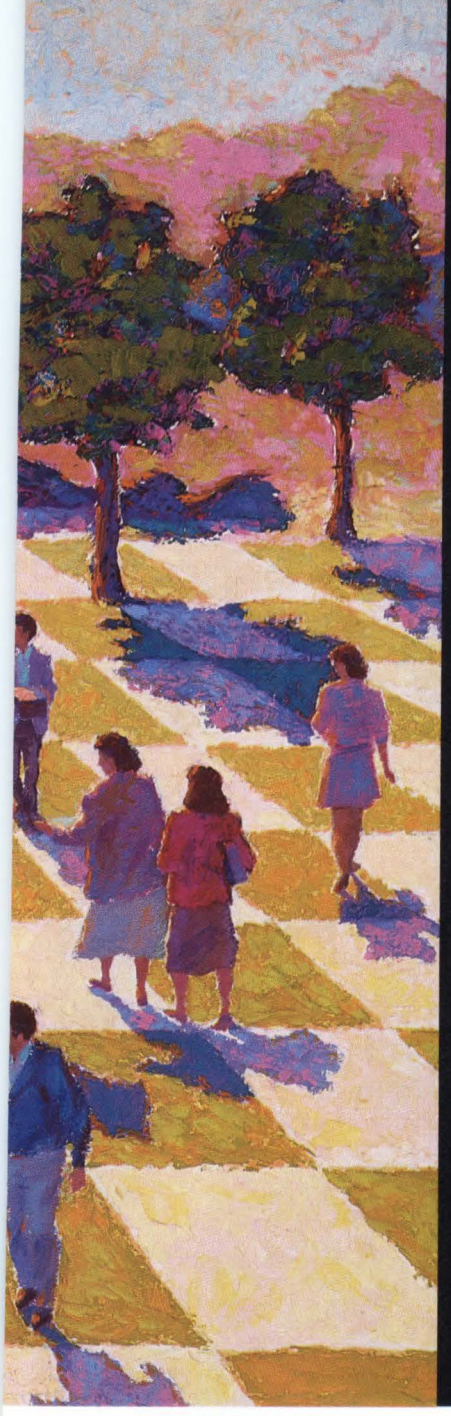
Think of it. Building the first laptop computer with the speed and graphics of a high-end workstation. Now imagine taking it from design to manufacturing in months, instead of years.

ASIC is the only way to do it. And LSI Logic is the only logical choice.

With an ASIC Design Methodology and in-depth support to help you design more ASIC devices across the board: on-chip RISC microprocessors, logic, A/D conversion, cache memory, everything.

It's what sets us apart from other ASIC companies: an end-to-end solution that combines the highest quality development tools with state-of-the-art IC fabrication technologies.

Like our Modular Design Environment™ software, with more than 400 complex



ASIC ACROSS THE BOARD.

building blocks containing accurate and fully functional timing models. You'll save time and money by performing complete simulations of your whole system before committing to silicon.

And our advanced technologies that can replace hundreds of standard devices with a single ASIC device: 0.7-micron technologies with up to 200,000 useable gates; Channel-Free™ array and cell-based architectures in CMOS or BiCMOS; integrated RISC technologies; three-layer metal; and plastic packaging so advanced you can specify up to 524 pins.

LSI Logic's ASIC Design Methodology. It's more than just a practical approach to system design. It's why we outperform other ASIC companies where it matters most.

Across the board.

LSI LOGIC®

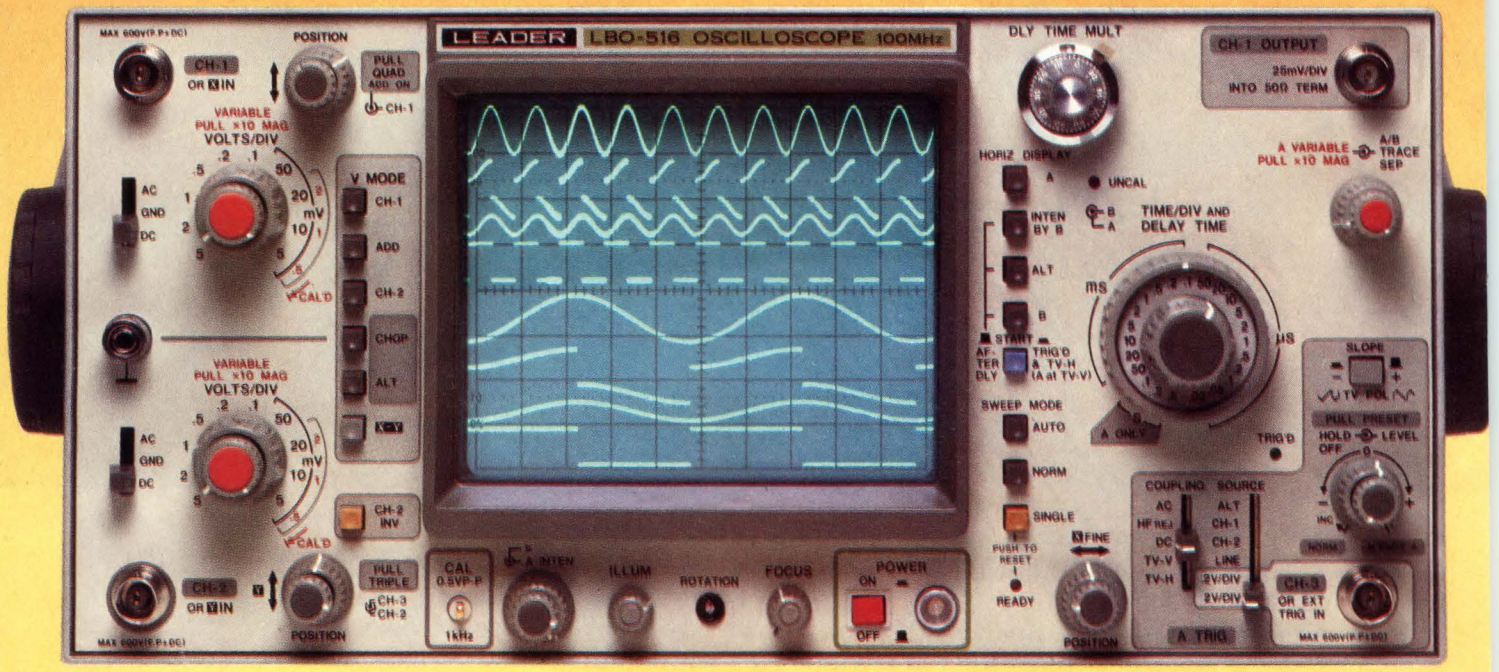
ACROSS THE BOARD

CIRCLE NO 76

LEADER

LBO-516
NOW 100-MHz OSCILLOSCOPE

$1495 Manufacturer's Suggested List Price



- 8-Trace Capability
- Alternate Triggering
- 2 Time Bases
- 3-Channel Input
- Clear, Bright Trace
- 0.5 mV Sensitivity
- 2-Year Warranty
- Coast-to-Coast Service

For immediate delivery or more information call toll-free

800-645-5104

In New York State
516-231-6900

For professionals who know the difference.

LEADER Instruments Corporation

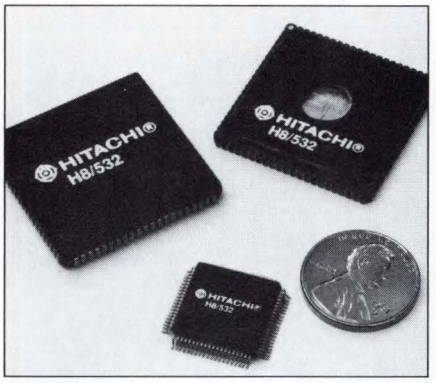
380 Oser Ave., Hauppauge, NY 11788

CIRCLE NO 77

8-bit microcontroller incorporates a slew of peripheral functions

The H8/532 is an 8-bit μC that features more than 25 built-in analog and digital peripheral functions. Its internal structure and memory capacity enable the device to support high-level languages. The device offers a dual ALU structure with a 16-bit-wide internal data path that lets the CPU run at 10 MHz. Instructions execute in 200 to 400 nsec.

The H8/532 provides plenty of memory space: 32k bytes of EPROM and 1k byte of RAM. The chip lets you access external memory either with or in place of the internal memory. Its five operating modes consist of internal memory only, internal *and* 64k-byte or 1M-byte external memory, or either of the external memory capacities alone.



Other features include a 10-bit A/D converter, an 8-input multiplexer, and four 16-bit registers that buffer the data. The converter has its own S/H circuit and offers a 13.8-μsec conversion time.

Digital data paths on the H8/532 include nine I/O ports and a serial-communications interface with a baud-rate generator. The serial interface handles either synchronous or asynchronous communications at a data rate of 2.5M bps max. The I/O ports include 57 bidirectional lines and eight input-only lines.

The H8/532 is available in windowed-EPROM and one-time-programmable versions in either an 84-pin plastic leaded chip carrier or an 80-pin quad flat pack. It costs $59 (100).

Hitachi America Ltd, 2210 O'Toole Ave, San Jose, CA 95131. Phone (408) 435-8300.

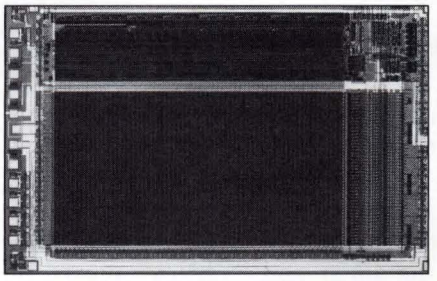
Circle No 445

Content-addressable memory yields address when given data

The Am99C10 memory device works in reverse: You give it data, and it gives you the address. Content-addressable memory (CAM) is suited to applications that require frequent searches for specific information.

The Am99C10 CAM is organized as 256 16- or 48-bit words and includes a mask register. When you present data to the CAM, it performs 256 simultaneous comparisons between the memory and the data word. You can use the register to selectively mask any or all bits from the comparison process. If the CAM finds a match, it sets a flag and identifies the address of the matching word.

To identify all the matches, you must use two additional bits of



memory located at each cell—the empty bit and the skip bit. Both bits can disable a match for their word. The empty bit indicates that a memory cell is available for new data; the skip bit lets you identify all matching words other than the word with the lowest address. To locate the multiple matches, set either the skip bit or the empty bit for each matching word and repeat this match operation until the CAM stops issuing a match signal.

The CAM lets you write the skip and empty bits of each word individually. You can either clear or set all the empty or skip bits simultaneously. Further, the device automatically clears the two bits when you write new data to a memory cell.

The Am99C10 CAM is a TTL-compatible CMOS device. It operates at 5V with 100-nsec cycle times and draws a maximum of 715 mW. Priced at $42.50 (100), the device comes in a 28-pin ceramic or plastic DIP or in a 32-pin plastic leaded chip carrier.

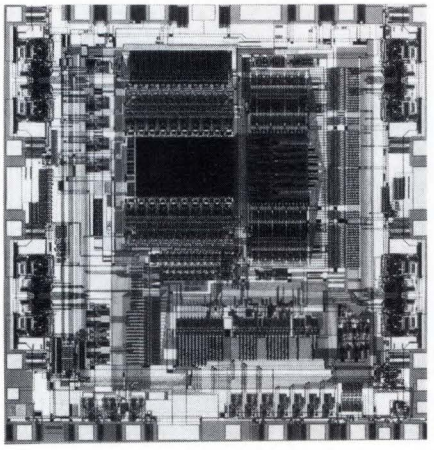
Advanced Micro Devices Inc, 901 Thompson Pl, Sunnyvale, CA 94088. Phone (408) 732-2400.

Circle No 446

ECL-compatible PLDs offer propagation delays of 6, 4, 3, or 2.5 nsec

If you'd like to combine the convenience of programmable logic with speed for your ECL design, consider the BiCMOS CY10E301 and CY10E302.

These devices are available in three speed ranges and two power levels. Standard-power 301 devices consume 240 mA; 302s consume 220 mA. Low-power versions of both devices consume only 150 mA. Propagation delay times are 6, 4, or 3 nsec for the 301 and 6, 4, or 2.5 nsec for the 302. The low-power versions are only available with 6-nsec speeds. Both the CY10E301 and CY10E302 are compatible with 10KH series ECL.



The CY10E301 features 12 input, four input/output, and four output-only signal lines. Each output signal comes from an AND-OR logic combination of the input and output signals or their complements. Each output line also offers selectable polarity, thus allowing you to specify either high or low as the active logic state. The device is functionally equivalent to an industry-standard 16P8.

The CY10E302 offers eight input and four output signal lines. Output signals are logic combinations of input signals and their complements only; output signals are not available to the AND-OR array. This device is equivalent to the 16P4.

Both devices offer a security feature—a fuse that, when blown, prevents the design pattern from being read. You can choose 24-pin ceramic DIPs or 28-pin LCCs for standard-power devices. The low-power versions come in plastic or ceramic DIPs or plastic leaded chip carriers. The 3-nsec CY10E301 costs $55.45; the 2.5-nsec CY10E302 is $66.50 (100). Low-power versions in plastic DIPs cost $37 and $44.35 (100), respectively.

Cypress Semiconductor, 3901 N First St, San Jose, CA 95134. Phone (408) 943-2600.

Circle No 447

μP packs workstation power and graphics ability in 1 M-transistor chip

The 80860 microprocessor, with more than 1,000,000 transistors, integrates a RISC core, a floating-point unit (FPU), a graphics memory-management unit (MMU), an instruction and data cache, and a bus control unit. At 40 MHz, the chip achieves 80M flops and can sustain 500,000 4×4 matrix transformations/sec. In addition, the graphics MMU can Gouraud-shade 50,000 100-pixel triangles/sec.

The RISC core has a 32×32-bit integer register file. This core decodes and executes load, store, integer, bit, and control-transfer instructions. It also fetches floating-point as well as integer instructions and can operate in parallel with the FPU.

The FPU has a separate register file that you can configure as 8×128, 16×64, or 32×32 bits. Both the adder and multiplier units can provide one result for every clock cycle. When pipelined, they operate at 2 results/clock cycle, thus yielding the 80M-flops rate.

The MMU can translate addresses from linear logical space to linear physical space for both instructions and data. The processor stores translated address information in a table and caches the table in a 64-entry, 4-way associative memory. The page tables are compatible with those of the 80386. The data and instruction caches' aggregate bandwidth is 1G byte/sec. Both caches are 2-way set-associative memories divided into 32-bit blocks. The instruction cache is 4k bytes; the data cache is 8k bytes.

The bus-control unit works with conventional static-column dynamic RAM. A pin indicates whether the next address takes place using the same page. The unit supports both pipelined and nonpipelined operation and costs $750.

Intel Corp, 3065 Bowers Ave, Santa Clara, CA 95051. Phone (408) 987-8080.

Circle No 448

This tiny vibration is about to give your customer the shakes.

Put a damper on vibration with 3M Scotchdamp™ Vibration Control Systems.

It's a fact of science. As materials become lighter, they are increasingly prone to the disruptive effects of vibration. Now there's a solution that makes life a lot easier for today's design engineers—Scotchdamp Vibration Control Systems.

Custom designed to your exact specifications, these systems combine energy dissipating polymers with other key materials to solve specific vibration problems. For example, stainless steel dampers, now being used on hard disk drive suspension assemblies, virtually eliminate vibration and thereby reduce data errors.

If you're designing electro-mechanical devices of any kind, Scotchdamp Vibration Control Systems can help you eliminate troublesome vibrations. Team up with 3M, a world leader in vibration control materials, to increase your customers' satisfaction—and yours—through vibration-free product performance. Circle the reader service number or write: 3M Industrial Specialties Division, Building 220-7W-04, 3M Center, St. Paul, MN 55144-1000. Better yet, call (612) 733-7411 today.

Circle 78 for Sales Assistance

Circle 125 for Information

3M

Ethernet controller chip supports 32-bit transfers

Although a latecomer to the LAN-controller market, the 92C28 Ethernet controller chip promises to deliver unusually high system performance through its 32-bit interfacing capability. The $35 (5000) device can operate as a local bus master or as a slave to a host μP, and it maintains a full complement of network statistics as defined by the IEEE-802.3 layer-management draft specification. Because the device uses design rules compatible with NCR's 1.5-μm ASIC fabrication process, the vendor can develop alternate versions of the controller for specific applications.

Internally, the 92C28 employs a 16-bit architecture. You can connect the IC to a host μP as a slave device by using either a memory-mapped or an I/O-mapped interface—the chip has control pins for both interface types. The chip can also share its buffer memory with a μP through a DMA request/acknowledge protocol.

Through multiplexing, you can adapt the 92C28's 16-bit data bus to a 32-bit system. Using a 32-bit interface improves the match between the LAN controller and a 32-bit μP. The interface also boosts system performance by raising the maximum data-transfer rate to 20M bytes/sec.

The Ethernet controller's 32-bit mode supports 256k bytes of buffer RAM compared with only 128k bytes for the 16-bit mode. The device maintains several network performance statistics in on-chip registers. In addition, the chip records error statistics relating to the transmitting and receiving of packets.

The 92C28's network-maintenance statistics registers implement the functions listed in the IEEE-802.3 layer-management draft specification, thus encouraging you to integrate layer-management functions in your Ethernet designs.

NCR Corp, Microelectronics Div, 2001 Danfield Ct, Fort Collins, CO 80525. Phone (800) 334-5454. FAX 303-226-9556.

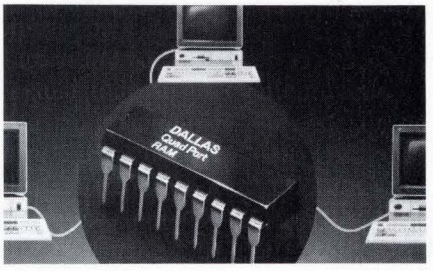
Circle No 449

Quad-port RAM solves contention and arbitration problems

The DS2015 quad-port serial RAM uses 4-way-access memory cells to permit simultaneous message passing among four independent devices at transmission rates of 4M bps.

This CMOS IC routes data from a given channel to any of the chip's four storage centers, storing the data until the intended recipient is ready for it. It then distributes the data and produces a signal when the message transfer is complete. This design provides simultaneous reading of data from any of four independent control points.

With this capability, you avoid having to resort to complex software algorithms and handshaking protocols in order to arbitrate access to memory. Accordingly, you



remove an extra processing burden from your μPs by eliminating such overhead logic, which in turn increases the speed with which the μPs can transfer data. You also avoid the data corruption that can occur during bus contention.

The DS2015 comprises four banks of 8-byte registers. Each port can read and write to its own bank and read the three other ports' banks. One additional byte in each bank serves as a flag register. This chip routes data from a given channel into one of the four storage areas and signals the presence of data in that area. Communication with each of the four ports occurs via a 3-wire serial bus, which is standard in most μPs. Its CMOS fabrication lets you build the DS2015 into a battery-powered, free-standing 4-port connector.

Available as either an 18-pin DIP or a small-outline package, the DS2015 sells for $6.25 (100).

Dallas Semiconductor, 4350 Beltwood Pkwy S, Dallas, TX 75244. Phone (214) 450-0400. FAX 214-450-0470. TWX 650-244-1669.

Circle No 450

SIEMENS

Perfectly Balanced CMOS A/D Converters

In the eternal balancing act between speed, accuracy and cost-effectiveness, nothing comes closer to perfection than the Siemens family of A/D converters.

With speeds as fast as 13μs, and a total unadjusted error of only $\pm$0.5 LSB over the entire temperature range, they're at the top of their class in performance. And when it comes to balancing costs, their flexibility and upgradability put them in a class by themselves.

Take our 12-bit SDA 0812. It's self-calibrating, so you can eliminate those time-consuming, labor-hungry trimming parts. It's fast (17μs). It also has a four-channel input multiplexer and 12-bit data output in a 2-byte format. Put it all together and it's a perfectly balanced choice for your high-performance applications.

TYPE	BITS	SPEED	ACCURACY*	TEMP RANGE	FEATURES
SDA 0812	12	17μs	±0.5 LSB	-40°C/+85°C	Self-calibrating
SDA 0810	10	15μs	±0.5 LSB	-40°C/+125°C	Software-upgrade of 8-bit to 10-bit systems
SDA 0808	8	13μs	±0.5 LSB	-40°C/+125°C	Faster and more accurate than the industry standard

*Total Unadjusted Error (TUE) over entire temperature range

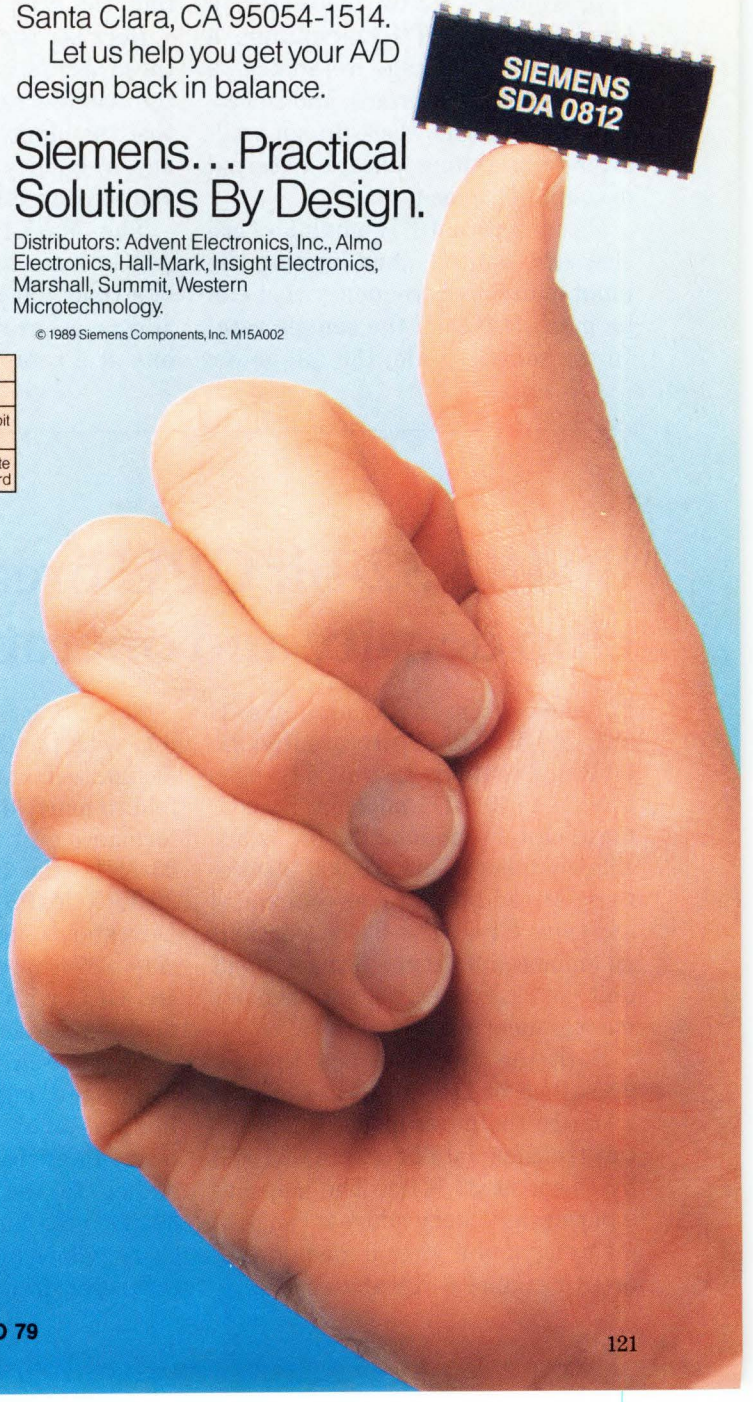
For an ideal balance between low and medium resolution requirements, our SDA 0808 and SDA 0810 both feature an 8-channel input multiplexer and are 100% pin-compatible with the ADC 0808 converters. In fact, you can even upgrade from 8- to 10-bit resolution by simply changing parts and adding a few lines of source code.

Find out more by calling 408-980-4500, ext. 4577. Or write Siemens Components, Inc., Consumer ICs, 2191 Laurelwood Road, Santa Clara, CA 95054-1514.

Let us help you get your A/D design back in balance.

Siemens...Practical Solutions By Design.

Distributors: Advent Electronics, Inc., Almo Electronics, Hall-Mark, Insight Electronics, Marshall, Summit, Western Microtechnology.



CIRCLE NO 79

Complete 10-μsec CMOS 12-bit ADCs include fast track-and-hold amplifier

It is much easier to use an A/D converter (ADC) when all the required circuit functions are included in a single package. The MAX163, MAX164, and MAX167 are complete 10-μsec CMOS 12-bit ADCs. The chips include a successive-approximation 12-bit converter, a track-and-hold (T/H) amplifier, a buried zener voltage reference, a 16- or 8-bit μP interface, and a crystal or an external clock-driven oscillator—everything except external decoupling capacitors.

Often, internal T/H amplifiers are slew-rate limited, thus limiting the input signal to a frequency that can be much less than the sample rate. In the sample mode, the full-power bandwidth of the T/H amplifier within the MAX163, -164, and -167 ADCs is typically 6 MHz. Such a wide bandwidth lets you use these devices for undersampling applications that let you convert a band-limited signal at a higher frequency than the sample rate.

Because the input bandwidth of these ADCs is more than 10 times the sample rate, you can be sure that the input section will not cause any frequency roll-off of the signal you're converting.

The MAX163, -164, and -167 ADCs have an aperture jitter of less than 100 psec. This parameter allows accurate conversion of 12 bits at a rate as high as 777 kHz—more than seven times the 100-kHz-max sample rate.

The three different versions of the ADC differ only in their input ranges. The MAX163 accepts 0 to 5V inputs; the MAX164 and MAX167 accept −5 to +5V and −2.5 to +2.5V inputs, respectively. The ADCs are powered by 5 and −12 or −15V; consume a maximum of 180 mW; come in a 24-pin, 300-mil DIP; and cost $21.25 (100).

Maxim Integrated Products, 120 San Gabriel Dr, Sunnyvale, CA 94086. Phone (408) 737-7600.

Circle No 451

80486 32-bit CPU breaks new ground in chip density and operating performance

Fabricated in the company's 1-micron CHMOS-IV process, the 32-bit 80486 contains 1,180,235 transistors on a 649 × 414-mil chip. By contrast, Intel's popular 32-bit 80386 chip contains about 275,000 transistors. In addition to an enhanced 386-type CPU, the 80486 contains an enhanced 387-type floating-point unit, an 8k-byte cache, and memory management with paging.

Both the data bus and the address bus of the 80486 are 32 bits wide. In the burst mode, the 80486 can transfer data at a rate of 106M bytes/sec at 33 MHz. The chip has a physical-memory address range of 4G bytes and a virtual-memory address range of 64 terabytes.

The 486 is 100% binary compatible with the 386, but it uses RISC design techniques to achieve a two-fold to fourfold improvement in performance over the 386 processor. At 25 MHz, the 486 operates at 15 to 20 VAX MIPS and executes 37,000 Dhrystones/sec. Moreover, the on-chip 387 coprocessor provides the 486 CPU with a capability of 6.1M double-precision Whetstones/sec.

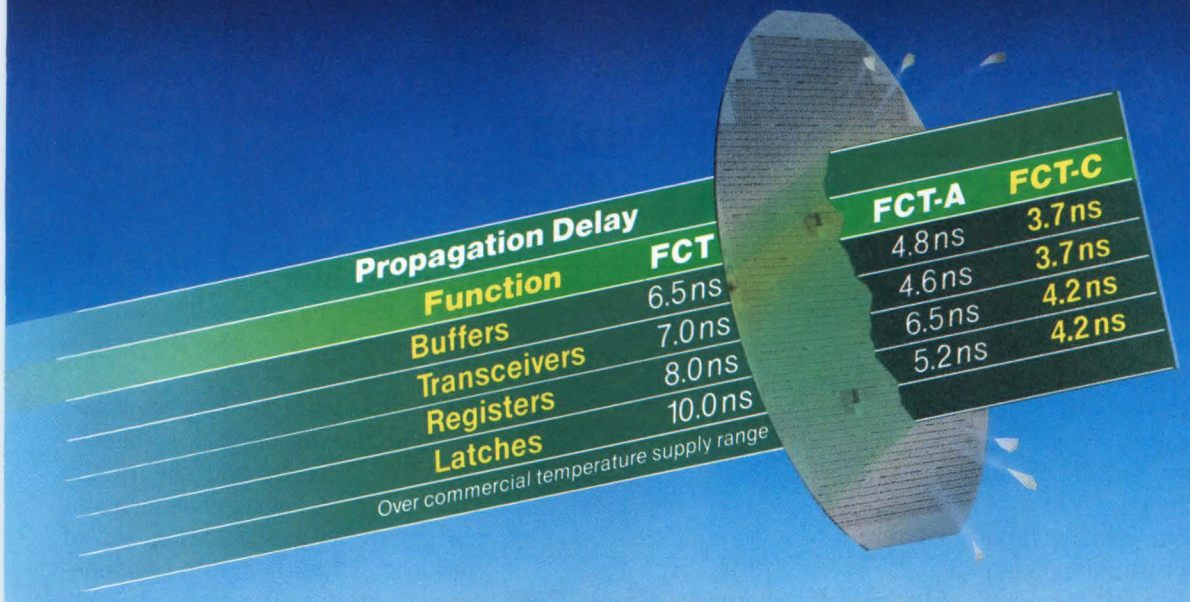
The on-chip 387 coprocessor meets the increasing demand for floating-point performance in numeric-intensive applications. Also adding to the performance of the 80486 is the built-in, set-associative cache, which optimizes hit rates and processes frequently used instructions in a single clock cycle. Other features include multiprocessor instructions, multilevel cache support, bus-snooping logic, and hardware bus arbitration.

Samples of the 25-MHz version of the 80486 will be available in the third quarter of 1989. Production quantities will be available in the fourth quarter along with samples of a 33-MHz version. The 80486 comes in a 168-pin pin-grid-array package, and the 25-MHz version costs $950 (1000).

Intel Corp, 3065 Bowers Ave, Santa Clara, CA 95051. Phone (408) 987-8080. TWX 910-338-0026. TLX 346372.

Circle No 452

Breaking the TTL Speed Barrier



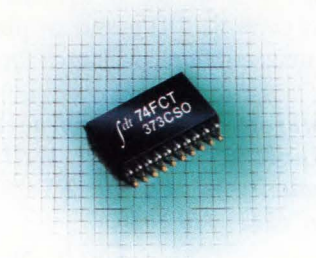
3.7 ns FCT-C Logic from IDT

World's first logic <4 ns

We set the standard three years ago with our FCT-A logic family. Today we are announcing a speed breakthrough and setting a new standard with our FCT-C logic family which is up to 30% faster than FCT-A logic. By using FCT-C logic, 33 MHz high-performance microprocessor systems can realize a 10% increase in timing margin safety factors.

The need for speed

You need the fastest TTL logic to optimize system performance and lower system cost. Our FCT-C buffers and transceivers operate at 3.7 ns, eliminating speed bottlenecks to achieve significantly higher system performance. FCT-C is the best TTL solution for 25 MHz and 33MHz RISC- and CISC-based systems.



Good, better, best — IDT has the fastest logic

Our CMOS products have established IDT as the industry's speed leader, and today we have the fastest TTL logic you can buy. Our FCT family matched FAST™ specifications; the FCT-A family was 40% faster. Now our FCT-C family is *over 55% faster* than the best bipolar devices!

FCT-C devices offer 64 mA output drive for heavy capacitive loading and better signal quality. And all the benefits of low CMOS power levels, at less than one-third the dynamic power consumption of equivalent bipolar logic.

FCT-C devices are pin and function compatible with other high-performance TTL logic products, but offer superior performance levels not found elsewhere.

Immediate availability

You don't have wait to break the speed barrier. The FCT-C family of TTL logic is available today in high-density SOIC packages for improved packaging density. Plastic and hermetic DIP, LCC, and Cerpack packages will be available in late 1989.

You can count on us

We'd like to tell you more about how you can use FCT-C TTL logic to improve your system speed. Call **(408) 492-8550** today for more information on FCT-C logic. Or call (408) 492-8225 for your copy of the FCT data sheets and the 1989 IDT Data Book Supplement with details about our current line of CMOS products.

IDT offers a full range of other high-performance building blocks including RISC processors, SRAMs, multi-port and FIFO memories, standard and complex logic, and RISC subsystems and modules.

IDT, P.O. Box 58015, 3236 Scott Blvd., Santa Clara, CA 95052-8015, FAX 408-492-8674.

When cost-effective performance counts

Integrated Device Technology

FAST is a trademark of National Semiconductor Corporation.

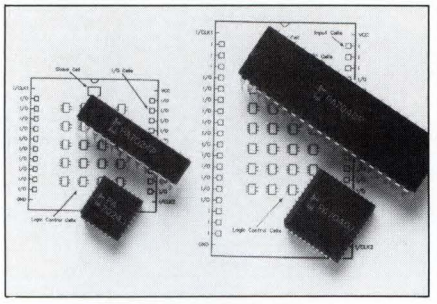
CIRCLE NO 81

Programmable device combines features of PLDs and PGAs

The PA7024 is the first member of a CMOS programmable-device family, PEEL (programmable electrically erasable logic) arrays, that combines elements of both PLDs and programmable gate arrays. The foundation of the PA7024 is its logic-control cell (LCC).

Each LCC has four primary input lines and produces two independent output signals. LCCs contain registers that can operate as synchronous or asynchronous D, T, or JK flip-flops. The input signals for each LCC are four of 80 possible sum-of-product terms, which you select by programming.

The four input signals can be used as data for the register or to clock and control the register. An LCC's two output signals are selectable from three of its input signals or



the register's output signal. One output of each LCC connects to an I/O cell, and the other is available for creating the sum-of-product terms.

The PA7024 has 20 I/O pins and two dedicated clock-input pins. Internal to the device are 20 LCCs, 20 I/O cells, and a global cell interconnected through a programmable-logic matrix. The device lets you define signals in PLD-like sum-of-product terms; but, as with gate arrays, creating internally used signals does not force you to sacrifice an I/O pin.

The global cell controls the selection and routing of clock signals to both the I/O cells and the LCCs. This cell can treat all cells as a single group with a common set of clocks or divide them into two independent groups. The internal clocks can operate as fast as 50 MHz. The propagation delay from one I/O pin through an LCC to another I/O pin is 23 nsec. The PA7024 costs $22.50 (100).

International CMOS Technology Inc, 2125 Lundy Ave, San Jose, CA 95131. Phone (408) 434-0678. TWX 910-997-1531.

Circle No 453

A/D converter uses sigma-delta modulation to resolve 16 bits at 100 kHz

The DSP56ADC16 100-kHz, 16-bit A/D converter implements sigma-delta modulation technology on a single chip. The sigma-delta conversion technique's inherent filtering eliminates the need for external filtering. This conversion process also has inherent oversampling and noise-shaping capabilities, which enable the converter to exhibit 90-dB signal-to-noise and signal-to-THD ratios for input signals of 0 to 45.5 kHz with an in-band ripple of less than 0.001 dB. In addition to the 16-bit output, the ADC's architecture lets you select an intermediate filter output to obtain 12 bits of resolution at 400 kHz.

The DSP56ADC16 oversamples the incoming data at 64 times the output sampling rate, or 6.4M samples/sec. The converter's third-order noise-shaping curve and its associated 18 dB/octave slope ensure that very little of the noise power remains in the passband.

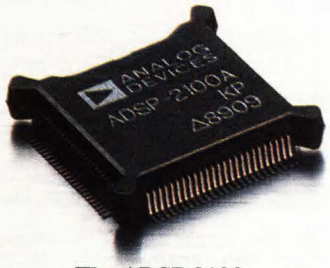
The ADC implements the digital lowpass filters in two stages: A comb filter performs 16:1 decimation on the modulator output, and a FIR filter performs 4:1 decimation on the comb-filter output. You can connect the output of either of these two filters to the device's serial output to achieve a 16-bit, 100-kHz output or a 12-bit, 400-kHz output.

The DSP56ADC16 operates from one 5V supply and nominally draws 30 mA. The device is available in 20-pin ceramic DIPs and in plastic and surface-mount packages for $25 (100).

Motorola Inc, Microprocessor Products Group, 6501 William Cannon Dr W, Austin, TX 78735. Phone (512) 440-2039.

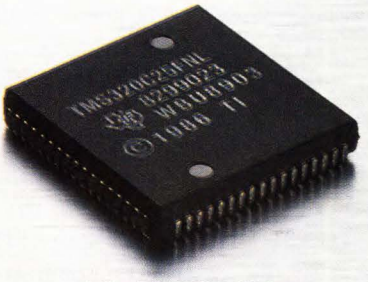
Circle No 454

Given enough time, the TMS320C25 can do almost everything the ADSP-2100 can.



The ADSP-2100.

- The ADSP-2100 computes a 1024-point complex FFT in less than 3 ms with a total memory requirement of less than 4k bytes. It also computes a 2 × 2 2D convolution in 1.2 μs and executes ADPCM in only 68 μs.
- The ADSP-2100 can access two words of external data every cycle.
- The ADSP-2100 supports zero-overhead loops of any length. So our looped code – which is the easiest to write – is also the fastest.
- The ADSP-2100's two dedicated data address generators can auto-increment/decrement by any offset value, and they have automatic circular buffer wraparound.
- The ADSP-2100 Assembler supports the easiest language in the business. So you code a multiplication/accumulation the same way you'd write the original algorithm. For example, the algebraic R = R + X*Y codes as MR = MR + MX0*MY0.



The TMS320C25.

- The TMS320C25 takes more than three times as long to compute the same size FFT, while it devours over 47k bytes of memory.[1]
- The TMS320C25 is limited to one access of external data every two cycles.
- The only zero-overhead loop the TMS320C25 can execute is one instruction repeated no more than 256 times.
- Circular buffers? The TMS320C25 doesn't support them.
- The TMS320C25 is programmed with 133 mnemonics like SPAC, BGEZ, MACD, XORX, and SBRK. A multiplication/accumulation is coded as MACD >FF03,*–. While this might not scare the XORX out of you, it's not the easiest thing to debug or maintain.

We're not saying the TMS320C25 is slow. But even if it were twice as efficient as it is now, it'd still be a lot slower at DSP than the ADSP-2100. The fact is, the ADSP-2100 is out in front of the TMS320C25 in performance, readability of code, and development tools.

Just how far out front? Get our free technical booklet and read about it. Or better yet, get an ADSP-2100 sample kit for only $49.95 and see for yourself. To request either, call DSP Marketing at 1-617-461-3771.

ANALOG DEVICES

Analog Devices, Inc., One Technology Way, P.O. Box 9106, Norwood, MA 02062-9106; Headquarters: (617) 329-4700; California: (714) 641-9391, (619) 268-4621, (408) 559-2037; Colorado: (719) 590-9952; Maryland: (301) 992-1994; Ohio: (614) 764-8795; Pennsylvania: (215) 643-7790; Texas: (214) 231-5094; Washington: (206) 575-6344; Austria: (222) 885504-0; Belgium: (3) 237 1672; Denmark: (2) 845800; France (1) 4666-25-25; Holland: (1620) 81500; Israel: (052) 911415; Italy: (2) 6883831, (2) 6883832, (2) 6883833; Japan: (3) 263-6826; Sweden: (8) 282740; Switzerland: (22) 31 57 60; United Kingdom: (932) 232222; West Germany: (89) 570050.

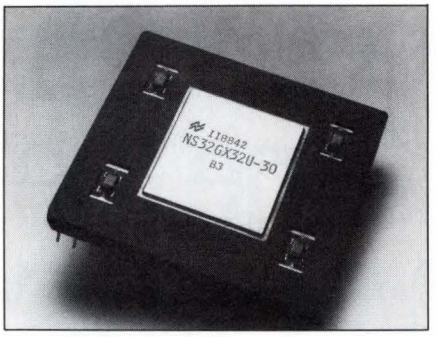
[1] EDN, "EDN's DSP Benchmarks," September 29, 1988.

32-bit embedded processor drives printers and imagers

Featuring a peak performance of 15 MIPS with no wait states at a frequency of 33 MHz, the NS32GX32 is a 32-bit embedded system processor that is software compatible with the vendor's 32000 series products.

The architecture of the NS32GX32 provides on-chip bit-block-transfer instruction primitives and logic; stack instruction syntax tuned for PostScript execution; and an on-chip, 2-way, set-associative 1k-byte data cache for character generation.

A 4-stage instruction pipeline enhances system performance by allowing multiple simultaneous instruction execution. With the pipeline, the processor can fetch one instruction, read the source operand of a second, calculate the results of



a third, and store the results of a fourth.

Unless the pipeline is broken by a jump or branch, this simultaneous-execution capability improves the performance of the processor. The NS32GX32 features branch prediction that works to minimize the penalty of a broken pipeline by reacting to a decoded branch instruction before it is executed. The reaction mechanism, with a few exceptions, is that backward branches are taken and forward branches are not taken.

The 32-bit embedded processor also provides an on-chip 512-byte instruction cache; a variable-bus-sizing feature that supports 8-, 16-, or 32-bit wide memories; and a floating-point support for the NS32381. The NS32GX32 is available in a 175-pin pin-grid-array package, and the 20-MHz version costs $99 (1000).

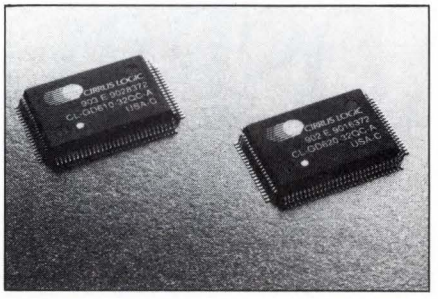
National Semiconductor Corp, Box 58090, Santa Clara, CA 95052. Phone (408) 721-2838. TWX 910-339-9240. TLX 346353.

Circle No 455

Chip set delivers VGA graphics to liquid-crystal-display panels

Using a patent-pending algorithm to map the VGA (video graphics adapter) standard palette of 256 colors to 32 shades of gray, The GD610/620 VGA-controller chip set provides high-quality CRT-display images to liquid-crystal-display (LCD) panels. The chip set offers full hardware compatibility to many LCD panels as well as electroluminescent and gas-plasma panels and CRT terminals.

The chip set uses a sum-to-gray-scale color-conversion algorithm and an on-chip color-palette memory for consistent color mapping. An automatic scaling technique converts the various pixel formats of the different display standards into the fixed LCD format of either 640×400 or 640×480 pixels. Using



this technique, the GD610/620 retains full compatibility with its graphics predecessors, like the VGA, EGA, CGA, HCG, and MDA standards. Additionally, automatic scaling has three modes: a compression mode, a compatibility mode, and an expanded mode.

Another feature of the GD610/620 chip set is low power consumption. Typical operating power consumption is 2.5 to 3W if your design uses pseudostatic RAMs and 3.5 to 4W if it uses dynamic RAMs. In standby mode, the chip dissipates 1.5 to 2W.

The chip set operates at 33 MHz and works with both high-resolution variable frequency and IBM PS/2 analog monitors. Refresh rates as high as 160 Hz provide high contrast and reduced flicker with dual-line, dual-panel, 400- or 480-scan-line LCD panels. The set costs $52.50 (100) in dual, 100-pin quad flat packs.

Cirrus Logic Inc, 1463 Centre Pointe Dr, Milpitas, CA 95035. Phone (408) 945-8300. FAX 408-263-5682. TLX 171918.

Circle No 456

SMART RAMs.™
They just dawned on you.

SGS-THOMSON's extensive family of very fast SRAMs has always been a pretty smart idea. But our new SMART RAMs™ are positively brilliant. Some of them keep time and never lose their memory. Others help one microprocessor system talk to another, intelligently. Still others tell the micro where to go, politely. But all our SMART RAMs have one thing in common. They make the design process, and the designer's life, a lot easier.

SMART RAMs give you the time of day.

A single chip, the 8K × 8 MK48Z08, is smart enough to sense pending power failures and keep the memory safe. If that isn't enough, the MK48T08 adds an extremely accurate built-in clock that always knows the exact year, month, day, hour, minute and second. Even during leap year. Even with daylight saving time.

SMART RAMs think fast.

The 1024 × 5 CMOS MK4505 FIFO supports two independent, asynchronous free-running clock inputs and accesses in a blazing 15ns. The MK4505 not only outsmarts other memories, it outruns them.

SMART RAMs plan ahead for you.

SGS-THOMSON's MK4505M/S Master/Slave concept gives you incredible speed and space-savings, plus all the status flags you need. No additional logic needed for depth/width expansion either. Now, that's really smart.

The MK45264/5 houses dual FIFOs and a transceiver function in one ultra-thin package for full bi-directional operation. That's twice as smart.

Cache in on our SMARTs.

The 4K × 4 MK41H80 CMOS Cache TAGRAM™ verifies addresses then tells the microprocessor where to look — 30% faster than less intelligent discrete solutions. No wonder it's the brain behind the brains in high speed processor environments.

One of the smartest moves you'll ever make is to ask for our SMART RAM memory data book and application notes. They make brilliant reading. Also ask about our SRAM and EPROM memories. For more information contact: SGS-THOMSON Microelectronics, 1000 E. Bell Road, Phoenix, AZ 85022. Phone 602/867-6259.

SGS-THOMSON MICROELECTRONICS

CIRCLE NO 83

Simulate

NCR

Your product design is brilliant. Inspired. A masterwork.

There's just one hitch.

Your design overwhelms the capabilities of your simulator.

It can't handle your mixed-signal analog-digital circuits even at the ASIC chip level.

Not simultaneously. Not accurately. Not with feedback.

And at the system level? With multiple ASICs? No way.

You need a simulator that can handle real world design.

That's NCR DesignSim™ A&D. This third-generation tool tightly couples analog and digital simulators to ensure the function and performance of mixed-signal ASICs. From the behavioral to transistor level. At the chip to multichip level. All within the system's context.

Plus, you can actually simulate complete systems and subsystems using optional models and templates for standard components, electromechanical devices, motors and sensors.

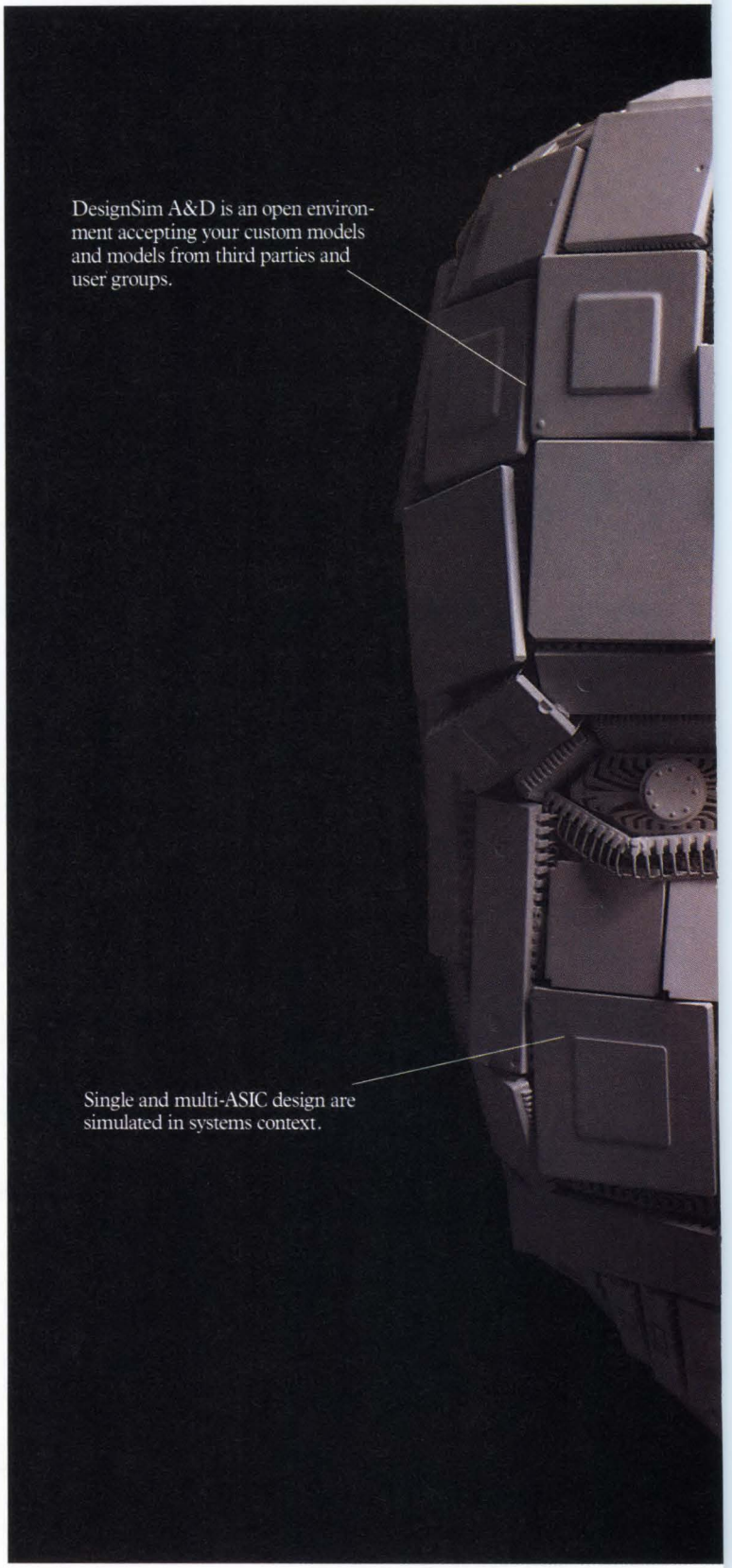
Imagine how that could shorten the design cycle and boost first-pass chip and system success.

And because DesignSim A&D is fully featured, one system provides many types of analysis such as fault-grading and frequency analysis.

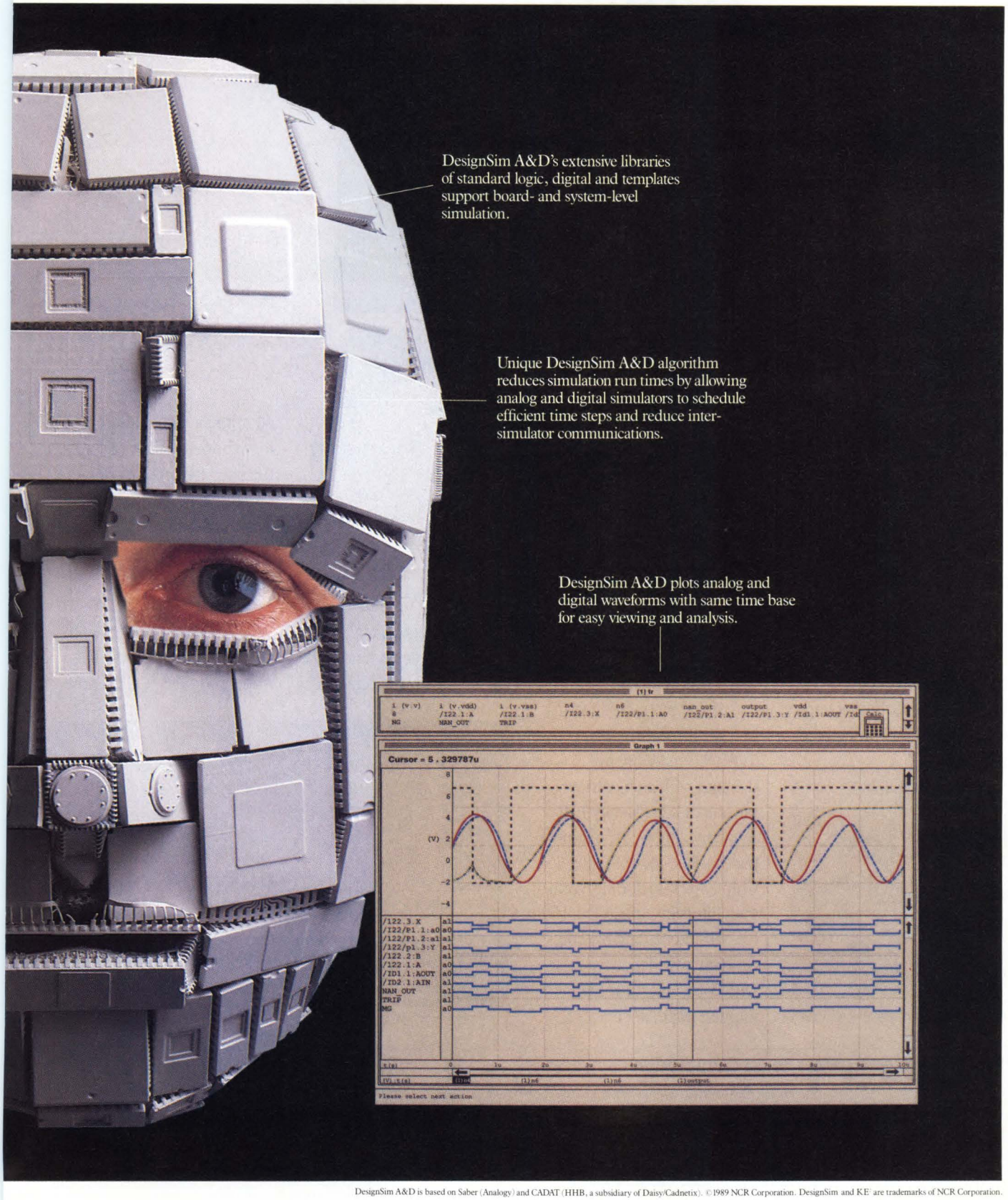
DesignSim A&D is just one benefit of working with NCR's Knowledge-based Engineering Environment (KE^2).

To receive a complete information package on DesignSim A&D and KE^{2}™ call 1-800-334-5454.

Creating value



the real world.

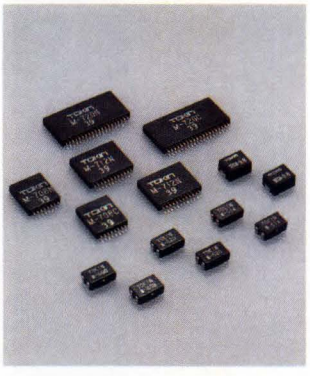


DesignSim A&D is based on Saber (Analogy) and CADAT (HHB, a subsidiary of Daisy/Cadnetix). ©1989 NCR Corporation. DesignSim and KE are trademarks of NCR Corporation.

Quietly Behind Miniaturization TOKIN EMC Filters

From laptop computers to video cameras to fax machines, the demand for compact electronic equipment has never been so great. And this is just the beginning.

This unceasing miniaturization has had a profound influence on circuit design, to the extent that circuits are getting smaller, thinner and ever-more-highly integrated.



It has also led to a growing demand for the best possible EMC components.

Backed by our long string of EMC Breakthroughs, TOKIN is meeting this demand with an incomparable line of high-quality EMC Data Line Filters. From compact surface-mount EMC Chip Filters (including 3 mm chip filters [as thin as LSIs] for half-pitches and SN chips for high impedance noise) to DIP Noise Filters for high impulse impedance over a wide frequency range.

Like our customers—who include the most demanding equipment manufacturers in the world—TOKIN realizes the need for precise countermeasures to noise in portable electronic equipment. That's why our customers recognize the need for TOKIN.

Find out how TOKIN can help you take excess pounds and inches off of your electronic products. Call us now.

Model	Frequency range (MHz)	Impedance (Ω)	
M-608□	5~200	≧300 (at 100 MHz)	Common mode
M-614□	5~100	≧700 (at 50 MHz)	Common mode
M-620□	5~50	≧1000 (at 300 MHz)	Common mode
M-720N	50~300	≧100 (at 200 MHz)	Normal mode 20 circuits
M-712N	50~300	≧100 (at 200 MHz)	Normal mode 12 circuits
M-708N	50~300	≧100 (at 200 MHz)	Normal mode 8 circuits
M-720C	50~300	≧70 (at 200 MHz)	Common mode 2 circuits×10
M-712	50~300	≧70 (at 200 MHz)	Common mode 2 circuits×6
M-708C	50~300	≧70 (at 200 MHz)	Common mode 2 circuits×4
M-540C	5~200	≧370 (at 50 MHz)	Common mode 4 circuits
M-580C	5~200	≧370 (at 50 MHz)	Common mode 4 circuits×2

S indicates stick types (25 pcs per stick type)
T indicates reel types (1,500 pcs per reel) (16×8 mm pitch, 13″ reel) ☐ indicates loose types (100 pcs per bag)

Model	Rated current (A)	Inductance Min. (μH)	DC Resistance Max. (mΩ)	Operating temperatue (°C)
SN-S3M-1503□	1.5	3.0	60	−25~+60
SN-S3M-1006□	1.0	6.0	100	−25~+60
SN-S3M-0513□	0.5	13.0	500	−25~+60

T indicates reel types 1,000 pcs per reel (16×12 mm pitch) ☐ indicates loose types 100 pcs per bag 13″ reel

TOKIN

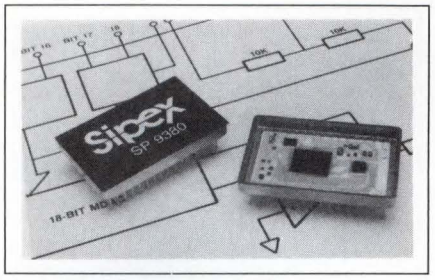
Tokin Corporation
Hazama Bldg., 5-8, Kita-Aoyama 2-chome, Minato-ku, Tokyo 107, Japan
Phone: 03-402-6166 Fax: 03-497-9756 Telex: 02422695 TOKIN J

Tokin America Inc.
155 Nicholson Lane, San Jose, California 95134, U.S.A.
Phone: 408-432-8020 Fax: 408-434-0375
Chicago Branch
9935 Capitol Drive, Wheeling, Illinois 60090, U.S.A.
Phone: 312-215-8802 Fax: 312-215-8804

Tokin Electronics (H.K.) Ltd.
Room 806 Austin Tower, 22-26A Austin Avenue,
Tsimshatsui, Kowloon, Hong Kong
Phone: (3) 679157~9 Fax: (3) 7395950
Taiwan Liaison Office
7/F-2, No.200, Sec.3, Hsin-Yi Road, Taipei
Phone: (02) 7059310~1 Fax: (02) 7015650

München Liaison Office
Elisabethstraße 21, 8000 München 40, Bundesrepublik Deutschland
Phone: (089) 271 75 22 Fax: (089) 271 75 67
Telex: 5 24 537 tokin d

You can reach our agents by phone: Denmark (03) 63 3830; France (1) 45-34-7535; Italy (0331) 67-8058; Spain 729-1155; Switzerland (01) 830-3161



D/A CONVERTER

The SP9380 18-bit D/A converter uses a stable thin-film resistor process and a digitally decoded switching architecture to provide ½ LSB accuracy for both differential and integral linearity. The SP9380 contains a precision reference, input data latches, and an output amplifier. Voltage-output settling time to 0.00019% is 30 μsec for a 10V step and 50 μsec for a 20V step. Analog output-voltage ranges are pin programmable for 0 to 5V, 0 to 10V, ±5V, and ±10V. Differential nonlinearity stability is 1 ppm/1000 hours at 25°C and 16 ppm/168 hours at 125°C. The SP9380 operates from ±15V supplies and is packaged in a 32-pin hermetic triple-DIP. Four product grades are available. $200 to $475 (100).

Sipex Corp, Hybrid Systems Div, 22 Linnell Circle, Billerica, MA 01821. Phone (508) 667-8700. FAX 508-667-8310.

Circle No 544

MOS POWER BOOSTER

The PB50 200V MOSFET power booster delivers 2A continuous output current. The power booster runs on 17-mA typ quiescent current and can slew at 50V/μsec min, with a typical slew rate exceeding 100V/μsec. The PB50 has a guaranteed power bandwidth of 160 kHz with output signals of 100V p-p, or more than 80 kHz at 180V p-p. The PB50 contains an internal gain-set and feedback resistor, and you can program the booster for a gain of 3 by tying two pins together. Using a single external gain-set resistor, you can program the PB50 for gains as high as 25. You can compensate the composite amplifier with one capacitor; however, it will be stable with most driver op amps and in most gain configurations without external compensation. You use one resistor to limit current. $49.50 (100). Delivery, four to eight weeks ARO.

Apex Microtechnology Corp, 5980 N Shannon Rd, Tucson, AZ 85741. Phone (800) 421-1865.

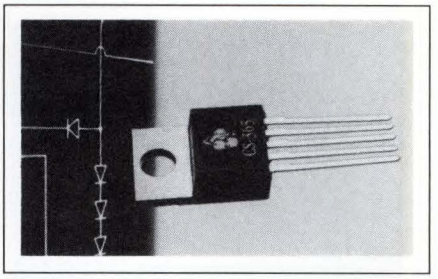
Circle No 545

SAMPLING ADC

Suited to high-performance signal-processing applications, the ADC603 hybrid A/D converter offers a resolution of 12 bits. At a 10-MHz sampling rate, the ADC features a typical differential nonlinearity of 0.4 LSB and a maximum nonlinearity of 1 LSB. Other specifications include an S/N ratio of 68.2 dB at 5 MHz, an input analog bandwidth of 70 MHz, and 2-tone distortion products of −77.7 dB. The ADC603 contains an S/H circuit, a 2-step subranging ADC, a voltage reference, and circuitry for timing and error correction. The ADC603 is available in both commercial and military temperature ranges and is packaged in a 46-pin, hermetic ceramic/metal DIP. $950 (500).

Burr-Brown Corp, Box 11400, Tucson, AZ 85734. Phone (602) 746-1111.

Circle No 546



POWER OP AMP

Operating from a ±6 to ±18V supply, the CS-365 power op amp has an open-loop gain of 80 dB typ, a slew rate of 8V/μsec typ, and an output-current rating of 3A max. Other specs include a typical input noise of 2 μV from 10 Hz to 10 kHz and common-mode rejection of 70 dB. The CS-365 includes on-chip thermal-shutdown and safe-operating-area protection. In addition to its use in motor-control and power-supply applications, the CS-365 can deliver 18W into a 4Ω load when used as an audio amplifier. The op amp comes in a 5-lead TO-220 package. $1.44 (1000).

Cherry Semiconductor Corp, 2000 S County Trail, E Greenwich, RI 02818. Phone (401) 885-3600.

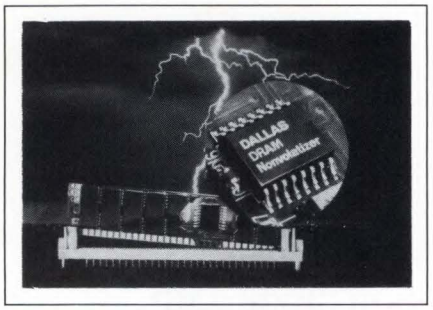
Circle No 547

BIPOLAR OP AMP

Suited to video applications and high-speed data-acquisition systems, the HFA-0002 bipolar op amp offers a gain bandwidth of 1 GHz and a slew rate of 150V/μsec. The op amp also features an offset voltage of 0.7 mV and a high gain of 80V/mV. The HFA-0002 is available in an 8-lead TO-99 metal package, an 8-pin side-brazed ceramic DIP, or an 8-pin plastic DIP. The metal and ceramic packages operate over commercial, industrial, and military temperature ranges. The plastic package is specified for commercial and industrial use. $7.05 to $38.15 (100).

Harris Corp, 1025 W Nasa Blvd, Melbourne, FL 32919. Phone (407) 724-7800.

Circle No 548



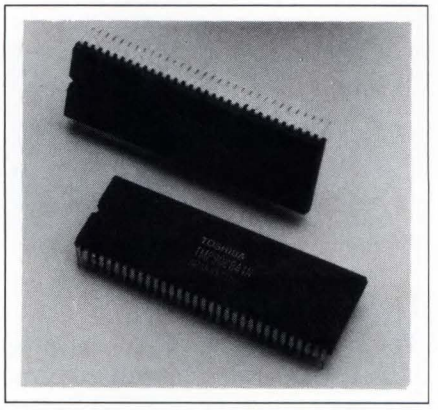
DRAM CONTROLLER

The DS1237 DRAM Nonvolatizer is an IC in a 16-pin small-outline package. The DRAM Nonvolatizer switches control of your memory's power-supply needs to a backup energy source during power outages and manages the dynamic RAM (DRAM) refresh that maintains memory. As the chip switches power sources, it intercepts system signals to prevent data destruction while the power is below or above acceptable levels. A hand-off procedure protects data when the main power returns.

The chip contains a regulator to ensure that the voltages supplied to your memories are within acceptable levels. You can use supplementary power from capacitors, rechargeable NiCd batteries, or long-life lithium batteries. To monitor or examine the condition on your secondary power supply, the chip contains a provision to report the remaining charge available to the computer after the power returns. According to the vendor, a small lithium battery can supply power to the DRAM Nonvolatizer for approximately two weeks. DS1237, $7; DS2219, in a 9M-bit, 120-nsec $\overline{\text{RAS}}$ access-time subassembly, $288 (100).

Dallas Semiconductor, 4350 Beltwood Pkwy S, Dallas, TX 75244. Phone (214) 450-0400. FAX 214-450-0470.

Circle No 549



MICROCONTROLLER

The TMP90C840 combines an 8-bit central-processing unit (CPU) with 8k bytes of ROM, 256 bytes of RAM, an 8-bit A/D converter, a multifunction 16-bit timer/counter, I/O ports, and a serial interface. Managed by an 11-channel direct-memory-access controller, external program memory can reach 56k bytes and external data memory can reach 1M byte. The device fea-

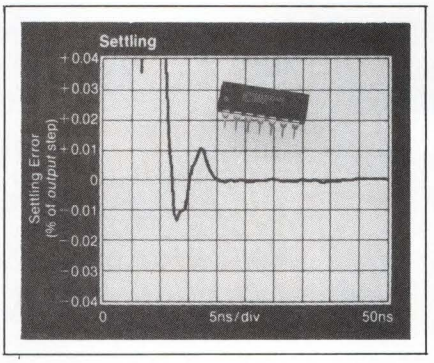
tures 163 basic instructions, including 16-bit arithmetic operations. It has a minimum instruction execution time of 400 nsec with a 10-MHz clock. The CMOS device operates from a single 5V supply and dissipates 250 mW. It comes in a plastic DIP or a quad flat pack. $9.50 (5000).

Toshiba America Inc, 9775 Toledo Way, Irvine, CA 92718. Phone (714) 455-2000.

Circle No 550

FAST-SETTLING OP AMP

The CLC500 is a 150-MHz operational amplifier that settles to 12 bits (0.01%—1/2 LSB) in 25 nsec overtemperature. A patented current-feedback architecture minimizes the dependence of settling time on gain settling. An output clamping feature lets you set maximum positive and negative output-



voltage levels for the amplifier so that it can protect delicate converter systems from destructive transients or other saturating signals. Additionally, the CLC500 has a 10-nsec overload recovery time, so normal operation resumes quickly after overdrive. The harmonic distortion performance of the CLC500 is better than -80 dB at 5 MHz for loads >500 Ω. The input-referred noise is only 40 μV_{rms}.- Industrial-temperature-range, 14-pin plastic DIP, $17.35; industrial-temperature-range, 14-pin hermetic side-brazed ceramic DIP, $27.75; military-temperature-range, 14-pin sidebrazed ceramic DIP, $43.30 (100).

Comlinear Corp, 4800 Wheaton Dr, Fort Collins, CO 80525. Phone (303) 226-0500. FAX 303-226-0564. TLX 450881.

Circle No 551

2M-BIT MEMORIES

Available in 32-pin DIPs with JEDEC (Joint Electron Device Engineering Council) standard pinouts, the WS-256K8-120 and WE-256K8-150 are organized as 256x8 static RAM (SRAM) and EEPROM, respectively. Both devices are CMOS and sport CMOS- and TTL-compatible inputs and outputs. Operating power consumption for the SRAM at 25°C and 5 MHz

Text continued on pg 140

A 40¢ component can stop what nature throws at you.

Every so often, nature throws your system a surge. And whether it's lightning, static or a simple crossed line, it can destroy the most expensive system with a single blow.

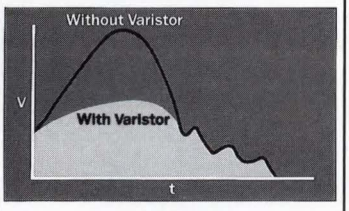
About 40¢ is all it takes to protect your design from this cruel fate. Thanks to the full line of surge suppression devices from Harris.

Catch A Surge.

Whether you're designing consumer products or aerospace systems, high-rel military or industrial controls, Harris has a surge suppression solution for you. Because if one of our varistors isn't right for the job, one of our Surgector™ devices will be.

All the Right MOVs.

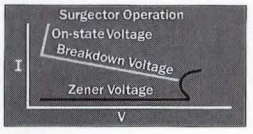
Harris offers the broadest line of MOVs in the industry. From 5V to 3500V. Up to 70,000 peak amps. And up to 10,000 joules.



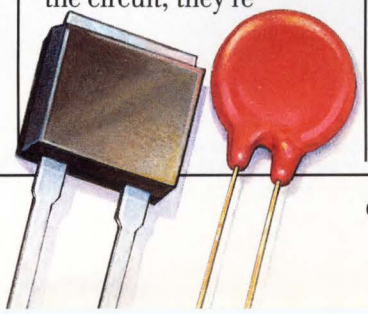
They're widely used for incoming AC protection and clamping circuits. And they're available in a wide range of packaging—axial leaded, radial leaded, leadless surface mount, high-energy modules and connector-pin configurations.

Inventor of Surgector.

Surgector devices combine a thyristor and a zener into one reliable cost-effective device. At low voltages the Surgector device is off. But the instant its clamping voltage is exceeded, the Surgector turns on. Within nanoseconds, the surge is shunted safely to ground, protecting your circuit from sure destruction.



Because Surgector devices respond so quickly and can shunt lots of energy away from the circuit, they're perfect for protecting expensive components from all kinds of transients. Lightning strikes, load changes, switching transients, commutation spikes, line crosses—all the things nature throws your system's way.



We'll Help You Choose.

Which technology is right for you? Just give us a call at 1-800-4-HARRIS, Ext. 1452 (in Canada, 1-800-344-2444, Ext. 1452). Or call your local Harris sales office or distributor.

What your vision of the future demands. Today.

HARRIS SEMICONDUCTOR

HARRIS · RCA · GE · INTERSIL

CIRCLE NO 87

FULL SPE

For the name of your nearest distributor in Europe, call 44-296-625462. Or contact Applied Microsystems Corporation Ltd., Chiltern Court, High Street, Wendover, Aylesbury, Bucks HP22 6EP, United Kingdom. **In Japan, call 03-493-0770.** Or contact Applied Microsystems Japan Ltd., Nihon Seimei, Nishi-Gotanda Building, 7-24-5 Nishi-Gotanda, Shinagawa-KU, Tokyo T141, Japan. AMC 240

ED AHEAD.

INTRODUCING THE FIRST 33-60 MHz MICROPROCESSOR EMULATOR FOR THE 68020 AND 68030.

Put your phone in front of you and get ready. You're about to get in touch with the future of high speed microprocessor emulation.

For quite some time Applied Microsystems has been designing a radical new concept in 32-bit development. Now it's ready. The EL 3200.

It's capable of not only matching current speeds, but can efficiently expand to support faster speeds and advanced 32-bit microprocessors of the future.

The news is not just speed, but how the EL 3200 gets up to speed.

It runs at full target clock speed—33 MHz for 68020 and 68030. It fully supports 68030 cache burst and synchronous bus cycles. And, since it sits as a node right on the trunk of your Ethernet network, the EL 3200 can be accessed from any workstation.

The EL 3200 offers your choice of source level or symbolic debugging. Whether you want to work in Assembly or C, we can provide the software tools for your exact needs.

The sophisticated breakpoint system has hundreds of real-time access breakpoints, six real-time execution breakpoints and unlimited software execution breakpoints. As an option, you can have up 2MB of no wait state overlay memory that runs at full clock speed, so there are no restrictions on memory, software or interrupts. The 16K deep by 139 bit wide trace provides true 32 bit support.

Seeing is believing. For a demonstration or more information, pick up your phone.

Dial full speed ahead and ask for Telemarketing. In WA (206) 882-2000.

Applied Microsystems Corporation, P.O. Box 97002, Redmond, Washington, USA 98073-9702.

1-800-343-3659

Applied Microsystems Corporation

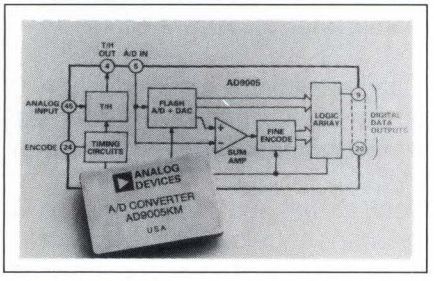
CIRCLE NO 88

is 33 mA; for the EEPROM, it is 60 to 70 mA. In standby mode, the SRAM typically consumes 1.8 mA, and the EEPROM consumes 1.1 mA.

The ICs have been designed and manufactured for hostile environments; the ceramic packages feature a welded metal cover and cofired construction. The SRAM retains data at voltages as low as 2V, and internal power-supply bypass capacitors enhance chip performance. Read-and write-cycle access times for the SRAM are 120 nsec. The EEPROM has a read access time of 150 nsec and lets you write a page in 3 msec max. The EEPROM uses the chip's 5V supply for data programming and features 10-year data retention. SRAM, $275; EEPROM, $2280 (100) for military versions.

White Technology Inc, 4246 E Wood St, Phoenix, AZ 85040. Phone (602) 437-1520. TWX 910-951-4203.

Circle No 552

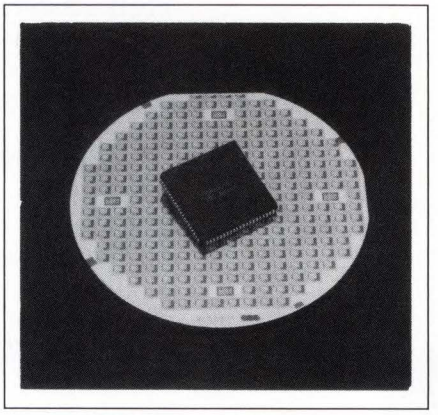


12-BIT A/D CONVERTER

Available in a 46-pin package, the AD9005 is a complete 12-bit hybrid A/D converter (ADC) that dissipates 3.4W of power—33 to 50% less than competitive versions, according to the manufacturer. The AD9005 features an onboard track-and-hold amplifier, a voltage reference, TTL timing circuitry, and output latches. The ADC uses a subranging architecture that samples inputs to 10M samples/sec. It also has a maximum transient response of 120 nsec and an overvoltage recovery time of 150 nsec at 25°C. Differential nonlinearity and integral nonlinearity are ¾ LSB and 2 LSB, respectively. With a frequency input of 4.3 MHz, in-band harmonics are −66 dB min, and S/N ratio is −61 dB min. The AD9005 is available in commercial and military grades. $800 and $1400 (100).

Analog Devices, Literature Center, 70 Shawmut Rd, Canton, MA 02021. Phone (617) 935-5565.

Circle No 553

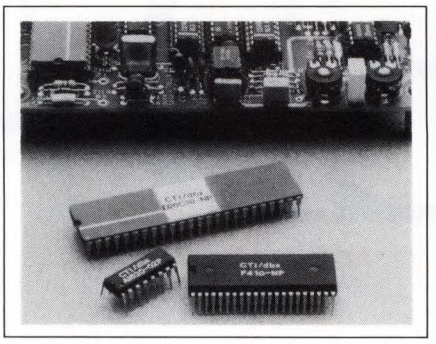


LAN CONTROLLER

A third-generation ArcNet controller, the COM90C65 provides highly integrated support for IBM PC-based LANs. The COM90C65 combines the controller, the transceiver, and the support logic required to interface ArcNet to the IBM PC bus. The controller contains a programmed sequencer and all the logic necessary to control the token-passing mechanism on the network and send and receive data packets at the appropriate time. You can connect a maximum of 255 nodes to the network, with each node assigned a unique ID. The COM90C65 establishes the network configuration and automatically reconfigures the token-passing order as new nodes are added to, or deleted from the network. 84-pin plastic leaded-chip carrier, $17.50 (5000).

Standard Microsystems Corp, 35 Marcus Blvd, Hauppauge, NY 11788. Phone (516) 273-3100.

Circle No 554



AUDIO ADC CHIP SET

The F410/D20C10/A1520 A/D converter chip set is designed for high-performance audio applications. It consists of the F410 front-end IC, the D20C10 20-bit decimator, and the A1520 precision resistor network. The ADC uses noise-shaped oversampling at 6 MHz and flash, 4-bit conversion. The D20C10 is a digital filter with a 6-bit input and a 20-bit output; it has a 128:1 ratio of input-to-output sample rates. The A1520 contains 15 matched, 20-kΩ resistors. It works in conjunction with the F410 and two 8-bit flip-flops to form the complete A/D converter. The basic chip set features 18-bit resolution, a signal-to-noise ratio of 105 dB, <0.005% THD at maximum output, and differential linearity of 0.000000076%. For 20-bit resolution, a second F410 and A1520 are required. $130 (100).

CTI Research, 71 Chapel St, Newton, MA 02195. Phone (617) 964-3210.

Circle No 555

3-BIT SINK DRIVER

The UCN5929B is a 3-bit serial-input, latched smart-power IC that merges low-power CMOS logic with high-power bipolar output drivers. The IC features three diode-clamped, open-collector npn output drivers that can sink as much as 1.7A continuous and sustaining load voltages to 80V. The UCN5929B also incorporates a 3-bit, externally clocked shift register and an externally strobed CMOS data latch for each driver; this combination sup-

Small Space Bus Interface.

SOLUTIONS ON A CHIP

Clip this coupon and you could save 4 square inches of board space, or more, on your VME, VSB or Micro Channel bus interface.

Save precious board space. Start using PLX high-drive bus interface ICs.

Just one 24-pin PLX IC does the job of 6 ICs: a PAL, plus high current drivers, Schmitt trigger buffers, delay lines, and registers.

Take advantage of our sample offer for two free ICs and discover how compact and efficient a bus interface can be.

PLX: I accept your offer, please send me a free sample of the two units checked below. *(Offer expires 12/31/89)*

- ☐ VME1220 Master Controller
- ☐ VME2000 Slave Controller
- ☐ VME3000 Interrupter
- ☐ VME4000 Interrupt Handler
- ☐ VSB1200 Master Controller
- ☐ VSB2000 Slave Controller
- ☐ MCA1200 MC Bus Master

( ) _____
BUSINESS PHONE

_____
NAME

_____
COMPANY

_____
ADDRESS

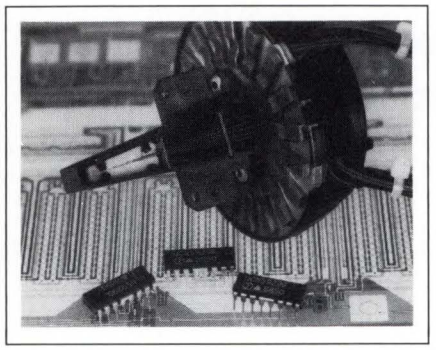
Attach coupon to business card or letterhead and mail to: PLX Technology, 625 Clyde Ave., Mountain View, CA 94043. Phone 1-800-759-3735.

EDN070689

PLX TECHNOLOGY

PLX is a trademark of PLX Technologies, Inc. Other brands or product names are trademarks of their respective holders.

CIRCLE NO 89

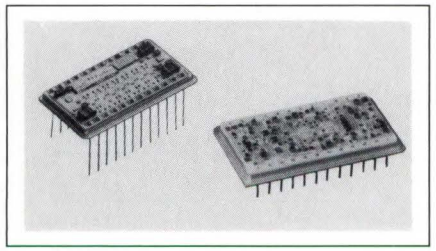


ports both serial and parallel data output. High-current clamping diodes on each output driver and internal thermal shutdown circuitry that turns off the drivers at a junction temperature of 165°C protect the IC from potentially damaging conditions.

To simplify the interfacing of the sink driver with its host controller, the UCN5929B has CMOS-compatible Clock, Serial Data In, Serial Data Out, and Strobe signals for external control over the latch-to-driver transfers. The chip can operate at clock rates to 3.3 MHz and comes in a power-tabbed 16-pin DIP with copper lead frames. When you operate the device within the specifications and with duty cycles below 40%, you don't need a heat sink. The chip draws between 1.5 mA (with all outputs off) and 8 mA (with all outputs on). $2.21 (1000).

Sprague Semiconductor Group, Box 15036, Worcester, MA 01615. Phone (508) 853-5000.

Circle No 556



12-BIT DAC

The DAC-02315 D/A converter and the DAC-02316 track-and-hold deglitcher have a 35-MHz update rate and a full-scale settling time of 50 nsec. The D/A converter generates digitally controlled, binary-weighted analog-output currents. Bipolar transistor switches that the digital input code turns on and off control a ladder network of thin-film precision resistors. The track-and-hold deglitcher contains—in simple terms—a capacitor, a switch, some buffers, and ECL. Through control of the switch, the logic determines whether the capacitor and output voltage track the input signal—switch closed—or retain the value of the input at the moment the switch opens.

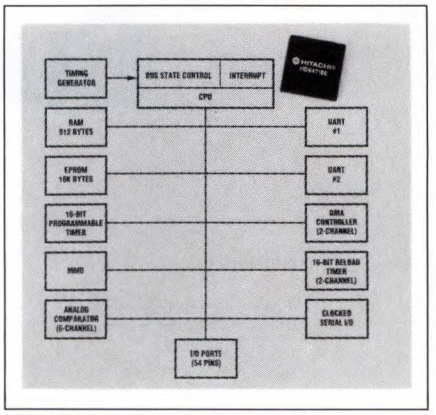
The deglitcher limits output glitch amplitudes to 14 mV peak-to-peak and duration to under 38 nsec. The devices are ECL compatible and have an operating temperature range of -55 to +125°C. Also available is a full-function evaluation card that contains the two hybrids, TTL/ECL translators, input latches, trimmers, and distributed capacitors to optimize glitch and settling time characteristics. D/A converter, from $189; track-and-hold deglitcher, from $369.

ILC Data Device Corp, 105 Wilbur Pl, Bohemia, NY 11716. Phone (516) 563-5678. FAX 516-567-7358.

Circle No 557

MICROCONTROLLER

The HD647180X is an 8-bit microcontroller that benefits from the Z80 architecture. Although the microcontroller uses a superset of the Z80 instruction set, it can directly execute older Z80 programs, and the chip processes instructions in 375 nsec. The additional instructions added to the HD647180X include special I/O instructions, a hardware multiple, and an instruction to put the chip into a low-power standby mode. In addition to instruction augmentation, the chip has several performance enhancements. Memory access is a 3-cycle process, unlike the Z80's 4-cycle process, and the integration of a



number of peripheral functions on chip reduces timing constraints imposed by having to run signals between chips. Real-estate requirements are also reduced as a result of this integration. The on-chip peripheral functions include a memory-management unit (MMU), 2 UARTs, a 2-channel DMA controller, 512 bytes of RAM, 16k bytes of one-time-programmable EPROM, three 16-bit programmable timer channels, and I/O ports (54 bits). The chip runs at 8 MHz. 80-pin quad flat pack, $17.70; 84-pin PLCC, $19.10 (1000).

Hitachi America Ltd, 2000 Sierra Point Pkwy, Brisbane, CA 94005. Phone (415) 244-7159. FAX 415-583-4207.

Circle No 558

ANALOG GRAB BAG

The 29-1000 is an analog IC that offers a host of uncommitted functions in a single package (a 40-pin ceramic DIP or a 44-pin LCC). The chip contains a programmable current source that can provide 1 to 10 mA; a programmable voltage source that offers 0.1 to 4V; a 3V bandgap reference source; a nonlinear function (AB/C); an exponential function (D^E); a gain-programmable differential instrumentation amplifier; a utility operational amplifier; two comparators; and a programmable 4- to 20-mA current loop transmitter. The IC operates from one 5V supply at an operating temperature range of −40 to

+80°C. Quiescent current is 22 mA, and typical device accuracy is ±0.1%. An evaluation pc-board kit for the 29-1000 is also available. The kit has provisions for resistors; capacitors; potentiometers; transistors; diodes; 8-, 16-, and 40-pin DIPs; voltage regulators; LEDs; and LCDs. $49.

International Microtronics Corp, 4016 E Tennessee St, Tucson, AZ 85714. Phone (800) 433-3767. FAX 602-790-2808.

Circle No 559

ANALOG SWITCHES

Fabricated in DMOS/CMOS technology, the DG540, DG541, and DG542 analog switches are TTL compatible and feature bandwidths to 500 MHz. Available in dual and quad versions, the devices provide 5 MHz off-isolation to −80 dB and crosstalk of −85 dB. The quad DG540 and DG541 are both spst switches. The DG541 comes in a 16-pin package. The 20-pin DG540 includes extra ground lines between the signal pins to improve off-isolation and reduce crosstalk. The dual DG542, which also comes in a 16-pin package, has four analog switches configured as two spdt functions. You can use each spdt switch as a selector between two channels, allowing the DG542 to handle two sets of video signals simultaneously. $3.93 to $15.83 (100).

Siliconix Inc, 2201 Laurelwood Rd, Santa Clara, CA 95054. Phone (408) 988-8000.

Circle No 560

PIN DRIVER

The EL2021 monolithic pin driver is suitable for loaded board testing as well as linear or logic bench-top testers. The device can overpower logic outputs and accurately drive independently set high and low levels that have programmed slew rates. The vendor provides dc output levels within 50 mV at a 100-mA load and within 300 mV at a 400-mA load. The EL2021 also has a 3-state capability, allowing you to put the outputs into a high-impedance state for load monitoring. The slew rate is 100V/μsec ±20% with a slew-rate control input of 1V and typically offers a 300V/μsec slew rate at higher control levels. To conserve energy, you can shut down the EL2021 when it's not in use. Typical quiescent power falls from 625 to 15 mW when you operate the device with supplies at 15V and −10V. EL2021CJ in an 18-pin ceramic DIP, $35 (100).

Elantec Inc, 1996 Tarob Ct, Milpitas, CA 95035. Phone (408) 945-1323.

Circle No 561

At AMD we've got all the basic ISDN functions you need for a terminal in a single device: The Am79C30A.

It's got an S transceiver, a data link controller and a codec filter. Everything for basic terminal applications.

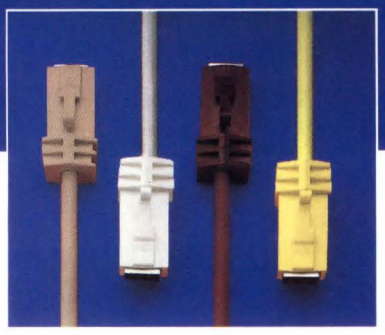
Then we give you lots of options for enhancing your terminal. If you want to add extra data channels, we've got three protocol controllers. Two different controllers conform to V.120 and a third that conforms to V.110. Adding a second voice channel is easy, too, with an extra codec filter.

There's more to terminals than great hardware.

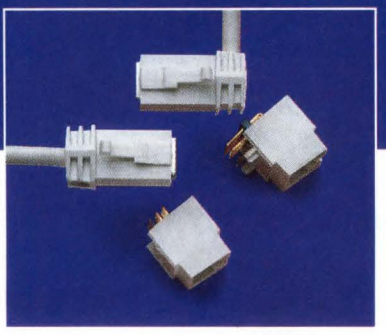
That's why we created AmLink3™ development software.

It makes designing ISDN terminal applications easy for a change.

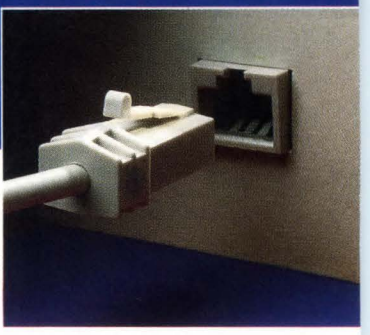
AmLink3 is a full source code implementation of Q.931 and X.25. It has



Any color.



Angled or straight.



"Click"—it's connected.

Plug new sales appeal into your system with Du Pont Latch-N-Lok™ Shielded Assemblies.

Improve your system's sales appeal with Du Pont Latch-N-Lok modular interconnections.

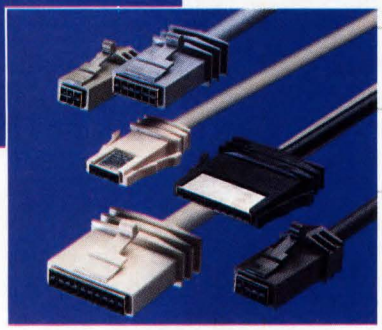
Choose from the industry's widest variety of compact plugs and receptacles. Straight, right-angle or combination designs. Latch on top, bottom or side. Panels, chassis or board mounted receptacles. And cords—coiled or straight—in any length, with any number of conductors, and foil, serve or braid shielding. What's more, Latch-N-Lok can use a variety of wire gauges (22 to 30 AWG) within an assembly.

All of these combinations can be customized and color-coordinated to your system. Yet Latch-N-Lok costs no more than standard assemblies.

And Latch-N-Lok is the only quick disconnect pin-and-socket system. With a contact design proven over millions of applications.

For a free sample or our free brochure call **1-800-237-2374.**

Or write, Du Pont Electronics, Room G-51155, Wilmington, DE 19898.



The smallest package.

Du Pont Electronics
Share the power of our resources.

DUPONT
REG U.S. PAT. & TM. OFF.

Prototyping techniques evolve to match design complexities

By testing your designs with some nontraditional prototyping techniques, you can satisfy that ever-present need to make sure your circuit works before committing to silicon.

J D Mosley,
Regional Editor

As the complexity of electronic circuits increases, prototyping techniques become more critical, and getting a sound prototype becomes more difficult. And in order to remain competitive in today's global markets, engineers find that they must shorten design cycles while improving product quality. Accordingly, novel ways to prototype have emerged, including solderless breadboarding, off-site prototype manufacturing, computer-aided prototyping machines, and circuit-emulation programs. Each has advantages and problems.

The widespread use of CAE programs has provided an efficient means for engineers to develop the schematics for complex, multilayered circuits. However, once such schematics exist, the engineer must somehow translate those colorfully plotted markings into operational hardware for debugging and testing purposes. Traditionally, wire wrapping and breadboarding could satisfy most prototyping requirements and provide you with a functional facsimile of your design. But as the density and operating frequency of your circuit increase, the probability of electrical and mechanical infidelity in point-to-point prototypes becomes greater.

If your design is relatively straightforward, breadboarding the circuit is still the quickest way to test your hardware. This is especially true if you use one of the latest offerings from 3M. The company's Powerace 203 is a solderless breadboard with an internal, triple-

A computer-aided prototyping machine (ProtoCAD)

output power supply; two logic monitors; a clock generator; data pulse sources; two logic-level switches; a pulse generator; and a pulse-detection circuit. A built-in power meter ranges from +15 to −15V dc, and you can remove the 203's Powerace-Plus circuit board, which provides 1680 connect points and an aluminum ground plane. For digital prototyping, you can purchase the Powerace 202 with three logic indicators, four data switches, and selectable frequencies ranging from 1 to 100 kHz. Both the 202 and 203 cost $165, and the removable Powerace-Plus circuit boards retail for $20 each.

If your design requires a prototype that offers strict mechanical and electrical fidelity, several pc-board manufacturers also offer prototyping services—usually in hopes of gaining your business for the production run once the prototype passes muster. Of the approximately 1500 pc-board fabrication companies in the US, very few are eager to expand their prototype business, however.

The key to successfully working with an off-site board manufacturer lies in the sophistication of your CAE system and the quality of its output. Select a CAE program that lets you enter your schematic; generate a net list; lay out your board; route your traces; and produce descriptive data in Gerber format, which you can later transmit via a modem to any prototype shop in the country.

Once you've selected your CAE software, you must consider the im-

As the density and operating frequency of your circuit increase, the probability of electrical and mechanical infidelity in point-to-point prototypes becomes greater.

pact your computer's peripherals will have on the finished prototype. Your monitor's level of resolution can affect the manufacture of the board if the density of screen pixels prevents you from precisely locating your pads and traces. Your plotting system can also affect the quality of prototypes.

Although pen and laser plotters are readily available in most engineering facilities, and therefore offer a quick and inexpensive means of generating a hard copy of your circuit design, such devices limit your resolution to 10- or 12-mil lines. A vector plotter provides finer resolution, and most off-site manufacturers recommend that you send them photoplots of your circuit. Some photoplotters can provide resolution as fine as 3 to 4 mils.

Photoplotting, however, requires the use of chemicals and darkroom conditions, so you may want to consider having a local photoplotting facility create your drawings rather than actually investing in a photoplotter for your company. But only by the careful inspection of the hard copy a photoplotter derives from your Gerber data can you be sure that your CAD output conveys the design you thought you had created. Although a paper plot may look good, photoplotting is the next best thing to having the actual prototype in your hands. Particularly for complex designs, you'll waste time and money if you insist on not proofing your CAD output until the prototype stage.

A solderless breadboard with power supplies, logic switches, and removable circuit boards (3M)

Don't do it yourself—and save

Of course, the most significant factor that can affect the quality and manufacture of your board's design is your own familiarity with the CAD program and your skill as a draftsman. It can take as long as two to three man-years for a company to gain enough proficiency in CAD design to produce a working prototype on only the first or second submission to a prototype manufacturer. And besides the expense of training personnel to use the system, there is also the expense of purchasing all the necessary equipment. If you will be working with your CAD system on an infrequent basis or if your company plans to produce fewer than 24 different boards a year, doing the CAD designing in-house can cost more than sending your net list and layout sketch to a pc-board design service center.

One such center, National Design, guarantees a 1-week turnaround on digital circuit designs. The company promises to deliver a CAD design of your board, check plots, and photoplots within seven days, or the board is free. You'll pay a minimum of $500 per board, with a typical IBM PC/AT-size board costing around $2000 and a larger VME-size board going for $3000 to $4000. If you're in a hurry, the company can provide 3-day turnaround for your design.

The company requires that you provide a parts list; a mechanical drawing of the board's layout, including holes, pads, and connectors; instructions regarding special orien-

tation, grouping, and spacing for your components; special grounding requirements; a general physical description of the board; a list of specific board markings; and details about vias and etchings. In other words, this company will be your electronic draftsman, but you still must dictate the engineered aspects of the board.

On the other hand, if your company plans to design 30 or more boards a year, you may want to supplement your in-house CAD system with an in-house CAP (computer-aided prototyping) system. Devices that fall within this classification can take data generated by your CAD system and produce working prototypes within hours instead of days or weeks.

A company called ProtoCAD offers three CAP systems, all of which are turnkey systems that cost from $40,700 to $75,385, and come with installation, chemicals, and training. ProtoCAD's units use a system called optical direct imaging to write your circuit pattern into a layer of dry-film photoresist. This system doesn't involve the use of phototools, so it's relatively inexpensive to use. All of the company's CAP systems accept CAD data, drill the board, insert plated through-holes in the board, laminate dry-film photoresist onto both sides, directly write the circuit pattern into the photoresist with intense UV radiation, develop the photoresist, etch and strip the board, and then tin-plate it. The boards produced with these units are production-quality pieces. In addition, each system is self-contained, and ProtoCAD asserts that any waste materials are of such insignificant levels that they don't come close to violating even the most stringent environmental standard.

If your company plans to produce between 30 and 50 different boards a year, consider ProtoCAD's entry-level system, which performs each of the aforementioned steps in sequence, one board at a time. At the high end, the company's $75,385 system has both a numerical control (NC) drilling station and a photoplotting unit, so you can produce as many as 100 boards a week at a rate of five every four hours. Significantly, you don't have to come up with 100 new designs a week—these figures can be thought of as low-volume production runs. Costs for producing an 8×10-in. board can run as low as $22, but on the average you can expect to pay about $120 per board.

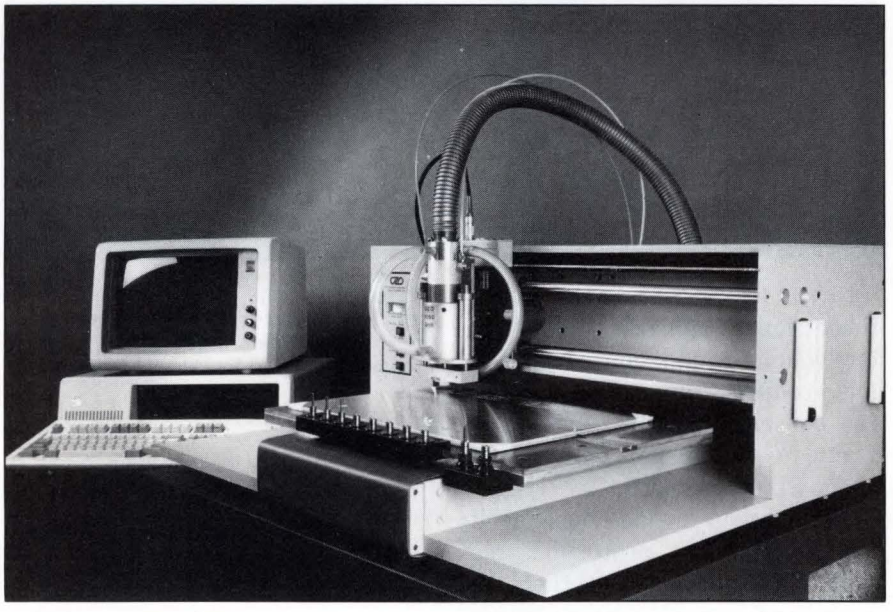
A behavioral data-management system that lets you interactively create signal definitions, device timing, data patterns, and waveform displays (Test Systems Strategies Inc)

Having your own in-house facility for cranking out prototypes may seem like Nirvana, but there are important considerations besides the cost factor. Optical direct imaging is a wet chemical process in which board cleanliness is critical. The operator must be technically trained in a wide variety of process and control procedures. And if your equipment includes photoplotting capabilities, you'll have to deal with photographic processing and possibly provide a darkroom.

The key to successfully working with an off-site board manufacturer lies in the sophistication of your CAE program and the quality of its output.

Taking a different approach to CAP, Ozo Diversified Automation has two benchtop machines that perform circuit-board milling to mechanically engrave the copper away in order to define your board's traces. Accordingly, this process does not involve any wet chemical processing—you simply sweep up any debris. However, these machines are limited in that they lack the ability to provide through-hole plating.

Ozo's Model 18 can mill boards as large as 12×18 in. It costs $27,996 for a workstation that includes a microscope head, a pen-plotter head, and an IBM PC-compatible computer for NC drilling and routing. You also get software that uses image-processing techniques to convert your Gerber data into outline form. On the average, a 6×6-in. pc-board takes two to three hours to mill. Additional heads cost $4000 to $12,000. A Model 18 with a mechanical etch head costs about $40,000, and for $36,000 you can purchase a basic Model 24 that can mill boards as large as 18×24 in.



A computer-controlled circuit-board milling workstation (Ozo Diversified Automation)

Besides lacking plated through-holes, prototypes generated by mechanical milling may differ from pc boards in high-frequency performance and trace-to-trace impedance. Also, copper debris melted into the epoxy at the base of a milled trough could cause shorts that are difficult to find and repair. The quality of your circuit's traces will depend significantly on the condition of the milling bit. But if you require instant gratification, CAP may be the only way to prototype.

Debug it in software

Then again, when you need to check-out the viability of an extremely complex, multilayer system, conventional CAD and prototyping systems may fall short of meeting your needs. In such a case, you may want to consider one of the many circuit-emulation programs that provide you with a single tool for designing, simulating, and debugging your circuit without reducing the schematic to hardware.

Test Systems Strategies Inc (TSSI) has a new product called WaveMaker, which creates and manages behavioral and functional data for electronic circuits. WaveMaker is a graphical interface for TSSI's TDS software package. It creates, captures, and uses state, timing, and data structure information from such sources as CAE design simulation tools, existing test programs, and test vectors generated by ATE systems in order to automate the link between CAE and ATE systems.

The $20,000 WaveMaker package lets you view and edit signal definitions, waveforms, data patterns, and device timing. Using a mouse, you can generate stimuli and expected responses for your circuit during the initial design phase. You can then view the resulting waveforms just as if you had connected a logic analyzer to a physical circuit. A graphics editor displays viola-

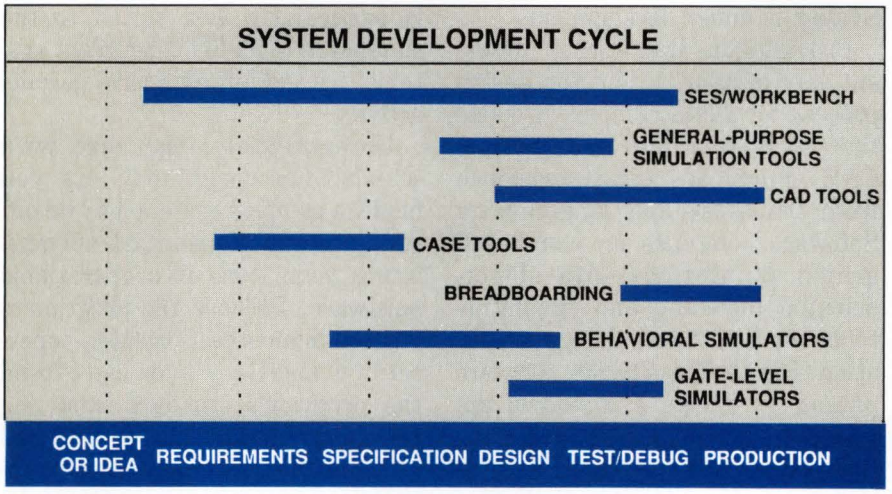


Fig 1—When comparing the strengths offered by a variety of development tools, you can see that SES/workbench lets you computerize the conceptualization, specification, design, and verification of your system.

tions of expected response state values. Its interactive operation lets you alter device timing and then compare the simulation results. So, not only can you verify circuit functionality at the design stage, but you can even tune the circuit's performance.

Another product lets you look inside the registers of more than 4000 ICs, including μPs, PLDs, and memory devices, without actually reducing your design to hardware. Acting like a software version of an in-circuit emulator, SmartModel Windows from Logic Automation lets you single-step your circuit's performance in software, set breakpoints on internal register states, or set register values. This $4000 product is actually an option in the manufacturer's $7900 annual subscription service for the SmartModel library of devices. SmartModel Windows can only be used with Mentor Graphic's QuickSim simulator, but a version for Hewlett-Packard's Electronic Design

Words of wisdom from board manufacturers

As manufacturers of pc boards, Rick Castonguay of Casco Electronics in Chatsworth, CA, ((818) 882-0972) and Emil Dragovich of Xcell Circuit in Anaheim, CA, ((714) 779-1300) have seen their share of design disasters generated by engineers who were inexperienced in CAE-based design. You might want to keep their tips in mind as you design your board for prototyping.

1. Send the prototype manufacturer both a Gerber tape and the artwork. A hard copy of your design will help prevent miscommunication and errors.

2. Fax written instructions for any changes. Good communication is paramount in the production of a prototype; you should avoid verbal instructions because they could be misinterpreted.

3. Photoplot your design. Although your design may look good on paper, you can only be sure of its integrity by proofing a photoplot.

4. Make the traces as large as possible in order to avoid oversights.

5. Use round pads—they're easier to register than other shapes.

6. Spend some time getting to know your system. Lack of experience is at the root of most design disasters.

Only by carefully inspecting the hard copy a photoplotter derived from your Gerber data can you be sure that your CAD output conveys the design you thought you created.

System is under development.

Providing a dramatically different way of approaching the design process for those complex projects that seem to rebuff conventional CAE approaches, SES/workbench from Scientific and Engineering Software combines an icon-based graphical interface with object-oriented modeling and simulation tools for multilevel design evaluation (**Fig 1**). This $28,000 software package provides a top-down approach to system design by permitting you to identify your circuit's high-level characteristics and specify its overall behavior and structure.

Once you've determined the general functions you want your circuit to perform, you can expand the circuit specifications at progressively lower levels of detail until you finally reach the component level. In other words, instead of starting out by defining your overall objective on a pad of paper and entering the computerized phase of your design only after you've determined which components will accomplish that objective, SES/workbench lets you automate every step of the design process all the way through the test and debugging stage. This program is particularly well suited to the simulation of highly concurrent systems that exhibit extensive parallel activity.

Unfortunately, the ease with which SES/workbench lets you model a complex system may be offset by the subsequent task of translating your icons into operational hardware. Because the program is written in an object-oriented superset of C and C++, you can extend the program's standard modeling primitives, write calls to external routines, or access any of the program's data structures. But take heart: At the University of Texas, at least one graduate thesis has been presented that defines a way of interfacing SES/workbench with a schematic design program. EDN

Article Interest Quotient
(Circle One)
High 518 Medium 519 Low 520

For more information . . .

For more information on breadboard and prototyping products such as those discussed in this article, circle the appropriate numbers on the Information Retrieval Service card or use EDN's Express Request service. When you contact any of the following manufacturers directly, please let them know you saw their products in EDN.

Logic Automation Inc
19500 NW Gibbs Dr
Beaverton, OR 97075
(503) 690-6900
FAX 503-690-6906
Circle No 425

National Design Inc
9171 Capital of Texas Hwy
Houston Building
Suite 230
Austin, TX 78759
(512) 343-5055
FAX 512-343-5053
Circle No 426

Ozo Diversified Automation Inc
7450 E Jewell Ave
Suite A
Denver, CO 80231
(303) 368-0401
FAX 303-368-4865
Circle No 427

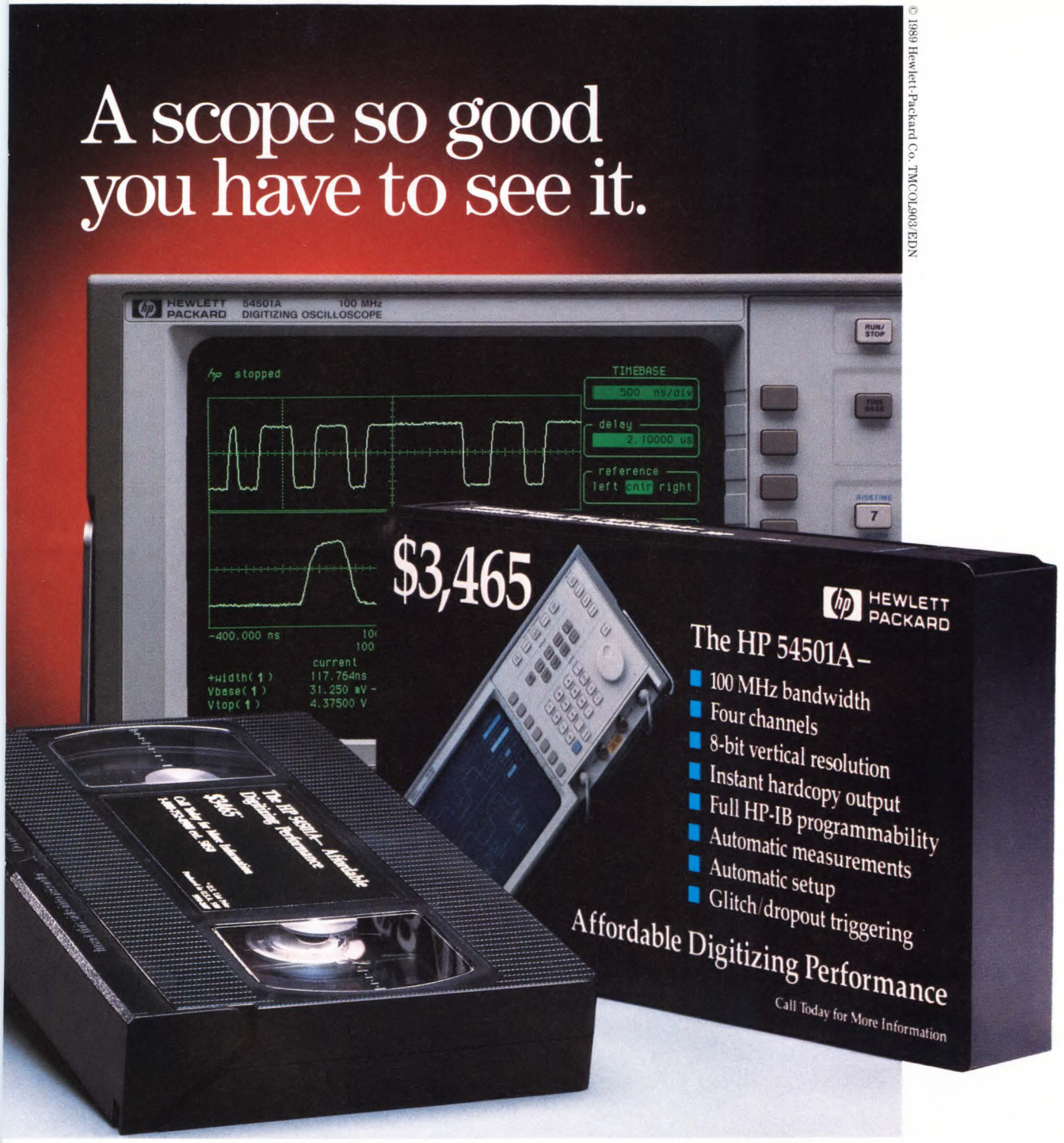
ProtoCAD Inc
1050 Elkton Dr
Colorado Springs, CO 80907
(719) 548-0222
FAX 719-599-9221
Circle No 428

Scientific and Engineering Software Inc
1301 W 25th St
Suite 300
Austin, TX 78705
(512) 474-4526
FAX 512-479-6217
Circle No 429

3M Electronic Specialty Products
3M Center—Austin
Box 2963
Austin, TX 78769
(512) 984-1800
Circle No 430

Test Systems Strategies Inc
8205 S W Creekside Pl
Beaverton, OR 97005
(503) 643-9281
Circle No 431

A scope so good you have to see it.



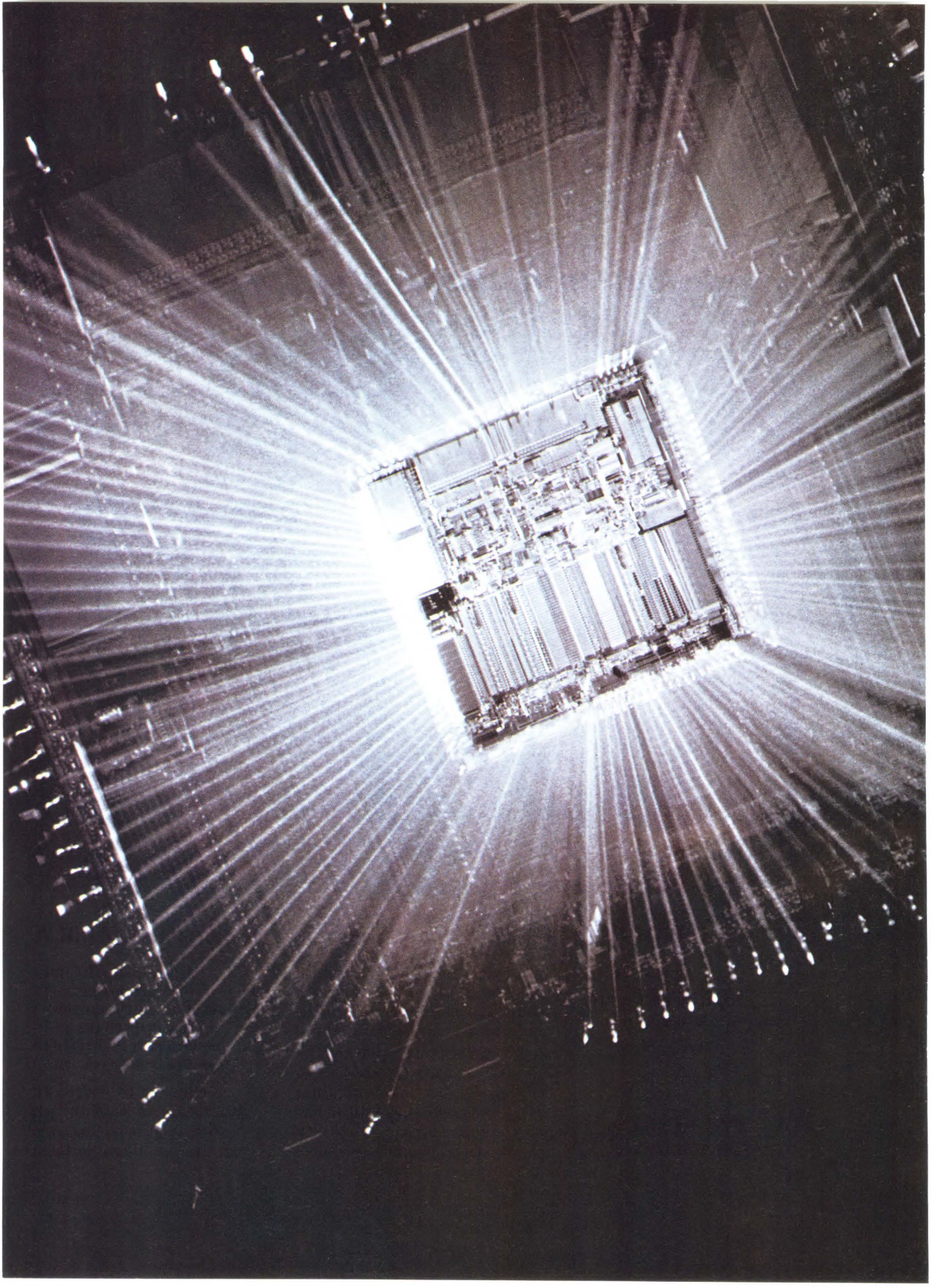
A 100 MHz Digitizing Oscilloscope for $3,465. The HP 54501A.

- **100 MHz bandwidth**
- **Four channels**
- **8-bit vertical resolution**
- **Instant hardcopy output**
- **Full HP-IB programmability**
- **Automatic measurements**

It's no typo! $3,465. Call for the FREE video and see the best price/performance, portable, digitizing oscilloscope on the market. See the power of glitch, dropout and TV triggering, measurement limit test and dual timebase windowing. The HP 54501A outperforms analog oscilloscopes and delivers extra capabilities found only in expensive digitizing oscilloscopes. See the ease and versatility of the HP 54501A on videotape.

Call HP now:
1-800-752-0900.
Ask for extension 216I for your free video, or to order.

HEWLETT PACKARD



NOTHING IS MORE CRITICAL THAN YOUR ABILITY TO RELY ON OUR PERFORMANCE.

In the computer industry with its never ending goal of miniaturization, nothing is more important than using the highest performance engineering plastics.

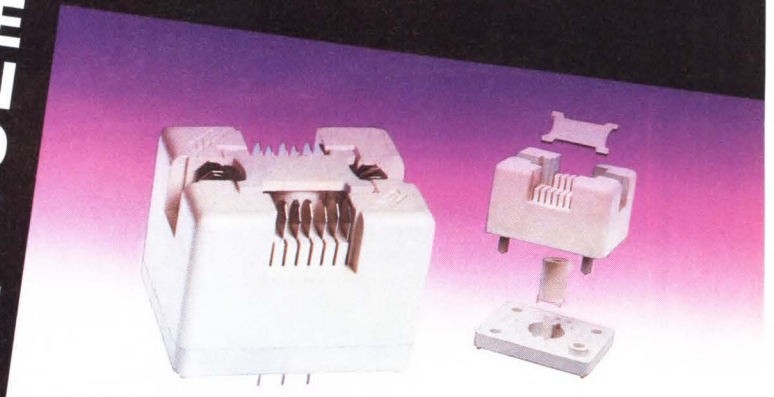
And Amoco Performance Products provides the highest performance resins that make down sizing of components possible.

Our Xydar® resin, for example, has excellent dimensional and creep stability at elevated temperatures. It is a natural choice for higher density connectors and IC sockets. Plus, it has low ionic contamination and is ideal for surface mount assembly.

For more information, write for our brochure, "Engineering Plastics for Performance and Value." Amoco Performance Products, 38 C Grove Street, Ridgefield, CT 06877. Or call 1-800-621-4557.

AMOCO

Amoco Performance Products
The higher performance plastics.



Xydar® resin was chosen by J.M. Ney for this extremely high temperature burn-in socket because of its dimensional and creep stability at temperatures above 200°C.

CIRCLE NO 92

To Brighten-up Your Display Innovations

...turn onto itron VFD super-smart modules.

- ☐ HIGH VISIBILITY ☐ LOW POWER
- ☐ SURFACE-MOUNT TECHNOLOGY
- ☐ LONG-TERM RELIABILITY
- ☐ 5Vdc POWER SUPPLY OPERATION

Noritake
WORLDWIDE FOR
itron®
VACUUM FLUORESCENT DISPLAYS ☐ MODULES
Patented and manufactured by
ISE ELECTRONICS CORP.

Model CU205SCPB

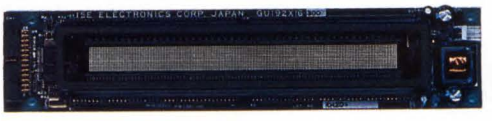
DOT CHARACTER DISPLAY MODULES

CHARACTER FORMAT	MODEL NUMBER	NUMBER OF CHARACTERS	CHARACTER HEIGHT (MM)	INPUT (SERIAL/ PARALLEL)	BI-DIRECT BUS
5 × 7 DOT MATRIX	CU165SCPB-S	1 × 16	5.0	S/P	
	CU169SCPB-L	1 × 16	9.0	P	X
	CU205SCPB-S	1 × 20	5.0	S/P	
	CU209SCPB-L	1 × 20	9.2	P	X
	CU2015SCPB-L	1 × 20	15.1	P	X
5 × 7 DOT MATRIX PLUS CURSOR	CU406SCPB-S	1 × 40	5.0	P	X
	CU20026SCPB-S	2 × 20	5.1	P	X
	CU40026SCPB-S	2 × 40	5.0	P	X
	CU40046SCPB-S	4 × 40	5.0	S/P	X
	CU40066SCPB-S	6 × 40	5.0	S/P	X
	CU40086SCPB-S	8 × 40	5.0	P	X

DOT MATRIX DISPLAY MODULES

DOT MATRIX FORMAT (DOTS/LINE × NO. OF LINES	MODEL NUMBER	NO. OF LINES AND CHARACTERS/LINE (5 × 7 DOT CONFIGURATION)	GRAPHICS CAPABILITY
192 × 16 (3072 DOTS TOTAL)	GU192X16	2 × 32	YES
256 × 16 (4096 DOTS TOTAL)	GU256X16	2 × 42	YES
256 × 64 (16,384 DOTS TOTAL)	GU256X64	8 × 42	YES

Model GU192X16



The models shown are typical examples of the broad selection available for immediate delivery. Contact our nearest Sales Office or Representative to help select the right Noritake VFD for your application as well as for details on costs, custom designs, etc.

NORITAKE SALES OFFICES

NORITAKE CO., INC. ☐ Electronics Division
LA: 23820 Hawthorne Blvd. ☐ Suite 100 ☐ Torrance, CA 90505
Phone: (213) 373-6704 ☐ FAX: (213) 772-3918
CHICAGO: 415 E. Golf Rd. ☐ Suite 109 ☐ Arlington Hts., IL 60005
Phone: (312) 439-9020 ☐ FAX: (312) 593-2285
BOSTON: 263 Winn Street ☐ Suite 1D ☐ Burlington, MA 01803
Phone: (617) 270-0360 ☐ FAX: (617) 273-2892 ☐ TLX: 4973468
DALLAS: 2454 Trade Mart ☐ Dallas, TX 75207
Phone: (214) 742-9389 ☐ FAX: (214) 747-5065

NORITAKE EUROPA GmbH ☐ Electronics Division
EUROPE: Frankfurter Strasse 97-99, D-6096 Raunheim, F.R. Germany
Phone: 06142-43095/96/97 ☐ FAX: 06142-22799 ☐ TLX: 4182982dnd

NORITAKE CO., LTD. ☐ Electronics Division
JAPAN: 1-36 Noritake Shinmachi, 3 Chome, Nishi-Ku, Nagoya
Phone: (052) 562-0336 ☐ FAX: (052) 581-1679 (GIII) ☐ TLX: 59738

REPRESENTATIVES

WA, OR: (503) 684-1671 ☐ Components West, Inc.
No. CA, NV: (415) 961-1422 ☐ Westech Sales
So. CA: SD (619) 292-1771 / OC (714) 891-4621 ☐ ELSCO
TX, OK, AR, LA: (214) 386-4888 ☐ Norcom, Inc.
CO, UT: (303) 794-4684 ☐ MRC
OH, WV, W. PA, KY: (216) 461-6161 ☐ Arthur H. Baier
No. IL, So. WI: (312) 439-9810 ☐ Coombs Associates, Inc.
AL, GA, MS, TN: (205) 533-1730 ☐ Interep Associates
IN: (317) 844-4842 ☐ Fred A. Dorsey & Associates, Inc.
No. WI, MN, No. IA, ND, SD: (612) 536-9512 ☐ Tech. Components
N.E.: (508) 788-0316 ☐ International Mktg. Group
PA, MD, DE: (215) 233-0333 ☐ C.H. Newson & Associates
FL, PUERTO RICO: (407) 831-8233 ☐ Semtronic Asso., Inc.
NY, NJ: (201) 376-3324 ☐ F.F. Sylvester Associates
VA: (804) 740-0063 ☐ Glasscock Associates
NC, SC: (919) 782-8100 ☐ C-Tech Sales Co.
CANADA: (416) 671-8111 ☐ Gidden Morton Associates

Panduit Raises the Speed Limit!

on all your wiring and cabling

Panduit speeds up every wiring and cabling job with the industry's largest selection of wiring accessories. And provides the technical expertise that makes sure you get the products to best meet your specific application. For wire bundles, flat cable, coax—Panduit leads the way to make your wiring job easier and faster...and hold down your installed cost.

- Mounting devices—adhesive backed, screw fastened, or adhesive applied—for any type of surface in any environment; also a full selection of clamps and clips. Widest range of sizes and materials, including stainless steel.
- Flat cable mounts and clips, adhesive backed or screw mounted.
- Coax cable bushings and adhesive backed clips.
- Flexible grommet edging and spiral wrapping to guard against abrasion.
- Full line of harness board accessories helps speed harness production.
- Plus the industry's most complete line of cable tie installation tools—from manual to automatic reel-fed.

Call TOLL FREE 1-800-777-3300
today and ask for Telemarketing Dept.
(In Chicago 312-532-1800)

FREE SAMPLES

P QUALITY **PANDUIT** CORP.

ELECTRICAL GROUP

Tinley Park, IL 60477-0981
In Canada: Panduit (Canada) Limited

CIRCLE NO 94

The biggest little pellet in the universe.

New pellet technology creates tantalum caps with built-in fuse or smaller case.

NEC is using innovative techniques to pack more capacitance power into each micron of its tantalum pellets. Therefore you can have a built-in fuse without any increase in case size, or a smaller case without any decrease in capacitance value.

Built-in fuse enhances safety.

Our SVE-Series tantalums incorporate a fuse to minimize damage from reverse current. Compatible with our R-Series, the SVE capacitors are ideal for noise absorption in computers, terminals or measuring equipment. Choose from 21 types with ratings from 1.0 to 33 μF and from 10 to 50 V DC.

10 μF power in the industry's smallest case.

R-Series extended-capacitance chips offer ratings up to 10 μF in the A case measuring 1.6 x 3.2 x 1.6 mm. The extended R-Series consists of 46 device types with ratings from 0.47 to 100 μF and from 4 to 35 V DC.

NEC not only produces more tantalum caps than anyone in the industry, we also invest more of our resources in intensive R&D programs dedicated to giving you the best device for your design. To find out how our tantalums give you maximum performance per micron, call NEC today. Ask about the SVE-Series with the built-in fuse or R-Series extended-capacitance chips.

For fast answers, call us at:

USA Tel:1-800-632-3531. TWX:910-379-6985. W. Germany Tel:0211-650302. Telex:8589960. The Netherlands Tel: 040-445-845. Telex:51923. Sweden Tel:08-753-6020. Telex:13839. France Tel:1-3946-9617. Telex:699499. Italy Tel:02-6709108. Telex:315355. UK Tel:0908-691133. Telex:826791. Hong Kong Tel:3-755-9008. Telex:54561. Taiwan Tel:02-522-4192. Telex:22372. Singapore Tel:4819881. Telex:39726. Australia Tel:03-267-6355. Telex:38343.

CIRCLE NO 95

NEC

U-shaped section forms base and sides of aluminum case

The Type 33 aluminum case has a U-shaped section forming its base and sides, both of which have slots for direct card mounting. The case also has an extruded cover, which fastens to the base with the same screws that mount the front and rear panels. Press-fitted bezels conceal all the screws. The aluminum design provides interference attenuation. The case is available with or without ventilation slots in the base and front and rear panels. In addition, aluminum panels are available with a sealing rim of foamed material that conforms to the IP54/NEMA 4 protection class.

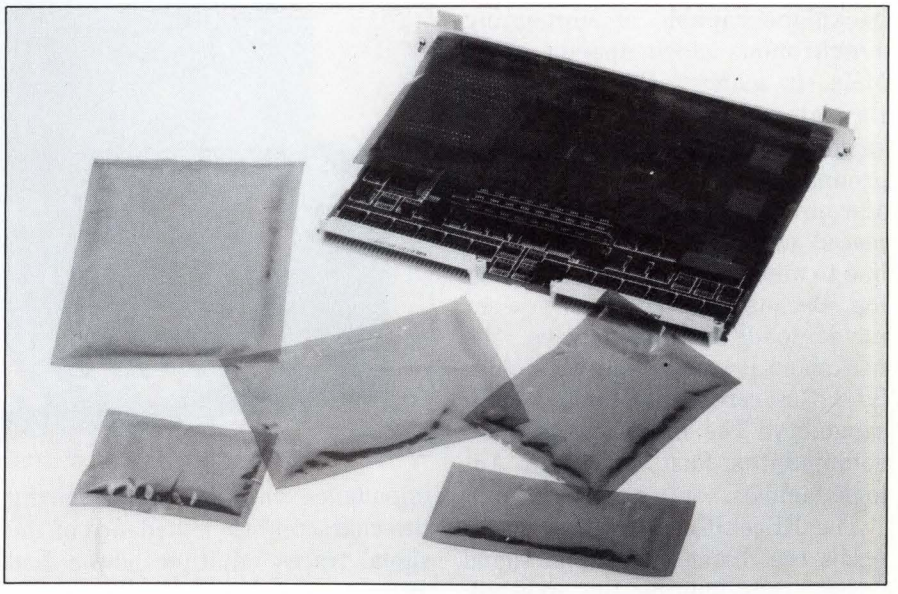
An accessory handle fastens in the side groove without drilling and permits the case to be tilted at an angle. Other accessories include card-carrier fittings for 100×160-mm Eurocards with DIN 41612 connectors, double Eurocard mounting sets, and receptacles for 3½- and 5¼-in. disk drives. The 2-tone gray case comes in heights of 2.72, 3.37, and 4.06 in.; widths of 6.12, 8.27, and 10.1 in.; and depths of 5.67, 8.03, 10.39, and 12.76 in. Prices start at $35.

ELMA Electronic Inc, 41440 Christy St, Fremont, CA 94538. Phone (415) 656-3400. FAX 415-656-3783.

Circle No 463

Liquid heat sink available in six standard sizes

The Fluorinert liquid heat sink (LHS) is a multilayer plastic package containing Fluorinert liquid. It dissipates heat in tight spaces by the natural convection of the liquid. The LHS comes in six standard sizes: 1.5×4, 2×3, 3×4, 3×4.75, 4×6, and 4×9 in. All sizes are 0.25 in. thick. The LHS transfers heat from an active component to the opposite LHS wall for conduction to an exterior surface. Its operation is completely passive, thereby eliminating the noise and dust-contamination problems associated with fans.



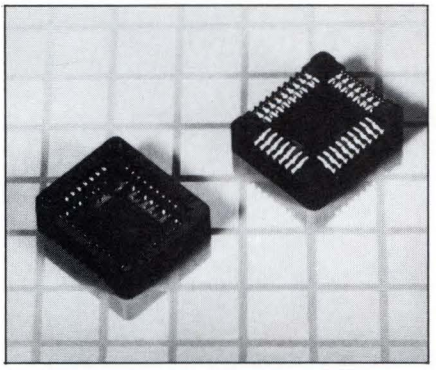
The units can be used with power densities as high as 15W per in.^{2} and have a dielectric strength that exceeds 35 kV across a 0.1-in. gap. The liquids are perfluorocarbons, which do not contain hydrogen, chlorine, or bromine. Because these liquids are not chlorofluorocarbons, they will not damage the ozone layer. A 3×4.75-in. sample is available by request on company letterhead. Prices range from $10.40 to $19.20, depending on size.

3M Co, Dept CH89-06, Box 33600, St Paul, MN 55133. Phone (612) 733-5755. FAX 612-736-3094.

Circle No 464

Surface-mount PLCC chip sockets measure 0.2 in. in height

These surface-mount PLCC chip sockets have visible internal solder tails. Their configuration combines the handling and small-size advantages of the J-lead package with the inspection and repair advantages of the gull-wing package. The sockets measure 0.2 in. in height when mated with a surface-mount chip. The sockets use the same board pattern as a standard JEDEC chip and have a high-pressure contact system, which eliminates the need for gold plating. The units have a center pad for structural integrity and adhesive bonding.



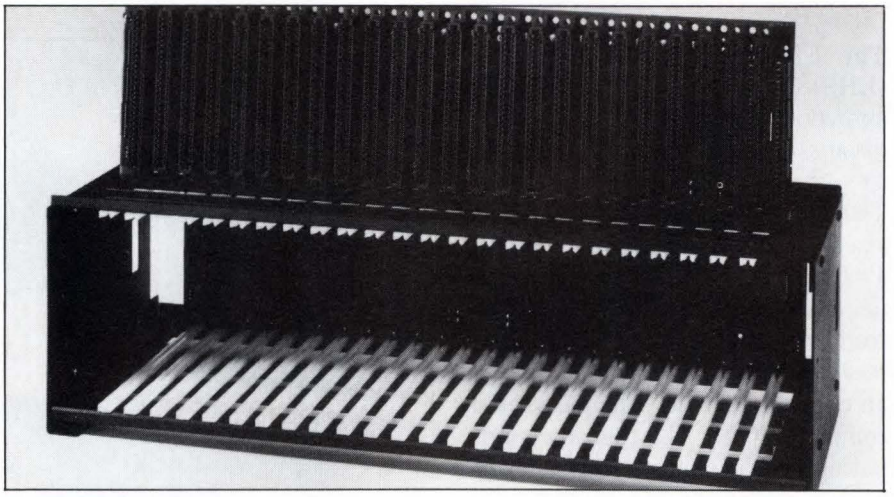
The sockets' electrical specifications include a contact resistance of 15 MΩ max after testing, an insulation resistance greater than 1×10^4 MΩ, capacitance of less than 1 pF at 1 kHz, self inductance of less than 5 nH at 500 kHz, and mutual inductance of less than 1 nH at 500 kHz. The sockets meet MIL-STD-810C standards for shock, vibration, and acceleration. Prices range from $0.035 to $0.05 per contact depending on quantity.

Methode Electronics Inc, Interconnect Products Div, 1700 Hicks Rd, Rolling Meadows, IL 60008. Phone (800) 323-6864; in IL, (312) 392-3500. FAX 312-392-9404. TWX 910-687-0760.

Circle No 465

STD Bus backplane supports synchronous clock speeds of 16 MHz

The BLackPLane is an STD Bus backplane capable of supporting synchronous clock speeds of 16 MHz. It achieves this high speed through a multilayered design that separates the signal, power, and ground planes. The signal layer has ac-coupled termination networks placed at both ends of the signal line to minimize overshoot and ringing. Because the networks present no dc loads to bus drivers, the backplane is compatible with older STD Bus cards with limited drive capability. The backplane also accommodates Fast, AC, and Act logic families.

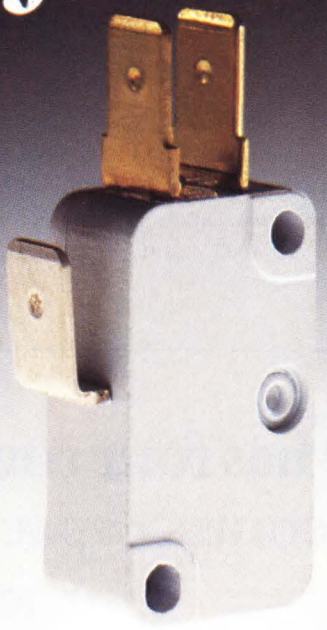


The BLackPLane's design maximizes the distance between signal traces, thus limiting the crosstalk between adjacent traces to less than 0.09%. Separating the power and ground planes from the signal traces permits a design that minimizes the power- and ground-plane impedance without compromising the characteristic impedance of the signal traces. Multiple power- and ground-connection points along the length of the backplane and a capacitor at each power-entry point for each slot ensure low power and ground impedances. Voltage stabilizers and low, ESR-rated capacitors permit the backplane to handle 36A at 5V, 6A at ±12V, and as much as 50A of ground current. Prices start at $144.

Matrix Corp, 1203 New Hope Rd, Raleigh, NC 27610. Phone (919) 833-2000. FAX 919-833-2550.

Circle No 466

Juice!



When the world needs "juice" in a hurry—and especially when the world needs it again and again, quickly and reliably—the world turns to a powerful quick-connect solution.

The AMP Ultra-Fast line of preinsulated, machine-feed FASTON receptacles and tabs.

And the world knows a good thing. To make our Ultra-Fast line, we take premier, stress-relieved FASTON connectors and insulate with nylon 6/6 to shrug off the stress of crimping and provide UL temp ratings of 105°C. We do it with a wide, wide range of styles and color-coded sizes.

And, so the line lives up to its name, we back it with industry's best-known application tooling, from hand tools to automatic harness-making machines.

For any production rate you need. And a crimp so consistent it's certifiable.

We offer advances, too, like our Ultra-Fast Plus line. Two types of plastics are co-molded to form the housing. The front half insulates. While the back half crimps to the wire insulation for extra strain relief. Plenty enough to meet VDE insulation support requirements.

The Ultra-Fast line covers 26-10AWG, with large-insulation-diameter versions for 22-10AWG (great for 2-wire applications). If you need juice—fast, simple, and reliable—there's one there for you, with just what you need: All the performance and productivity you expect from AMP.

Call 1-800-522-6752 for details on the Ultra-Fast line. AMP Incorporated, Harrisburg, PA 17105.

AMP Interconnecting ideas

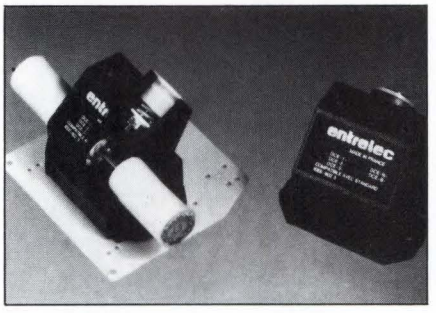
AMP and FASTON are trademarks of AMP Incorporated.

CIRCLE NO 96

Coaxial-cable tap connectors install without service interruption

These coaxial-cable tap connectors tap into Ethernet-network coaxial cable. Their design permits a reliable connection between a transceiver and the network cable without cutting or displacing that cable. The connectors meet all of the requirements of the IEEE-802.3 standard. The units can be switched on and off by removing the contact pin; you can test the signal through the contact-pin opening.

The connectors are available with BNC or TNC plugs, or they can be mounted onto a printed-circuit board with solder or plugs. You can install the units on-line without



service interruption. Mounting directions and a cable-perforation tool come with the units. Their electrical specifications include a contact resistance of less than 10 mΩ, an insulation resistance greater than 5000 MΩ at 500V, and a capacitance of less than 2.5 pF. In addition, the units can withstand 1500V at 50 Hz between the center conductor and the shield. The connectors operate from −50 to +60°C, and the insulation material conforms to the UL 94V-O recommendation. Model DCE-1, which solders directly onto a pc board, lists for $24.86. Delivery is 4 to 6 weeks ARO.

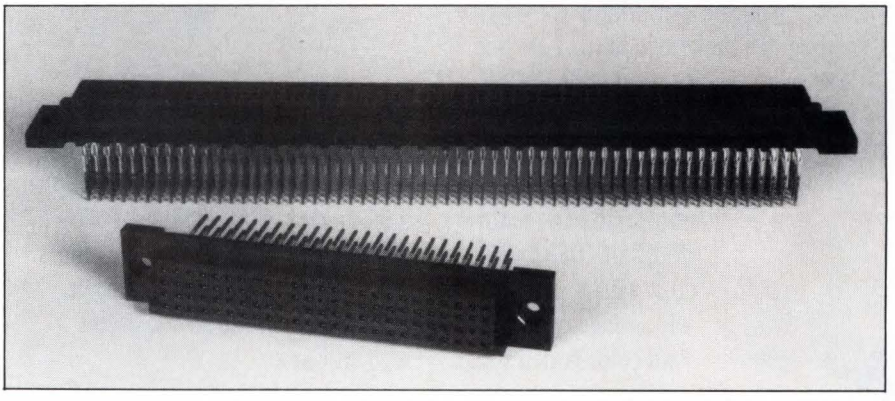
Entrelec, 2 Ram Ridge Rd, Spring Valley, NY 10977. Phone (800) 431-2308; in NY, (914) 425-7460. FAX 914-425-8108

Circle No 467

Female connector has four rows with 0.1 × 0.1-in. contact spacing

The HDC Series consists of female socket connectors with 4 rows of 0.1 × 0.1-in. contact spacing and are available with 100 to 240 pins. The terminals feature a 0.25- or 0.55-in. press-fit Flexpress contact that requires no soldering. Electrical specifications include a maximum contact resistance of 20 mΩ, an insulation resistance greater than 10^{12}Ω, a current rating of 1A at 100°C ambient and 4A at 20°C ambient, and a dielectric voltage of 900V rms.

The connectors require an insertion force of 4 oz per contact max and a withdrawal force of 0.75 oz per contact min. The contacts have either gold or Robex-plated coat-



ings. You can repair the connector by replacing the individual contacts. Contact installation requires a simple flat insertion tool that pushes into the insulator. The connectors cost $0.20 per pin (100).

Robinson Nugent Inc, Box 1208, New Albany, IN 47150. Phone (812) 945-0211. FAX 812-945-0804. TLX 810-540-4082.

Circle No 468

Global Interface

From standard connectors to custom overmolded cable assemblies, Molex makes the connection.

Molex offers you a broad line of reliable, innovative I/O connectors with full shielding where higher speed signal transmission is required.

Molex has developed a series of high density D-subminiature and circular mini din connectors satisfying the need for increased performance functions and miniaturization.

Lower Total Applied Cost

As part of our systems design approach, we offer a full range of application tooling from hand tools to automated assembly machines. Or we can provide pre-tested custom overmolded cable assemblies that match both appearance and performance specifications of your equipment.

Dependable Service Worldwide

Molex's distribution network ensures local inventory availability.

Recognizing your needs as an international marketer, Molex's multi-national coordination of sales, design and manufacturing services works to meet your global interconnection needs.

Look to Molex for the answers that make the I/O connections.

Durable SEMCONN™ shielded plug and receptacle available in 4, 6, 8 and 16 circuits. Positive locking plugs and easy in easy out applications.

For full line catalog, call 312-969-4550, or write Molex, Inc.

molex®

Service To The Customer...Worldwide

Corporate Headquarters: 2222 Wellington Ct., Lisle, IL 60532 USA, (312) 969-4550 • **European Headquarters:** Munich, West Germany, 49-89-496093
Northern Asia Headquarters: Tokyo, Japan, 03-487-8333 • **Southeast Asia Headquarters:** Jurong Town, Singapore, 65-660-8555

CIRCLE NO 97

PCD has built a better, tougher Pluggable Terminal Block System... right here in the U.S.A.

PCD's new ELF Series pluggable terminal blocks and headers give you a compact circuit board interface for industrial and process control systems and plenty of other applications. Better than anything else on the market, the ELF is made in the U.S.A. by PCD, America's premier supplier of edgecard terminal block connectors. Our new ELF offers all of the advantages of local manufacture. And it's a fully interchangeable drop-in replacement for many of the imported brands.

MADE IN USA

Better Material, Higher Reliability

ELF Series connectors are made from tough, stable PBT, not nylon. That means they're stronger and more reliable under extreme conditions. And the headers don't deform under even the highest soldering temperatures.

Extra Features, Easier Separation

Once ordinary headers and connectors are mated, they're difficult to separate – and you risk damaging them if you do. The ELF Series, however, features something new – molded-in U-shaped slots on the face of the header. Just slip in a screwdriver, turn it 90°, and the connector is opened. No matter how many positions you're working with.

Improved Wire Termination

The ELF's moving wire clamp termination with captive screws traps wire and contact between parallel surfaces. No strand damage. No fragile pressure pads. And wires can be terminated with connectors in the plugged or unplugged position.

Plenty to Choose From

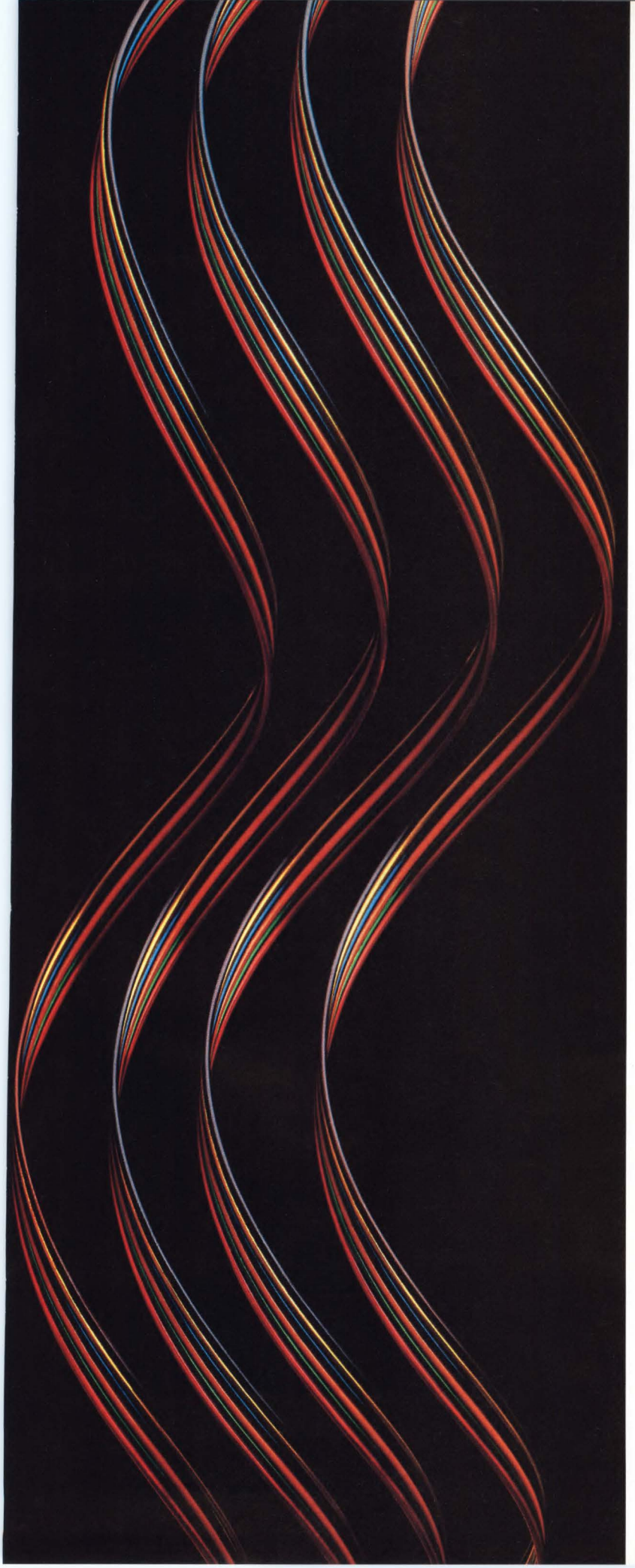
The ELF Series gives you all the choices you need. Vertical and horizontal headers. Open or closed end headers. .200" and 5 mm (.197") centers.

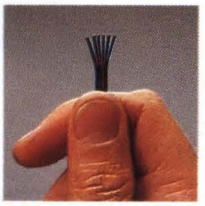
Available Now from the Smart Connector Company – PCD

The best pluggable terminal block system ever built is available now. From stock. With better performance, better delivery, and better technical support services from your U.S. connection – PCD. The Smart Connector Company. Call us for details. PCD, Inc., 2 Technology Drive, Peabody, MA 01960. Tel: (508) 532-8800, Fax: (508) 532-6800.

pcd
PRECISION CONNECTOR DESIGNS, INC.

The smart connector company.





MULTIFILAR®

MAGNET WIRE

Parallel bonded for windings and leads.

When two or more magnet wires travel together, MULTIFILAR magnet wire is an excellent alternative.

This parallel bonded, color-coded magnet wire offers more consistent capacitance and impedance characteristics when compared to windings using two or more separate magnet wires.

And, it allows for increased layer winding speeds, as well as reduced labor and handling. Color-coding assists in conductor identification and helps eliminate termination errors.

MULTIFILAR magnet wire is custom produced to guarantee flat, parallel construction in an array of sizes, 16–52 AWG, with up to 20 conductors in some sizes.

Available constructions include round, flat or square conductors. Individual conductors meet NEMA MW 1000, JW 1177, temperature classes 105–220°C; single through quadruple film builds. Color-coded conductors are available in most insulations with up to 10 different colors in some sizes.

Call or write for your free copy of our Technical Data Booklet and Capabilities Brochure. Both contain valuable information on all wire produced and inventoried by MWS Wire Industries. Samples of MULTIFILAR are available upon request.

MWS

Wire Industries

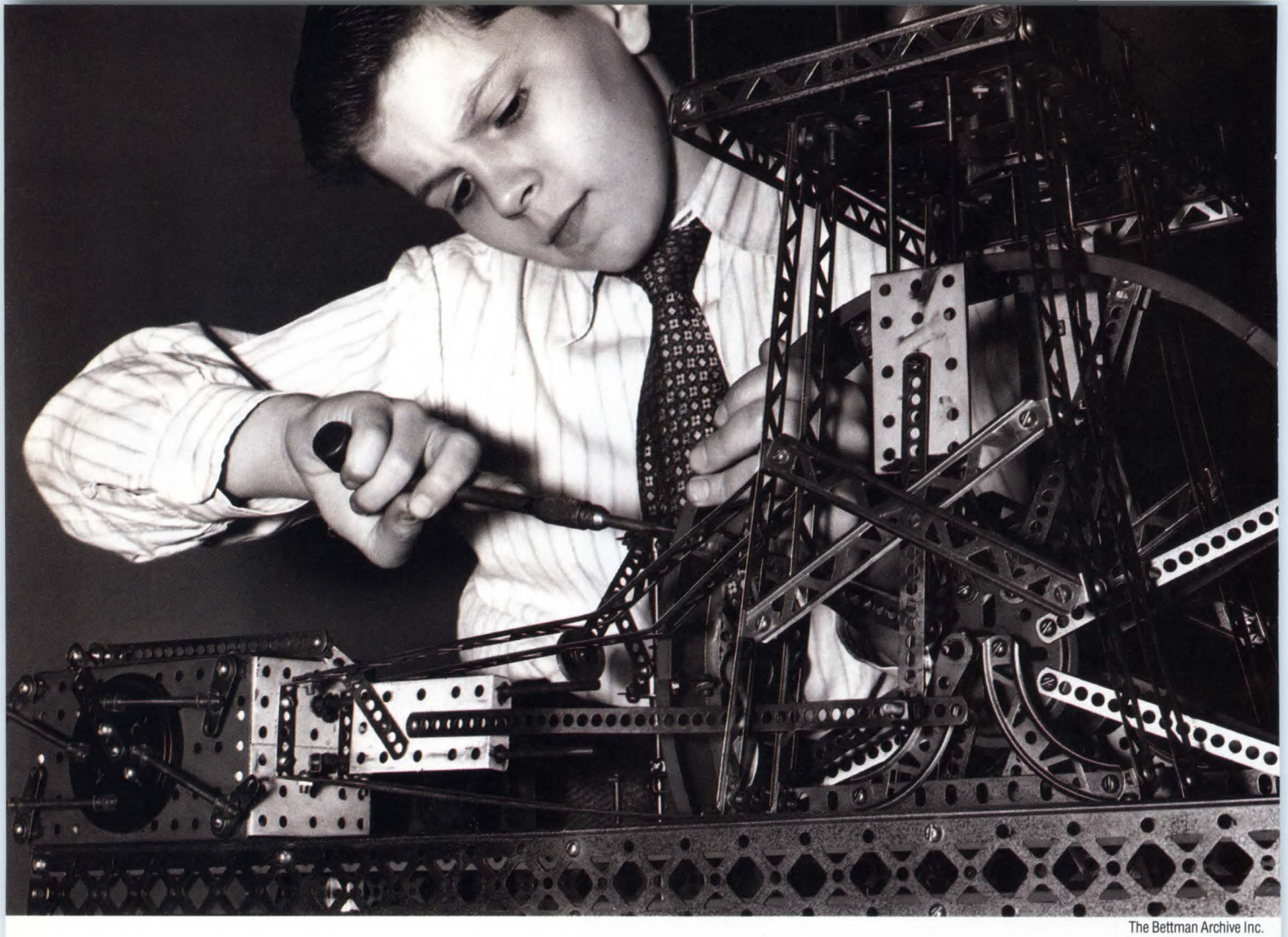
31200 Cedar Valley Drive, Westlake Village, CA 91362

CALL TOLL FREE 800 423-5097

In California 800 992-8553. In L.A., 818 991-8553

MULTIFILAR® is a registered trademark of MWS Wire Industries

CIRCLE NO 104



The Bettman Archive Inc.

Even the most ambitious project is limited by its parts.

Most kids use the pieces of their building toys just like they came out of the box. So they're limited by the characteristics of those pieces.

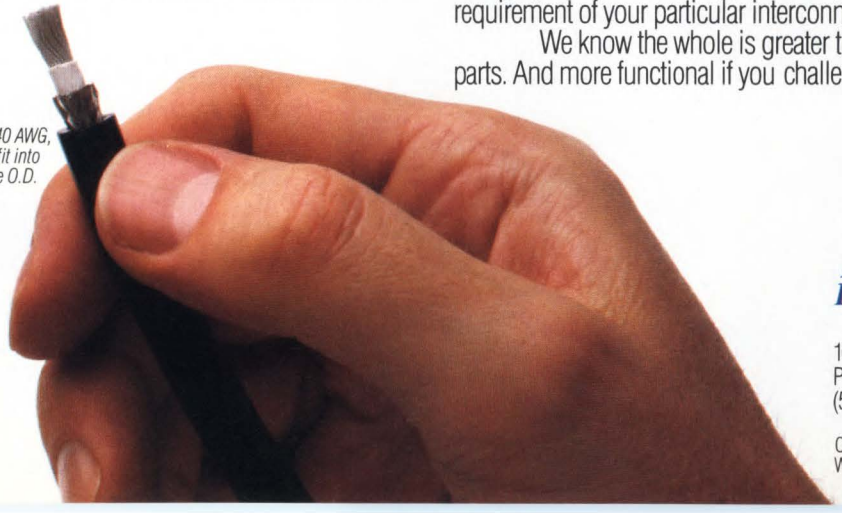
The same is true of today's suppliers of "custom" interconnect systems. Assembling systems from components that are readily available, they call these products custom when they're really only customized.

At Precision Interconnect we're often not satisfied with the components or assembly procedures readily available. So we design, test and implement our own.

First we ask every question imaginable about the application of the product. Then we apply our knowledge of manufacturing, materials, cable and connector designs, and termination processes to solve the problem.

So the complete interconnect systems we deliver will be high performance and application specific, meeting every requirement of your particular interconnect problem.

We know the whole is greater than the sum of the parts. And more functional if you challenge those parts.



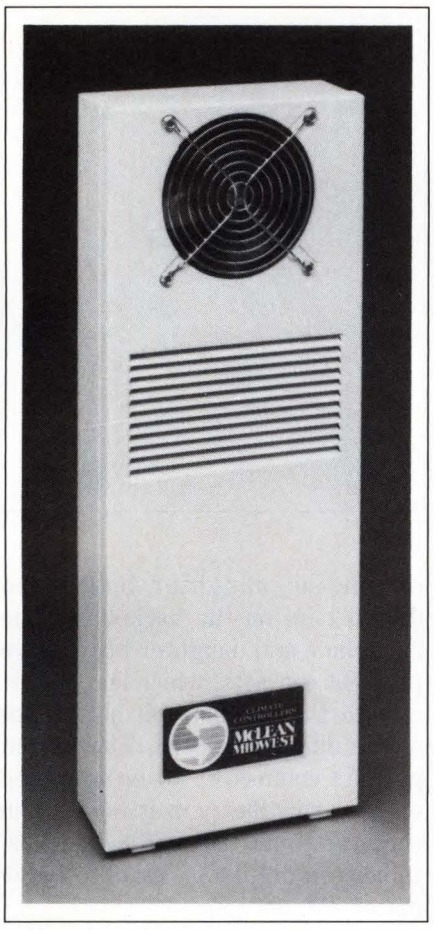
P.I. miniaturized this cable of 68/40 AWG, 50 ohm coaxes to a .192" O.D. to fit into the end of an endoscope tube. The O.D. of one RG-59 is .242".

CIRCLE NO 103

PRECISION INTERCONNECT

16640 S.W. 72nd Avenue
Portland, OR 97224
(503) 620-9400

Offices in San Francisco, Boston, Wilmington and Düsseldorf.



HEAT EXCHANGERS

The Proair series heat exchangers consist of six heat exchangers that have cleanable exchanger cores and contain no filters. The XR-20, the smallest model, measures $20 \times 7\frac{1}{2} \times 3$ in. It can remove 400W of heat from a sealed enclosure and maintain an average temperature of approximately 28°F above the ambient temperature in the enclosure. This unit operates at temperatures as high as 155°F and is available for 115 or 230V ac outlets operating from 50 to 60 Hz. Other units conform to international cabinet lengths of 29, 47, and 60 in. Two draw latches on the bottom of the exchangers access the slide-out, cleanable core. Each unit, approximately $390.

McLean Midwest, 4000 83rd Ave N, Brooklyn Park, MN 55443. Phone (612) 561-9400. TLX 290883. FAX 612-569-0533.

Circle No 611

PC-BOARD CONNECTORS

The BetaFlex family of 22 pc-board connectors comes with a centerline pitch ranging from 0.025 to 0.1 in. Configurations include 80 to 320 contacts with a 0.025-in. pitch; 50 to 300 contacts with a 0.04-in. pitch; 40 to 240 contacts with a 0.05-in. pitch, and 20 to 120 contacts with a 0.1-in. pitch. Because the units are stackable they can deliver densities as high as 80 contacts/in. A .025-in.-pitch connector with 320 contacts occupies a footprint of 4.68×0.5 in. The total height of the connector is 0.42 in.

To install the connector on a pc board, you use a low-voltage power supply to open a shape-memory-alloy actuator. After the board is inserted, you remove the supply, and the actuator closes on the board. The mechanical construction is rated for a minimum of 500 cycles. Nickel-contact areas are plated with a minimum of 30 μin. of gold. Demonstration kit including multidensity connector with 0.025-, 0.05-, 0.1- and 0.3-pitch centerlines; a mating pc board; and a power supply for the actuator, $500; $0.25 to $0.35/contact (1000).

Beta Phase Inc, 1060 Marsh Rd, Menlo Park, CA 94025. Phone (415) 494-8410. FAX 415-327-1163.

Circle No 612

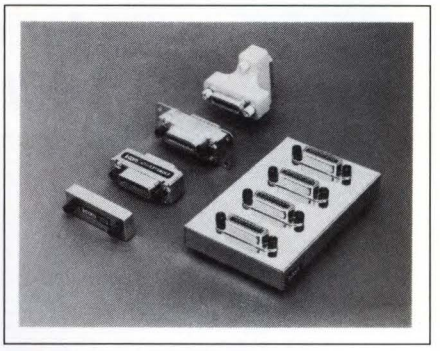
COMPONENT MOUNTS

The Vert-O-Mounts series of vertical-component mounts permit you to install components, such as DO-7, DO-34, and DO-35 diodes and 0.125, 0.75, and 0.5W resistors in a vertical position on a pc board. They are available with positions for 1, 2, 3, and 4 components. The mounts not only save valuable pc-board space, but they also cushion the components against vibration and shock.

The mounts also have standoffs that facilitate cleaning. A total of 12 mounts are available in heights of 0.312, 0.437, and 0.562 in., which meet MIL-M-38527/11 and WS-653E requirements. The molded units are made of a black thermoplastic polyester, which meets MIL-P-46161, grade B, class 30 specifications. The material meets the UL requirements for continuous operation at 130°C. $37.50 (1,000,000 in 10,000,000 lots).

Bivar Inc, 4 Thomas, Irvine, CA 92718. Phone (714) 951-8808. FAX 714-951-3974. TLX 852348.

Circle No 613



IEEE-488 PRODUCTS

These five interconnection devices contribute to a more effective means for interfacing with the IEEE-488 bus. The Model CIB24BA, a bulkhead connector, provides a simplified method for routing the multiple signals through a panel or enclosure. Model CIM24RA, a right-angle adapter, rotates a bulky cable 90°. Model CIB24X, an extender adapter, lengthens an IEEE-488 cable without stress. Model CIB24XR, a reverse-entry adapter, pivots a cable 180° and is available with male and female, or female and female connectors.

The multitap bus strip comes in two models, CIB24MT and CIB24MT2, and accommodates as many as eight IEEE-488 cables and connectors. You can disconnect any of the cables without disturbing the others. CIB24BA, $24.50; CIM-24RA, $26.50; CIB24X, $19.50; CIB24XR, $21; CIB24MT, $78.50; CIB24MT2, $159.50.

L-COM Data Products Inc, 1755 Osgood St, North Andover, MA.

Phone (508) 682-6936. TLX 882157. FAX 508-689-9484.

Circle No 614

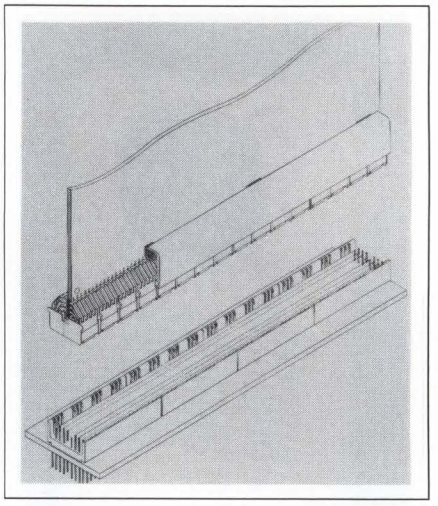
CONNECTION SYSTEM

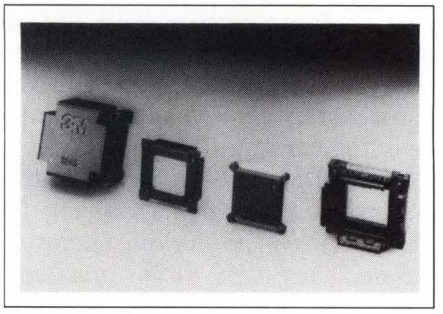
You can use the HD+80 backplane connection system to mount daughter boards on mother boards. Based on the company's 4-row HD+ format, the system provides a density of 80 contacts/in., using eight rows of contacts—six rows of signal contacts and two rows of low-inductance contacts. This configuration eliminates the need to sacrifice signal pins for ground and power pins.

Contact grid spacing is 0.05×0.1 in. on the daughter board and 0.1×0.1 in. on the backplane. The backplane and daughter board have press-fit contacts, which let you terminate the contacts on both sides of the daughter board. The format permits connectors to be arranged end to end, thus permitting custom configurations. Depending on customer requirements, $0.10 to $0.30/mated contact pair.

Teradyne Connection Systems Inc, 44 Simon St, Nashua, NH 03060. Phone (603) 889-5156, ext 509. TWX 710-228-1431.

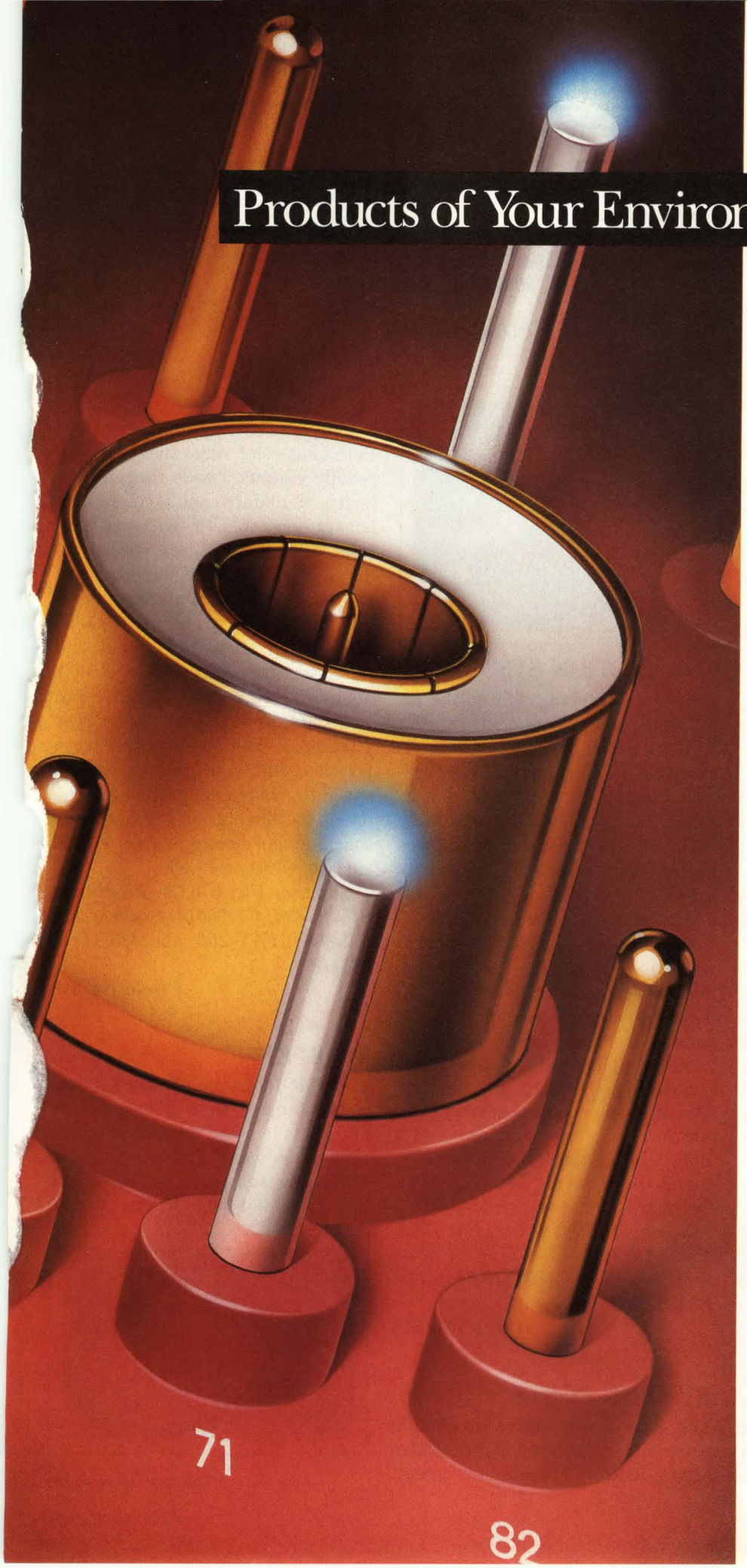
Circle No 615





FLAT-PACK SOCKETS

These end-use sockets are designed for plastic quad-flat-pack devices. Socket contacts are on 0.025-in. centers. Units that accommodate flat packs with 84, 100, 132, and 164 leads are available. The design of the socket body and lid protects μPs during handling, loading, and end use. You can apply the lids to



Products of Your Environment.

A field-use fiber optic connector so tough, you could roll a 5 ton truck over it. A Parallel Interconnect that allows a gas-tight interface in 60 seconds flat. A cabling assembly enabling a single connector to handle electronic signals, fiber optics *and* power supply.

These are but a few innovations in interconnections from ITT Cannon. But we couldn't have done it without you. Because success throughout our company relies on a thorough knowledge of your company's environment.

Take strategic partnering, for example. We don't create a custom solution by shaking your hand and jotting down a few notes. When we design-in, we get *inside* your environment.

Then there's Cannon's near-zero defect rate. It got that way, and stays that way, because we test each product in a carefully simulated environment.

As for delivery, we built a dependable system by studying the needs and scheduling realities of our customers' business environments worldwide.

And Cannon stays price competitive by always asking the question, "How will this connector be used?" Considering the connector's ultimate environment has taught us that keeping quality high ends up costing our customer less.

So if you'd like a partner who will take the time to learn about your environment, take a moment to contact ITT Cannon at (714) 261-5300.

Worldwide Headquarters
1851 East Deere Avenue
Post Office Box 35000
Santa Ana, CA 92705-6500

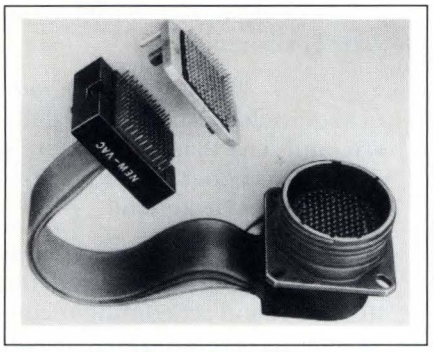
ITT Cannon
An ITT ElectroMechanical Components Worldwide Company
Discover our strengths.

CIRCLE NO 105

the μPs while they are still in IC handling trays. Tines in the lid grip gull-wing packages for pick-and-place or manual-handling operations. The body latches audibly snap into lid grooves to secure the lid/package assembly. A latching tool ensures manual alignment and insertion of the lid/flat-pack assembly into the socket. By applying downward pressure to the tool, you load the device and securely close the hinged socket latches around the lid. The sockets will operate over a range of −55 to 125°C. 100-position socket, $14.38 (100).

3M, Electronic Products Div, Box 2963, Austin, TX 78769. Phone (512) 834-6563.

Circle No 616



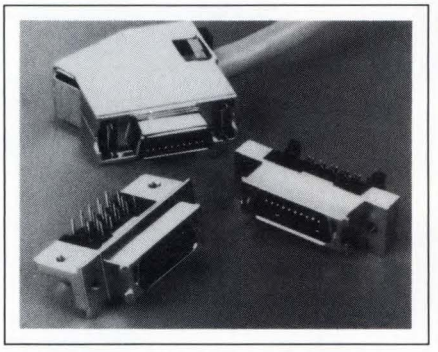
EXTENDER/CONNECTOR

The Board Saver, an extender/connector combination for troubleshooting purposes, eliminates the need for disconnecting a soldered-or hardwired-multipin connector on a mother board when a failure occurs. The extender consists of a glass-epoxy dielectric base that permanently attaches to the mother board. The extender has an array of low-profile, low-insertion-force pin receptacles for the connector to plug into. A polarization key and locking-jack screws provide error-free mating.

The connector detaches from the mother board after debug, and the extender remains affixed to the board. The extender arrays provide from 10 to 150 pin positions. The connector can attach to a wide variety of cable types and gauges. 60-pin model, $30 (100). Delivery, four to six weeks ARO.

New-Vac Electronics Inc, 9035 Eton Ave, Canoga Park, CA 91304. Phone (818) 998-4818. FAX 818-998-8710.

Circle No 617



CONNECTION SYSTEM

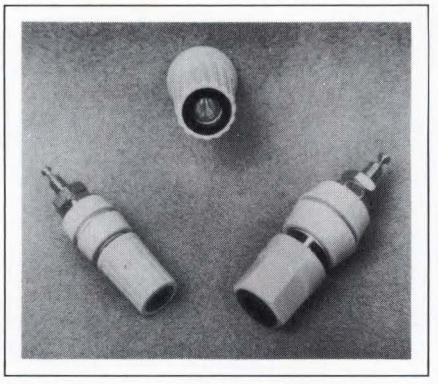
Providing a 50-mil pitch on the input and output connectors, the PAK-50 interconnection system is available in 20- to 100-position products. The system consists of a 2-piece, 50-mil flat-cable assembly with flat-cable connectors, 2-piece horizontally mated and vertically mated pc-board connectors, a right-angle board-mounted I/O connector, and a mating I/O connector with an EMI shield. The I/O connector accommodates #28 AWG discrete wire. When mating the connectors, the female and male contacts dynamically deflect, thus facilitating the high pin density. The interconnect system requires a 20g insertion force and provides a 100g min normal force. 50-position connector system, $44/set. (100). Delivery, four to six weeks ARO.

Robinson Nugent Inc, Box 1208, New Albany, IN 47150. Phone (812) 945-0211. TWX 810-540-4082. FAX 812-945-0804.

Circle No 618

BINDING POSTS

The Ring 5-way series of binding posts come in a choice of red, white, blue, yellow, black, or green



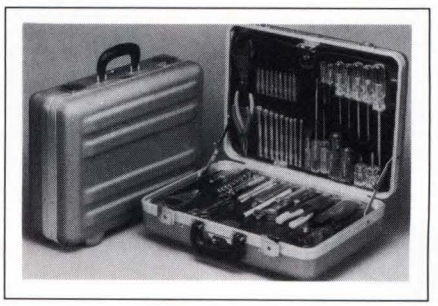
thumbnut color rings that help you readily identify a wide range of polarity. Standard units come in a natural-gray plastic with customized colors available on special order. All current-carrying parts are gold-plated brass. Miniature fluted-nut types are rated for 15A at 1000V, and standard hex-nut and fluted-nut types are rated for 30A at 1000V. Hex-nut and fluted-nut types are also available with larger stud sizes. The thumbnuts have a positive stop, which allows enough space to make a connection and reduces the likelihood of accidentally touching an electrically energized surface. $1.01 to $1.80.

Superior Electric Co, 383 Middle St, Bristol, CT 06010. Phone (203) 582-8098. FAX 203 589-2136. TLX 962446.

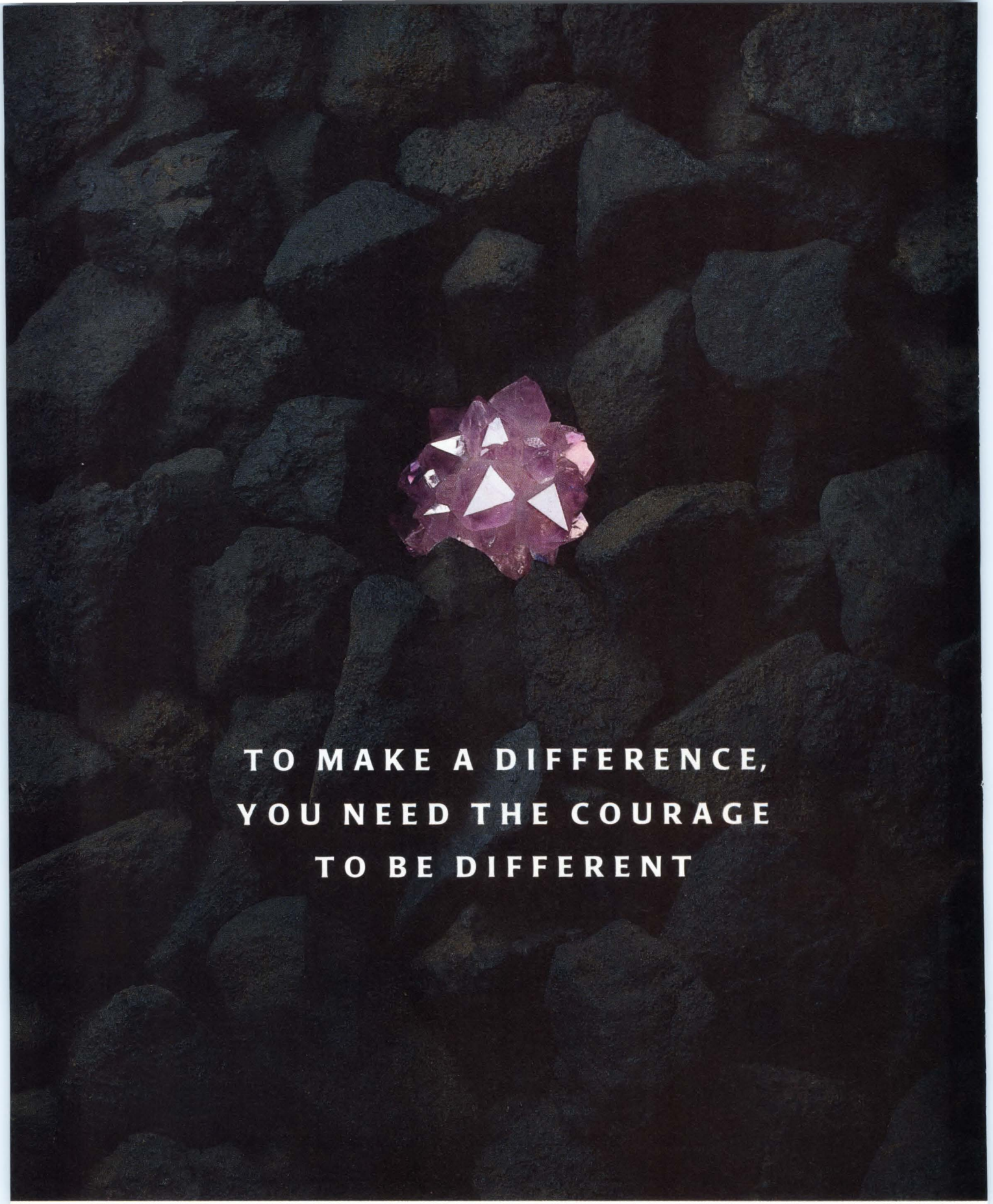
Circle No 619

TOOL KIT

The JTK-1001 Clean Room Kit consists of more than 100 tools for maintenance and repair of clean room equipment. The case is made of high-density polyethylene, and it has a molded-polyethylene handle



Text continued on pg 178



C&C Computers and Communications

For fast answers, call us at:

USA Tel:1-800-632-3531. TWX:910-379-6985.
W. Germany Tel:0211-650302. Telex:8589960.
The Netherlands Tel:040-445-845. Telex:51923.
Sweden Tel:08-753-6020. Telex:13839.
France Tel:1-3946-9617. Telex:699499.
Italy Tel:02-6709108. Telex:315355.

INTRODUCING V53: THE MS-DOS-COMPATIBLE, 16-BIT MICROPROCESSOR WITH A 400% PERFORMANCE EDGE

To make a difference in laptop PCs, modems, POS systems or ISDN terminals, you need a 16-bit microprocessor that offers genuine advantages in performance and integration.

The new V53™ meets your needs with the powerful V33™ CPU – rated four times higher in overall performance than the V30™ CPU. The V53 also integrates all basic peripherals on-chip to maximize system speed and minimize circuit board size.

Other top-end V53 features include expanded address space (up to 16M bytes) and dynamic sizing for 16/8-bit external buses. The V53 facilitates laptop designs with power-saving stop and standby modes. In PC applications, it provides AT performance, plus XT software-compatibility.

If you're determined to design an outstanding system, choose the 16-bit microprocessor with the courage to stand out. The V53 from NEC.

MS-DOS: Trademark of Microsoft Corp.

UK Tel:0908-691133. Telex:826791.
Hong Kong Tel:3-755-9008. Telex:54561.
Taiwan Tel:02-522-4192. Telex:22372.

Singapore Tel:4819881. Telex:39726.
Australia Tel:03-267-6355. Telex:38343.

CIRCLE NO 107

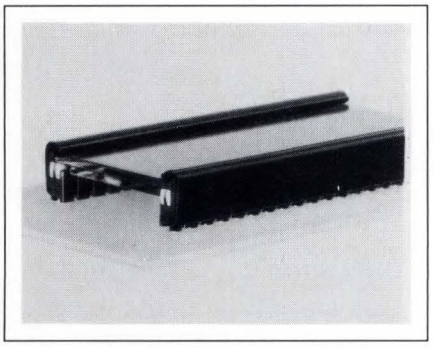
NEC

and a polyethylene retaining strap. A tongue-and-groove closure features an O-ring gasket that seals out dust and moisture. The kit also has a combination lock and two keyed latches for security.

The tool palettes feature transparent pockets for easy tool selection. Each pocket has a drain hole and the entire palette can be cleaned in a tank or by hand. The kit contains all the standard inch-measure tools for servicing process-control instruments, test equipment, computers, and communications systems. JTK-1001, inch-measure version, $455; JTK-1002, inch/metric version, $580.

Jensen Tools Inc, 7815 S 46th St, Phoenix, AZ 5399. Phone (602) 968-6431.

Circle No 620

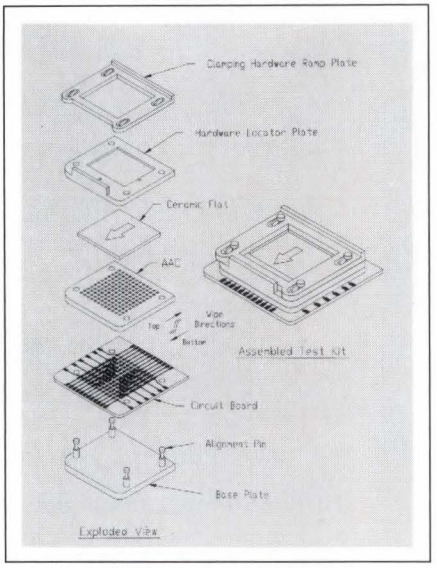


LCD CONNECTOR

The LCD Series hybrid connector connects LCDs to pc boards and combines the advantages of pin-and-socket with the advantages of elastomeric connectors. One standard connector can accommodate LCDs as long as 4 in. with any centerline-spacing widths. A snap-strip feature allows you to build short-length connectors in multiples of 0.1 in. The elastomeric connection provides a cushion against vibration and shock. The pin-and-socket connector is a zero-insertion-force connector. $0.10 to $2.50 (100).

Samtec Inc, Box 1147, New Albany, IN 47150. Phone (812) 944-6733. FAX 812-948-5047.

Circle No 621



ARRAY CONNECTOR

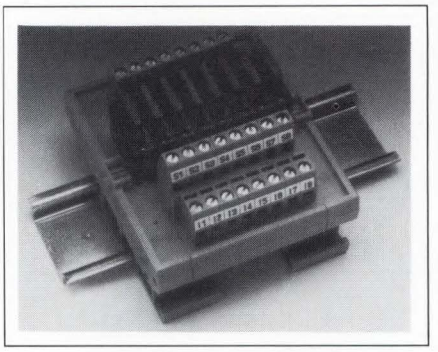
The Area Array Connector provides an interconnection between a pad-grid array package and a circuit board without using pins or soldering. The connector consists of rectangular conductors inserted into a cellular elastomeric sheet. Two contact-pad arrays compress the sheet to make contact with the conductors. The conductors pivot on their axes during compression to produce a controlled contact force. Each electrical contact has a resistance of <5 mΩ per I/O. The connector can be used with multichip modules or single chips and can work at digital speeds of more than 100 MHz. $0.10/contact; test kit, $400.

Rogers Corp, 1 Technology Dr, Rogers, CT 06263. Phone (203) 774-9605.

Circle No 622

CONNECTION SYSTEM

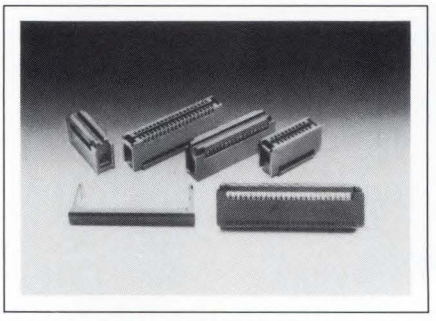
The FLKM-8-GMT interconnection system joins discrete wires. The module has screw-clamp terminal blocks that reside in a shock-proof housing. The terminal blocks accept discrete wires as large as #14 AWG wire. The module also accommodates as many as eight GMT fuses that can transmit a blown-fuse indication signal to a programmable logic controller. The GMT fuses can



have individual ratings of 0.18 through 10A. The unit also has a universal foot for convenient mounting on any DIN rail. From $50.

Phoenix Contact, Box 4100, Harrisburg, PA 17111. Phone (717) 944-1300. FAX 717-944-1625.

Circle No 623



CARD CONNECTORS

You can use the 636 Series card-edge connectors to install flat-cable interfaces on double-sided pc boards. The connectors are available in three mounting configurations: with full- or half-mounting ears and without mounting ears. A strain relief is available for connectors with no mounting ears. The series comes in 9 connector sizes: 10, 16, 20, 26, 30, 34, 40, 50, and 60 positions.

An integral side latch ensures positive crimping and keeps the assembly intact during and after crimping. Self-aligning cable guides ensure virtually error-free contact alignment. The contact mating area has a minimum of 15 μin. of gold plating. A polarizing key is optional, and it locks securely into the body of the connector tabs. The con-

Bendix® Connectors — tomorrow's technology today.

Programmable – Removable filter or transient protection for maximum flexibility in circuit design.

The Bendix® transient protection system is the weight, space and cost saving way to protect sensitive circuitry from interference or destruction by energy transients.

To meet these threats the Bendix® system can package filters, diodes or metal oxide varistors (MOV) individually or in combination within a connector that is intermateable and intermountable with MIL-SPEC connectors. This same protection is now available with **programmable – removable** EMI/EMP contacts.

Programmability with rear insertable, rear removable contacts enhances user flexibility, allowing unique mixes of filters, ground contacts, feed-thrus and power contacts.

System maintenance is simplified using Bendix® front repairable connectors. The need to remove flex print or printed circuit boards for repair purposes is eliminated, as is the need to enter a sealed box.

Programmable or repairable EMI connectors are available with single capacitors or Pi filter arrangements in the MF, VHF, and UHF frequencies. EMP repairable protection is available for sensitive circuits ranging in voltage from 5V to 200V, and with unipolar or bipolar characteristics. Both pin and socket contacts are available in sizes 16, 20 and 22.

For more information on the Bendix® programmable – removable transient protection system

Call (607) 563-5301
or (607) 563-5309

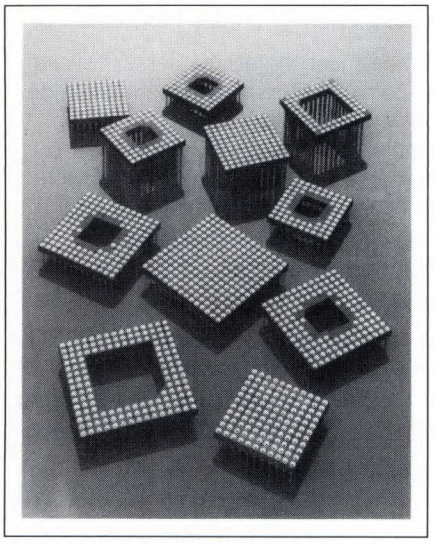
Bendix Connector Operations
40-60 Delaware Avenue
Sidney, New York 13838-1395

Amphenol
an LPL company

nectors are constructed from a thermoplastic that is 94V-O UL rated. $1.08 (1000). Delivery, six to eight weeks ARO.

Thomas & Betts Corp, Electronic Div/Technical Service, 1001 Frontier Rd, Bridgewater, NJ 08807. Phone (201) 685-1600. TLX 833190.

Circle No 624



PGA SOCKETS

The UXP Series consists of molded pin-grid-array sockets. The mold is a glass-filled thermoplastic polyester that conforms to the 94V-O UL rating. The sockets come in all standard and some custom configurations, and in grid sizes ranging from 10×10 to 18×18 receptacles. A wide variety of soldertail and wire-wrap terminations are available. An optional staggered-entry contact arrangement produces an average insertion force of 1.75 oz/line. Another option for molded standoffs aids in soldering.

Some mechanical specifications include a 2.9-oz insertion force, a 0.5-oz withdrawal force, an average contact pressure/pin of 1.5-oz normal force, an operating temperature of -50 to $+125$°C, and a minimum durability of 25 cycles. Electrical specifications include a 1A/contact maximum operating current, a dielectric voltage of 600V rms, a pin-to-pin capacity of <0.4 pF, and a contact resistance of <20 mΩ. 68-pin socket, $3 (100). Delivery, stock to eight weeks ARO.

Precicontact Inc, Box 798, Langhorne, PA 19047. Phone (215) 757-1202. TLX 834253. FAX 215-757-8025.

Circle No 625

DISK-DRIVE CHASSIS

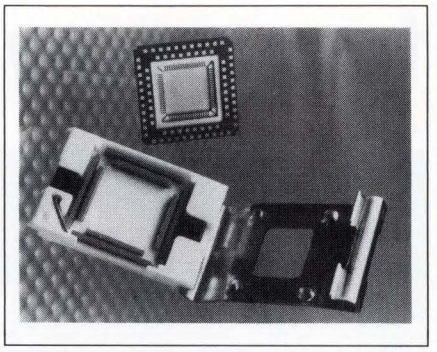
The SA-H116/2 chassis provides power and mounting for as many as three 5¼-in. disk drives. Two drives that show through the front panel allow you to use removable-media drives such as tapes and optical and floppy disks. A filler panel covers the unused slot for applications involving only one drive. The third drive also mounts near the front of the chassis but is concealed behind the front panel. In order to meet FCC requirements, the unit includes shielded connector data cables. The standard chassis connector configuration provides two 50-pin D subminiature connectors for SCSI in and out. Other configurations are available. The H116/2 includes a 200W power supply and two fans. The supply operates from either 115 or 230V ac inputs and includes an unswitched ac outlet. $586.

Sigma Information Systems, 3401 E LaPalma Ave, Anaheim, CA 92806. Phone (714) 630-6553.

Circle No 626

CARRIER AND SOCKET

The model 363 carrier-and-socket combination uses solderless elastomeric interconnections and is designed to replace pin-grid arrays and conventional leadless ceramic chip carriers where high-speed and high-density ICs are used. The land-grid-array socket connects to a 76-pin LCCC that's only 650 mil square. The LCCC achieves its small footprint by having two rows of contact pads around its perimeter



instead of the conventional one row. Connections are made through elastomeric connectors that provide low inductance and a low profile.

The socket is fastened to the board by two plastic connectors, and the LCCC is held in place by a stainless-steel snap lid that compresses the elastomeric connectors, making a gas-tight seal. You can insert the LCCC upside down so its metalized case can serve as a ground plane. A cut-out area in the socket lid accepts a heat sink, if necessary. $8 to $10 (1000). Delivery, six to eight weeks ARO.

Elastomeric Technologies Inc, 2940 Turnpike Dr, Hatboro, PA 19040. Phone (215) 672-0787. TLX 387236. FAX 215-672-4633.

Circle No 627

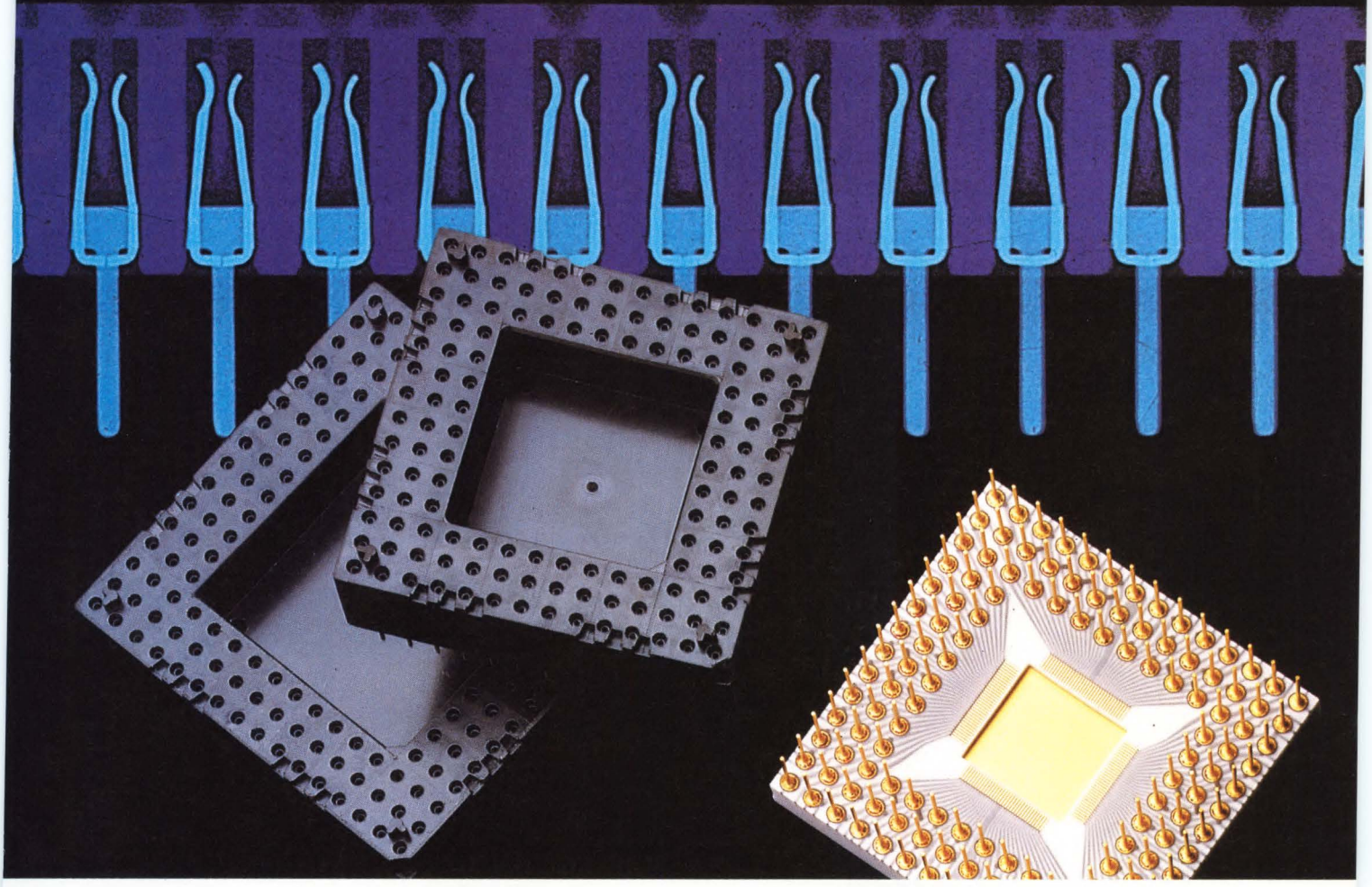
ZIP CABLE

Thermoplastic elastomer (TPE) insulated zip cable is available in sizes from 10 through 64 conductors. The thermoplastic elastomer insulation allows you to operate this cable over -65 to $+125$°C. Cable construction consists of #28-7 AWG tinned-copper conductors on 0.05-in. center spacings. One edge of the cable is marked for polarity reference. UL recognized at a rating of 125°C and 300V, the cable is available on 100-ft put-ups. A 10-conductor cable, $18.69 (10).

Amphenol Spectra-Strip, 720 Sherman Ave, Hamden, CT 06514. Phone (800) 572-2253; in CT, (203) 281-3200.

Circle No 628

X-ray: Enlarged cross section of LIF Pin Grid Array socket showing staggered cantilever beam contacts.



A revealing look at the difference in high performance IC interconnect systems.

The X-ray of our LIF Pin Grid Array socket is our way of emphasizing that it's what's **inside** an IC interconnect that makes the difference — in performance, reliability, and protection for your valuable IC devices.

To help you make the best choice in IC interconnects, we offer a close look at our new LIF Pin Grid Array socket — it's typical of the engineering quality that we build into our IC interconnect systems.

Unique cantilever beam contacts

- Low insertion (1.7 oz. avg.) and low withdrawal (1.3 oz. avg.) forces, plus high normal force (64 grams/min.) provide for easier insertion/extraction, and maximum performance.
- Our unique, easy-to-use extraction tool lifts the IC device evenly to prevent bent pins and device damage.

Improved design for manufacturability/reliability

- Anti-wicking contact design keeps solder where it belongs — on the solder joint.
- Top-side standoffs prevent contact damage due to over-insertion.
- Our LIF PGA socket is low profile, oriented for robotic placement, and available in standard or custom pin configurations in grid sizes from 10 x 10 through 16 x 16.

The company behind the product

A close look at our company will reveal our strong financial position, our commitment to the future, and our ability to support you worldwide. Write for our Annual Report — it's like an X-ray of our company.

To take a close look at our new LIF Pin Grid Array socket and our versatile line of ANSLEY® High Performance IC Interconnection Systems, and for the location of our nearest stocking distributor, call

1-800-344-4744.

Thomas & Betts Corporation, Electronics Division,
1001 Frontier Road, Bridgewater, NJ 08807 201-685-1600.

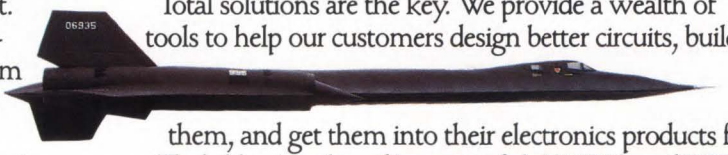
Thomas&Betts

Thomas & Betts facilities in **Australia:** Wyong North N.S.W., 43 53 2300; **Canada:** Ontario, 416-858-1010; **France:** Rungis Cedex, 1-46 87 23 85; **Hong Kong:** Kowloon, (852) 3-7391286; **Italy:** Milan, 02-61 20 451; **Japan:** Tokyo, 3 791 6411; **Mexico:** Naucalpan, 905 393 85 10; **Singapore:** 747 0244; **Spain:** Barcelona, 03-3 00 22 52; **Sweden:** Upplands Vasby, 07 60-8 81 10; **Taiwan:** Taipei, 2 713 0509; **United Kingdom:** Dunstable 0582-608101; **West Germany:** Egelsbach, 0 61 03-40-40.

WE JUST INCREASED

In the electronics industry, if you don't get your product to market first, you might as well get there last.

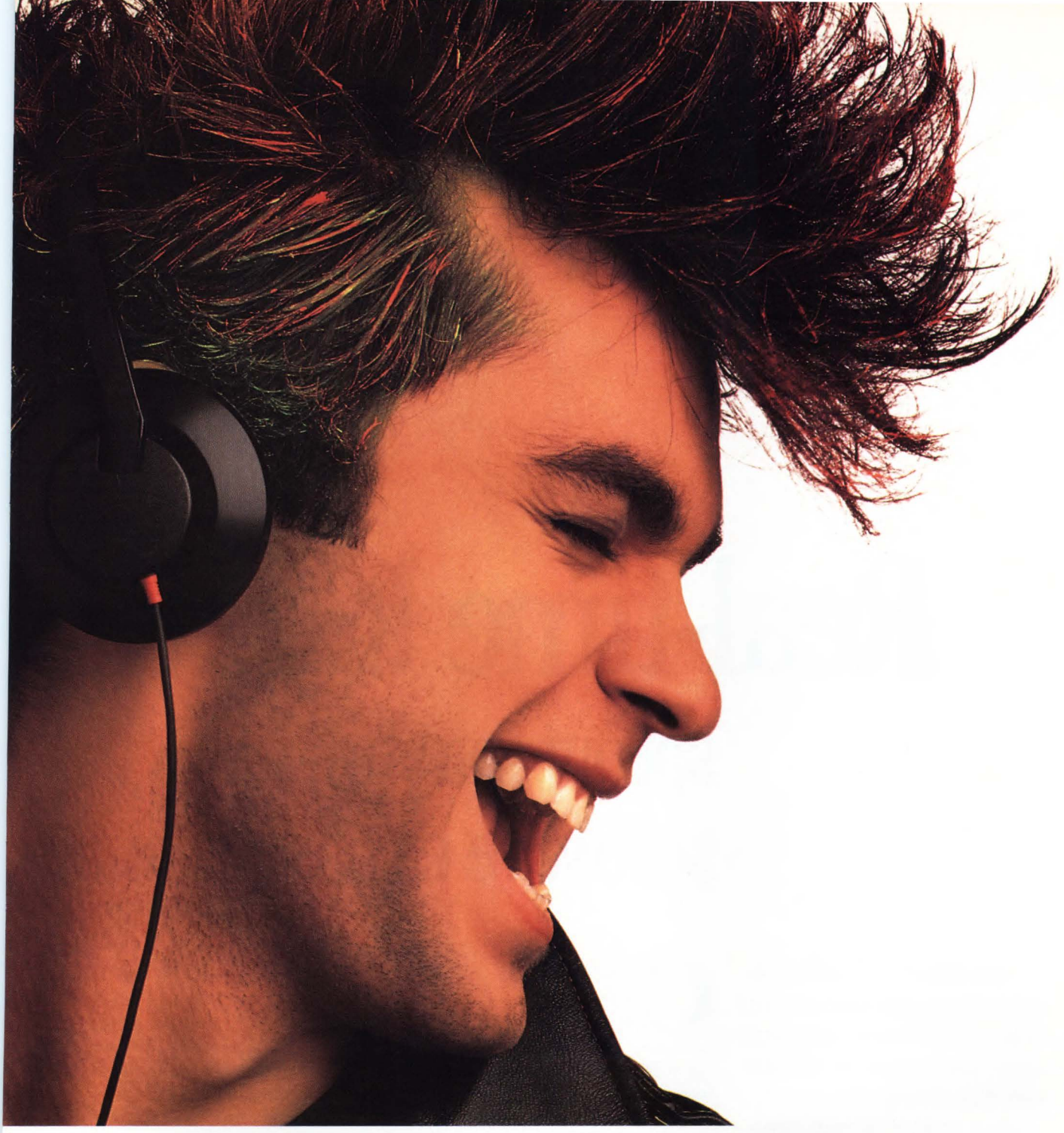
That's why more electronics manufacturers, from makers of sound systems to makers of aerospace assemblies and printed circuit boards, are turning to Prime. Our ability to integrate design and engineering–to get teams of people working simultaneously on a single project–helps our customers minimize development time, and get their ideas to market first.



Total solutions are the key. We provide a wealth of tools to help our customers design better circuits, build them, and get them into their electronics products fast.

Tools like Autoboard,® a powerful, UNIX-based PCB design package that produces designs that take less time to create, cost less to develop, and are easy to manufacture.

And Schematic Design, a powerful electronics circuit design system that comes with a comprehensive library

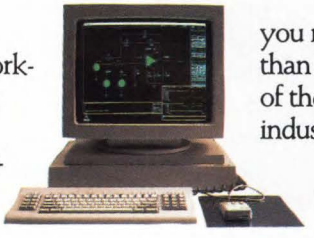


THE SPEED OF SOUND.

of thousands of parts and simulation models.

And Design Verification Manager, an electronics workbench that lets you easily integrate the simulation tools of your choice.

And CADDS® 4X software, one of the most powerful 3D modeling packages available. It will facilitate the packaging of your electronics products quickly and easily.



The list goes on. In fact, nobody offers you more CAE/CAD/CAM solutions than Prime. Maybe that's why we're one of the largest suppliers to the electronics industry.

For more information on how we help our customers get to market first, call 1-800-343-2540 (in Canada call 1-800-268-4700). Or write to us at Prime Computer Inc., 100 Crosby Dr., Bedford, Massachusetts 01730.

Prime®

CIRCLE NO 109

Real-time kernels sprout into full-grown software environments

Two groups of software engineers, both unused to formal, real-time software tools, are poised to invade and overwhelm the small, cozy realm of real-time kernels.

Charles H Small,
Associate Editor

Currently, software engineers do the overwhelming bulk of their real-time programming using home-brewed software systems. But two teeming hordes of programmers are just now beginning to migrate to formal, real-time software tools such as real-time kernels. These two groups are assembly-language programmers and high-level-language programmers. At present, the high-level-language programmers are mostly Unix wizards who program in C. The ranks of C programmers writing real-time code for embedded systems will soon be swelled, if not overwhelmed, by a torrent of Ada programmers hewing to the Department of Defense's software-language mandate.

Each group brings with it a different set of strengths and weaknesses, a different mix of skills and knowledge gaps, and distinct areas of interest. Both groups are moving toward formal real-time tools for the same reason: Embedded systems having fast, powerful processors and vast memories permit software systems that are too big and too complex to be written with ad hoc, low-level, unverified software tools.

Getting a real-time kernel couldn't be easier. Many OEM computer-board makers, such as Motorola and Force, offer a variety of targeted, ready-to-go real-time kernels as check-off items for their CPU boards. Force, for example, offers its VMEPROM, which is a version of Eyring Research's PDOS. VMEPROM includes a de-

Real-time software powers the real world
(Forth Inc)

bugger similar to Motorola's industry-standard MAXbug. Force also supplies the Software Component Groups' PSOS in EPROM, as well as Wind River Systems' VxWorks, and Ready Systems' VRTX as board-support packages. Similarly, all real-time-kernel vendors have targeted versions of their kernels—or "ports"—for common OEM CPU boards.

Roll your own

If you're designing your own μP system, you can avoid using OEM boards by having real-time kernel vendors supply you with versions of their kernels for most μPs. These vendors have written drivers for many μP-support chips; the drivers are not a resource to be taken lightly, as anyone who has tried to write a driver for Zilog's 8530 dual-serial controller, using only Zilog's documentation, can testify.

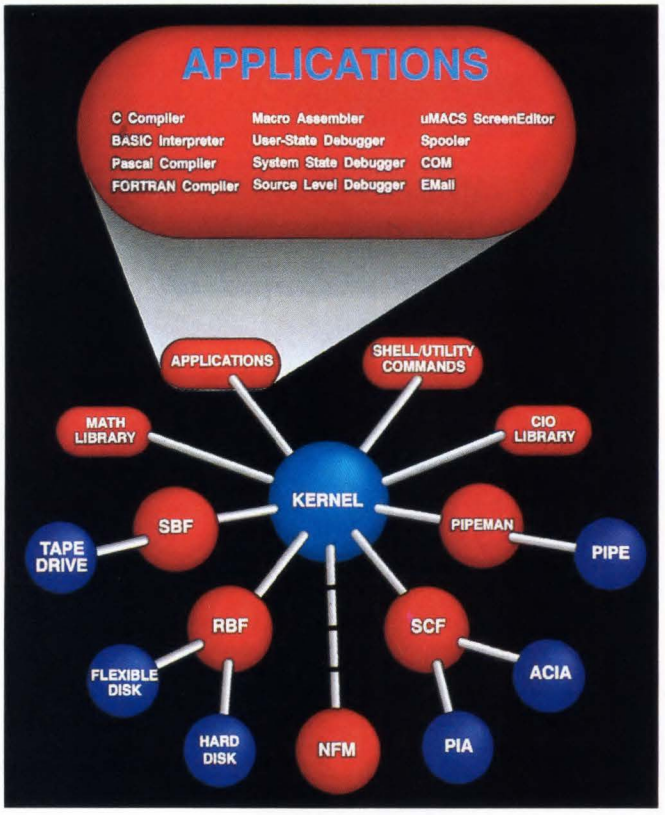
Makers of full-fledged, real-time operating systems sound a note of counterpoint, however, to the usefulness of the very notion of a real-time kernel. Alycon, maker of Regulus, Digital Research, maker of FlexOS, and Microware, maker of OS/9, note that their Unix-like, real-time operating systems are made up of re-entrant modules. Thus, they claim, you can easily strip their full-featured operating systems to encompass only that bare minimum of facilities provided by a skeletal kernel. They also point out that with the exception of Boston Systems Office, kernel makers are offering such operating-system add-ons as file systems, multipro-

Software engineers are moving toward formal real-time tools because embedded systems are getting too big for low-level, unverified software tools.

cessor support, local-area-network communications packages, graphics packages, and debuggers.

Kernel makers now offer these add-ons because many embedded systems no longer operate stand-alone with only rudimentary user interfaces. Embedded systems are being linked with local-area networks, large databases, and often require powerful, graphics-oriented user interfaces for control and information display.

And, as always, Forth stands alone. Forth Inc's PolyForth provides even less built-in facilities than a kernel. PolyForth has built-in multitasking, in the form of its pF/x operating system, and Forth words for controlling tasks. But it has no intertask communications constructs comparable to the semaphores, flags, mailboxes, etc of other real-time kernels. And yet, the entire PolyForth system, comprising operating system, editor, and compiler, is as small as many kernels. Forth programmers bravely challenge others to write real-time systems that are smaller and faster than theirs.



Add-on modules expand kernel to operating system (Microware Systems Corp)

As for real-time kernels—they are not all created equal. Even now, several standards committees are laboring, probably in vain, to standardize software interfaces to real-time kernels. These efforts are arguably doomed until widespread acceptance and use of real-time kernels winnows the range of available real-time kernels and their attendant diversity of features down to a manageable set of more-or-less similar products.

Currently, despite the fact that all real-time kernels perform the same two basic real-time functions of multitasking and intertask coordination, no two kernels do these jobs in quite the same way. You can, in some instances, tell by inspection that some real-time kernels have facilities that others do not. For example, no other real-time kernel has the controlled-shared-variable feature of Industrial Programming Inc's MTOS.

But beware! Many features of various real-time kernels appear, at least on the surface, to be similar. They are not. Two factors hamper your efforts to penetrate the jungle of alien jargon used in real-time programming: inadequate metaphors for real-time operations and lack of uniformity in implementing similar operations among different real-time kernels.

Take, for example, the simplest real-time mechanism, the so-called "semaphore." In real life, a semaphore is a visual signaling apparatus that has lights, flags, or mechanically moving arms. Railroads use them to signal locomotive engineers. In real-time kernels, semaphores have such starkly different

uses and properties that the metaphor reveals itself to be quite inadequate.

Real-time programmers use a semaphore for both simple signaling *and* for controlling tasks' access to shared resources, such as a disk, printer, or I/O port, which can be used safely by only one task at a time. Thus, a semaphore can function like a bus-grant signal in a hardware system.

Unlike a railroad semaphore, requesters queue up at a software semaphore. The requesting task at the head of the queue blocks all the other tasks in the queue from running until it relinquishes its place at the head of the queue. Thus, a real-time programmer can, for example, guard a shared memory area with a semaphore. This guarding can eliminate race conditions, such as those that occur when one task starts reading from a common memory area before another task finishes updating the area's data.

In addition to not operating like a real semaphore, real-time-kernel semaphores display a range of ingenious variations. First, consider the semaphore's queue. Some real-time kernels, and Ada, use a simple-minded, and possibly fatal, first-in, first-out (FIFO) method of ordering requesters in the semaphore's queue. This scheme, under some circumstances, could cause your system to lock up or crash.

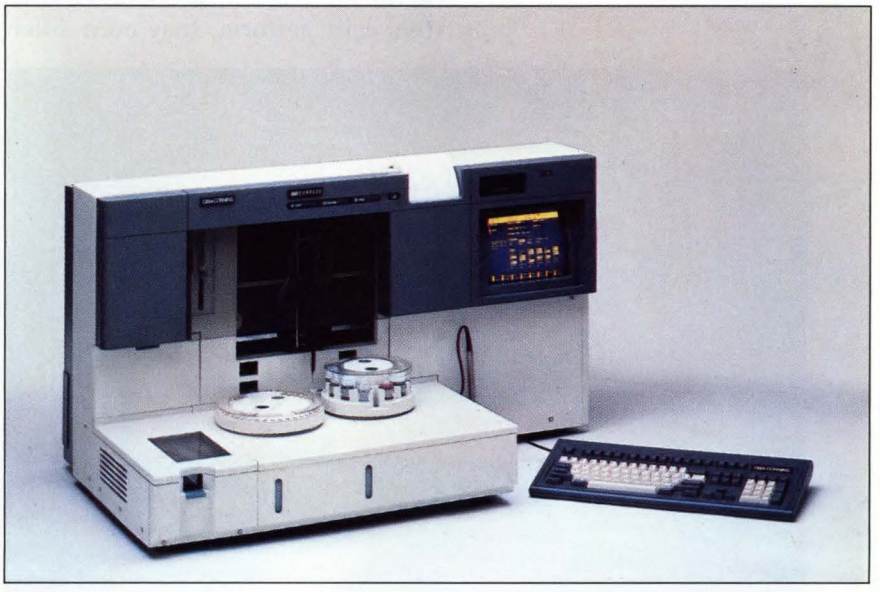
Dynamic priority adjustments

More sophisticated kernels employ a prioritized queue, which allows more urgent requesters to move ahead of low-priority tasks. Still other, more canny real-time kernels have subtle mechanisms for dynamically changing the priorities of tasks in the queue.

For example, Intel's iRMK has a cryptically named "region" function. This function will change the priorities of all requesters in a queue to the priority of the highest-priority task in the queue. This change keeps low-priority tasks from blocking high-priority tasks.

Industrial Programming's MTOS real-time kernel allows you to infect tasks with anxiety. That is, the longer the task goes without running, the higher its priority becomes.

Real-time kernel designers claim you need these dynamically changing priority schemes because, in many commonly encountered real-time situations, tasks will sometimes be blocked no matter how you assign relative priorities *if* those priorities remain fixed.



A real-time kernel controls this chemical analyzer (Industrial Programming Inc)

The same situations occur with another common real-time construct: the mailbox. Real-time mailboxes don't work very much like the ones you encounter in the Post Office. In the real world, only the boxholder can get mail from a mailbox. Also, the boxholder can receive different-sized messages through his mailbox.

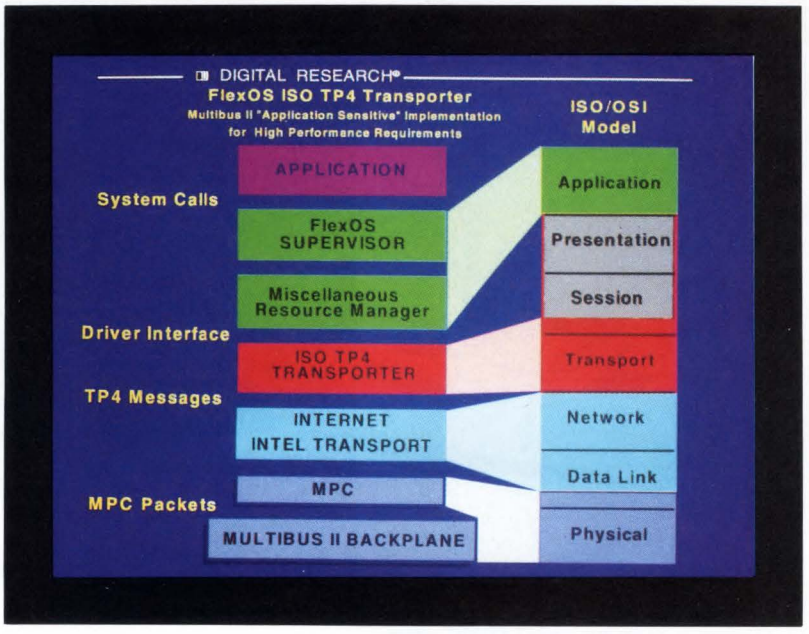
Real-time mailboxes can have queues for both posting and *receiving* messages. Naturally, just as with semaphores, the methods for ordering tasks in these queues

Several standards committees are laboring, probably in vain, to standardize software interfaces to real-time kernels.

vary. Thus, not only can any task post a message at a mailbox, any task can receive a message from a mailbox instead of restricting receiving to just a single boxholder. And, what's more, mailbox messages usually come in fixed sizes because real-time kernel designers find that fixed-length message buffers are easier and faster to manage than variable-length buffers.

Once you get beyond these at least commonly named, if not commonly acting, functions, real-time kernels have an amazing array of noncompatible, unusual features.

Real-time kernels not only differ in the functions their operating-system calls perform, they even differ in the mechanism they use for performing an operating-system call itself. You invoke some real-time kernels via a software trap, and others use the native subroutine-call mechanism of the host processor. Real-time kernels that cater to high-level languages tend to view a kernel call as just another subroutine call; software-trap kernels treat a kernel call as a context switch to a godlike supervisory program.



Some real-time systems have optional packages for standard networks
(Digital Research Inc)

The original purpose of using the software-trap mechanism for kernel calls was to make the real-time kernel a so-called "software component." Because the entry points, or "hooks," to the kernel routines are memory locations that are fixed by the processor's architecture, kernel makers could then supply the kernel in a fixed, preprogrammed PROM in much the same fashion as the operating system for a personal computer is supplied.

Do not confuse the software-component concept with ROMable code. All real-time kernel vendors are aware that their systems must live in the real world and function in stand-alone systems. Because stand-alone systems often have no mass storage, all real-time kernels are set up so that you can burn them into a PROM.

Detail ignites debate

Surprisingly, this seemingly minor implementation detail is the subject of a heated debate. Proponents of the subroutine-call method, such as JMI Software, claim their method meshes seamlessly with code written in a high-level language (in JMI's case, C). Their way, the real-time kernel is just another library routine that your linker can meld with your other software modules to form a software system. The software-trap mechanism, they point out, varies from processor to processor, eats up scarce processor resources, and requires additional overhead.

The software-trap call mechanism requires additional overhead, it is claimed, for two reasons. First, each high-level language has a specific way of passing parameters and commands to subroutines. Consequently, real-time kernels that use the software-trap mechanism often require you to go through an intermediary to get to the kernel's software trap. This intermediary con-

sists of a set of library functions that resolve differences between a given high-level language's calling procedure and the requirements of the software-trap mechanism.

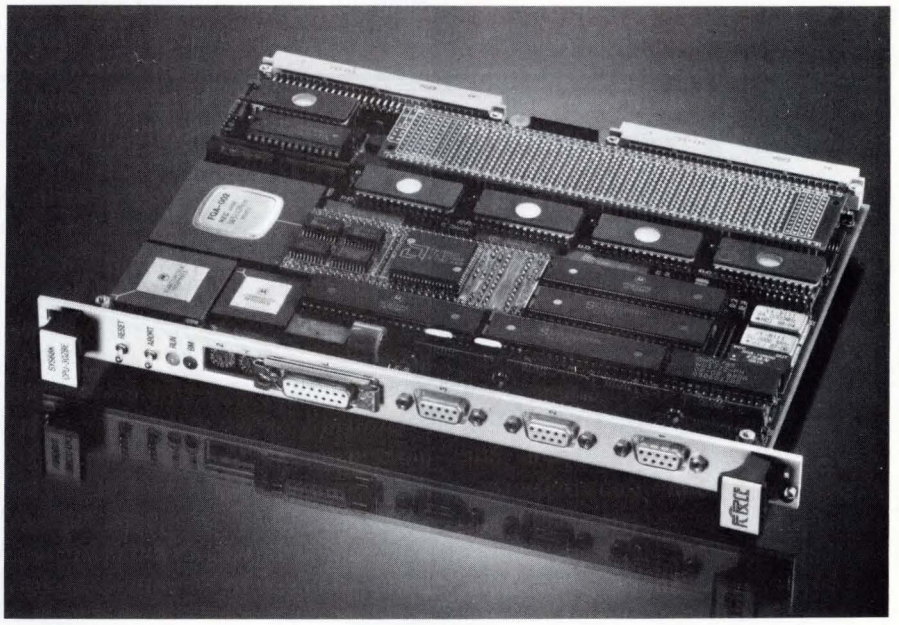
Second, because software traps are scarce resources, kernels that use the software-trap mechanism tend to use a small number of traps as gateways to numerous kernel functions. Therefore, the kernel's trap-handling routine must decode, or demultiplex, the commands and parameters that a calling routine passes, and vector execution to the proper system call. With a direct subroutine call, on the other hand, such demultiplexing is eliminated because the calling routine can call the desired kernel routine directly.

Trap hogs

Proponents of the software-trap mechanism counter that although software traps are a scarce resource, no user has ever complained that their real-time kernels hog too many traps. They also point out that while software-trap mechanisms do, indeed, vary from processor to processor, subroutine-calling mechanisms, too, vary from language to language—and from compiler to compiler—even for the same language. In fact, subroutine-calling mechanisms can vary from one release, or version, of the same compiler for the same language.

As for overhead, high-level languages automatically impose overhead on a processor's native subroutine-call mechanism—overhead that's not visible to the high-level-language programmer but nonetheless is very real. So that while an intermediary routine must shuffle parameters and commands such that high-level languages' kernel calls will match the requirements of a given software-trap mechanism, high-level-language compilers do much the same sort of machinations in the machine language they generate before invoking a processor's subroutine-call instruction. In other words, overhead is overhead no matter which mechanism the kernel uses for function calls.

Software-trap proponents further propound that you cannot add modules or functions to a linked system without relinking and reloading. You can judge whether or not this constraint is a major problem from the fact that Wind River Systems, which has a linked system, has a method of working around this problem. During development, you can dynamically link in additional modules or functions via a table-look-up facility. For your final run-time version, you strip out the table-look-up facility and let your linker hook your function calls directly to the kernel routines.



Computer boards come with real-time kernels
(Force Computers Inc)

Lastly, software-trap proponents point out that many processors' software traps automatically entail changes in status from user to supervisor, and changes in memory privileges. These automatic status changes are just the ticket for both error handling and a robust context switch from task to kernel.

Not all kernel designers make use

No two kernels perform the same two basic real-time functions of multitasking and intertask coordination in quite the same way.

of such powerful, built-in processor facilities for context switches. Intel's iRMK real-time kernel for the 80386 resides in one memory segment and runs at one protection level. On the other hand, Ready Systems's VRTX32 uses the 80386's built-in memory protection and status-changing mechanisms for context switches (but not the 80386's context-switch instruction, which has proved to be too cumbersome for real-time applications).

Real-time kernel designers also debate the virtues of writing their kernels in a high-level language or in an assembly language. There's no consensus. Some small kernels, such as JMI Software's C Executive, are written in high-level languages, while some large real-time operating systems such as Microware's OS/9, are written in assembly language. (Keep your eyes peeled for an OS/9 port to the 80386.)

Currently, when kernel makers say their kernels suit high-level lan-

Self-help resources appear slim

How does a tyro begin to master real-time programming other than learning, if at all, by painful trial and error? Remember: The best way to learn a bad habit is to practice it over and over; just because you've previously made errors doesn't necessarily mean you learned anything useful from them. Universities are not much help. Few courses, if any, exist that teach real-time, embedded-system programming.

Although many of the real-time kernel vendors listed in this article are just mail-order houses, some (for a fee), will act as consultants to your firm. Some also offer seminars. You can naturally expect such seminars to be like all other vendor-sponsored seminars—biased toward the vendor's products. Further, the seminar will probably accentuate the host company's product's good points, while minimizing any deficencies the product has, or difficulties you, as a beginner, may encounter.

Skilled customers

Most vendors offer help phone lines, and some have field-application engineers. But until recently, these vendors have enjoyed working with customers who were generally as skilled or more skilled than the vendors are in real-time programming. Most vendors do not have application literature that even begins to approach the high-quality, extensive application literature of hardware vendors.

Any comparison of the application literature of hardware vendors, such as Analog Devices or Hewlett-Packard, with real-time kernel vendors' invariably leaves the software literature looking pitifully inadequate.

Self-study opportunities are limited, too. Most texts on real-time programming are very academic. Reading these texts, you will become very familiar with such abstruse topics as the "Dining Philosophers' Problem." Apparently, despite years of furious effort and cogitation on the part of multitasking theoreticians, no one can ensure that a bunch of absent-minded philosophers will all get something to eat.

As fascinating as this problem is, your real-time system will probably be feeding no philosophers. More practical is the soon-to-be-published, "An Implementation Guide to Real Time Programming" by David L Ripps, Prentice Hall, $39. Ripps, one of the developers of Industrial Programming's MTOS and a long-term Industrial Programming employee, naturally uses MTOS in all his examples. But this focus shouldn't be a problem because MTOS has more features than any other real-time kernel; the book should prove helpful no matter which kernel you use.

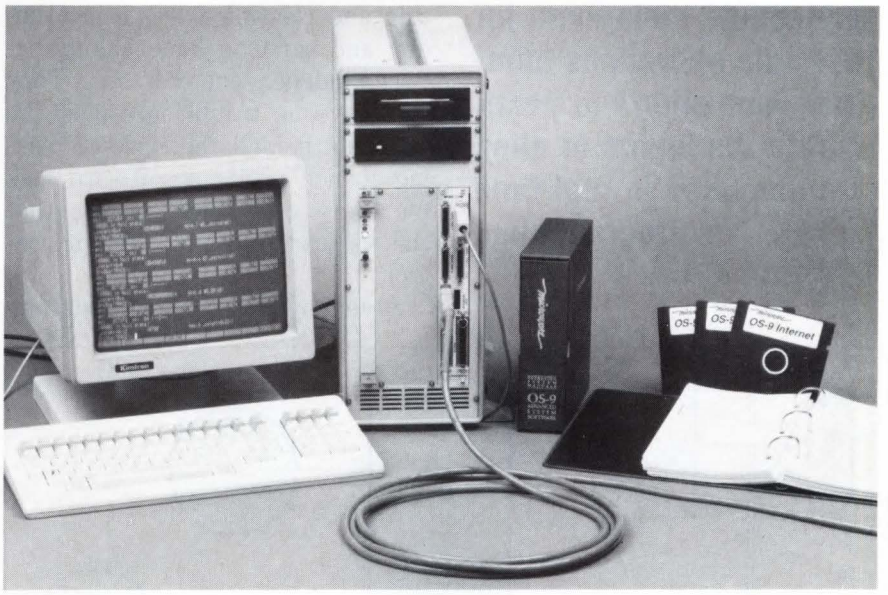
Andyne Computing Ltd's PCMASCOT real-time operating system for the IBM PC costs $795 and comes with an excellent manual. The manual presents a detailed series of application examples of increasing complexity. After working through the examples, you should be able to acquire a good, basic feel for intertask communication and control.

But, even with PCMASCOT background, you will still have to master three other vital, basic areas of real-time programming on your own: dividing an application into tasks, setting priorities, and testing and fine-tuning the system.

guages and operating systems, they really mean C and Unix. That is, their kernels' calls look like C subroutine calls; their command syntax, string handlers, file and I/O routines, and commications methods look, as much as possible, like Unix ones. For example, they would substitute message queues for Unix pipes and allow programmers to "fork" threads of a program instead of requiring them to fork the entire program.

Obviously, not everyone programs in C; more to the point, Ada syntax differs from C syntax. And the Ada specification doesn't just mandate a compiler. The full Ada specification defines a complete computer-aided software-engineering (CASE) development environment and runtime environment which differs from, and covers areas ignored by, C and Unix.

Cooking up a kernel call to handle Ada's rudimentary "rendezvous" function for intertask coordination is not difficult, yet so far only Ready Systems and Industrial Programming have done so. You can expect other kernel vendors to jump on the Ada bandwagon soon. Luckily, Ada allows you to use, or "import," non-Ada routines. Therefore, Ready Systems' and Industrial Programming's Ada-compatible kernels offer all of the companies' usual kernel calls in addition to the Ada rendezvous.



Real-time systems handle local-area-network communication (Microware Systems Corp)

Comparing different real-time kernels, for all the preceding reasons, is therefore a difficult job for the uninitiated.

The difficulties experienced by software engineers new to real-time kernels depend on the engineers' backgrounds. Because of their intimate association with hardware, assembly-language programmers are, on the one hand, very comfortable with low-level minutiae such as set-

Modern aircraft depend on real-time kernels (Ready Systems)

Inadequate metaphors for real-time operations hamper your efforts to penetrate the jungle of alien jargon used in real-time programming.

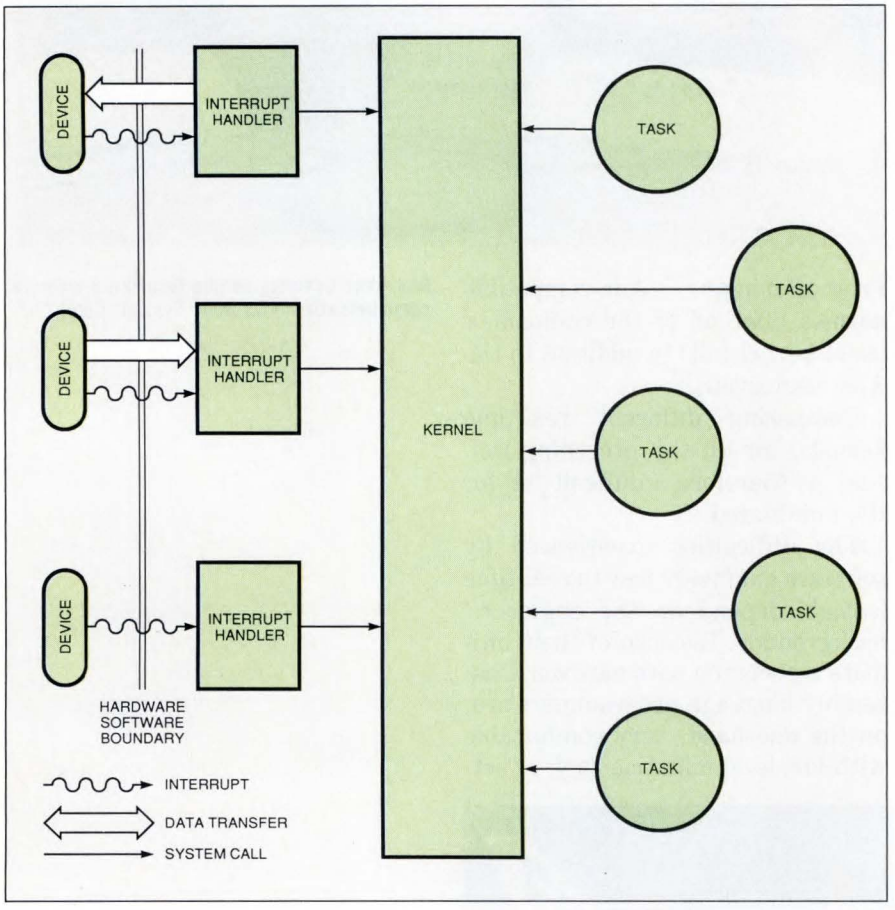
ting and clearing flags, using timers, and handling handshaking between independent processes. They also have no trouble grasping the rationale behind the style of tasking, which posits a software task for every real-world process that the software must monitor or control.

Assembly-language programmers have difficulties, on the other hand, with classical control and data-flow problems such as corrupted data or two tasks getting locked in a fatal embrace. (A fatal embrace results from two processes blocking each other, each one waiting for a reply from the other.)

High-level language programmers have fewer problems with data-flow but correspondingly more problems with low-level real-time-kernel functions. And because the cost of spawning a new task ("forking") is high under Unix, Unix wizards tend to write monolithic programs that could be better broken up into a number of small tasks. Real-time-kernel context switches are much faster than Unix context switches; real-time tasks are orders of magnitude smaller than Unix tasks. Unix programmers are amazed when shown that a task occupying only a few hundered bytes of memory and comprising a couple of lines of code can, in fact, do useful work.

Further, while the Unix forking model has some elegant properties that prove useful for certain applications, forking is a cumbersome, unwieldy model for real-time programming. To fork a task, Unix must make a copy of the entire task. The "child" process thus forked off inherits all the properties and I/O privileges of its "parent." So rather than actually comporting with the parent-child metaphor commonly employed by Unix programmers, forking more closely resembles cloning.

Unix programmers are used to the "pipes" mechanism for passing data between processes and are often uncomfortable, at first, with the less flexible, but faster, mailboxes and message queues provided by some real-time kernels.



Real-time kernels mediate between the real world and software (Ready Systems)

Shared date is a moving target

Also, experienced high-level-language programmers who are familiar with data-flow design commonly have designed software systems whose tasks acquire a set of data, modify it, and then pass the complete set of data on to another task for further processing. In contrast, data sets in real-time systems often have several tasks working on them at one time. Thus, although software pundits promote data-flow design as both the best structured software-design method and the

EZ-PRO Supports: 1802/05/05AC/06 . . . 64180R0/R1/Z . . . 6301V1/01X0/63701V0/63701Y 6303R/03V1/03X/03Y/03Y0 . . . 6309/09E . . . 6502/C02/03/04/05/06/07/10/12/13/14/15 6800/02/08 . . . 6801/01U4/68701/68701U4/03/03U4 . . . 68HC05C4/C8/D2/P1 . . . 6805 ASIC 1468HC05E2/E3 . . . 6809/B09/09E . . . 68HC11A0/A1/A8/E1/E2/E9 . . . 68000/68008/68010 8035/39/C39/40/48/8748/49/8749/C49/50 . . . 8051/51AH/C51/C51BH/C51FA (80C252) 8751/51H/51BH/C51 . . . 8052/52AH/C52/52BH/C52T2 . . . 87C52/52BH . . . 8031/31AH/C31/C31BH 8032/32AH/C32/32BH/C32T2 . . . 80C154/83C154/85C154 . . . 8344/44AH . . . 8053AH/8753H 80515/535 . . . 80C152JA/C152JB . . . 80C321 . . . 80C451 . . . 80C552 . . . 80C325 . . . 80C452 8085/8085AH-2/80C85 . . . 8086/80C86 . . . 8088/80C88 . . . 8096/97/8396/8397/8098/80C196 80186/80C186 . . . 80188/80C188 . . . 8X300/305 . . . NSC800 . . . V20/V30 . . . Z80A/Z80B/Z80H Z180 . . . . . and more.

IN-CIRCUIT EMULATION

for 140 devices

Now 42 versions in the 8051 Family!

Start with dual level debugging, C-source and assembly. Add a 4K deep trace, powerful performance analyzer; breakpoints for simple address, conditional, delayed, ranging, and X before Y before Z; plus logic probes, other attributes, other options, and you have **EZ-Pro™**, the most versatile microprocessor development system in the world.

IBM® XT, AT, PS/2, Sun Microsystems and Macintosh host EZ-Pro development systems.

EZ-Pro will handle **your project,** or return it within 10 days under our zero risk Suitability Warranty.

You may take advantage of the EZ-Pro equity rental plan or make a standard purchase. Either way, we are ready to ship most systems. Call for ETA!

Your call will expedite prices and specifications. Or write: Customer Service, 2651 Dow Avenue, Tustin, CA 92680-7207.

american automation

EZ-Pro is a trademark of American Automation Inc. IBM & PS/2 are registered trademarks of International Business Machines Corporation. XT & AT are trademarks of International Business Machines Corporation. Macintosh is a registered trademark of Apple Computer, Inc. Sun Microsystems is a trademark of Sun Microsystems, Inc.

Real-time kernels differ in the functions their operating-system calls perform and in the mechanism used for an operating-system call itself.

ideal model for CASE tools, data-flow designs match up poorly with many real-time kernel facilities.

Reportedly, neither assembly-language nor high-level-language programmers understand the power and pitfalls of a pre-emptive scheduler. They will all have to leave behind them their timing diagrams and flow charts and adopt new design aids.

Metasolutions hard to come by

The problem the uninitiated have in understanding and evaluating different real-time kernels is the same one faced by anyone who must master a complex field—the novice's lack of "metasolutions." Any experienced designer, in any field, has general solutions, in his head, to common problems. Metasolutions transcend the low-level characteristics of the particular technologies that the designer works with.

For example, an experienced logic designer knows general ways to solve logic problems. He will search through the manuals describing a particular logic family until he finds the bits and pieces that will realize his metasolution. Often, the solution to a "metaproblem" involves using a particular device in

For more information . . .

For more information on real-time kernels such as those described in this article, circle the appropriate numbers on the Information Retrieval Service card or use EDN's Express Request service. When you contact any of the following manufacturers directly, please let them know you saw their products in EDN.

Alycon Corp
6888 Nancy Ridge Dr
San Diego, CA 92121-2232
(619) 587-1155
TWX 510-600-4947
Circle No 351

Andyne Computing Ltd
544 Princess St, Suite 202
Kingston, Ontario K7L IC7
Canada
(613) 548-4335
Circle No 352

Boston Systems Office Inc
128 Technology Center
Waltham, MA 02254
(617) 894-7800
Circle No 353

Digital Research Inc
60 Garden Ct
Box DRI
Monterey, CA 93940
(408) 649-3896
Circle No 354

Eyring Research Institute Inc
1455 West 820 N
Provo, UT 84601
(801) 375-2434
Circle No 355

Force Computers Inc
3165 Winchester Blvd
Campbell, CA 95008
(408) 354-3410
TLX 172465
FAX 408-395-7118
Circle No 356

Forth Inc
111 N Sepulveda Blvd
Manhattan Beach, CA 90266
(213) 372-8493
TLX 275182
FAX 213-318-7130
Circle No 357

Industrial Programming Inc
100 Jericho Quadrangle
Jericho, NY 11752
(516) 938-6600
TLX 429808
FAX 516-938-6609
Circle No 358

Intel Corp
5200 NE Elam Young Pkwy
Hillsboro, OR 97123
(503) 640-7147
Circle No 359

JMI Software Consultants Inc
Box 481
904 Sheble Ln
Spring House, PA 19477
(215) 628-0840
Circle No 360

Microware Systems Corp
1900 NW 114th St
Des Moines, IA 50322
(515) 224-1929
FAX 515-224-1352
Circle No 361

Motorola Microsystems
2900 S Diablo Wy
DW12
Tempe, AZ 85282
(603) 438-3507
Circle No 362

Ready Systems
Box 60217
Sunnyvale, CA 94086
(408) 736-2600
FAX 408-736-3400
Circle No 363

Software Components Group
4655 Old Ironsides Dr
Suite 370
Santa Clara, CA 95054
(408) 727-0707
Circle No 364

Wind River Systems
1351 Ocean Ave
Emeryville, CA 94608
(415) 428-2623
Circle No 365

VOTE . . .

Please also use the Information Retrieval Service card to rate this article (circle one):

High Interest 509
Medium Interest 510
Low Interest 511

Analog CAE Solutions—from picoseconds to GHz

EEsof has the high-frequency analog CAE tools you need today—to build the advanced hardware of tomorrow!

System Simulation

Device Characterization

Time-Domain Simulation

Nonlinear Simulation

Design Environment and Circuit Layout

Call us today for details on the wide range of high-frequency analog tools manufactured by EEsof. Our software is supported on most popular CAE computers and workstations, including those from Apollo, SUN, HP, and DEC and also IBM DOS and OS/2 compatibles.

Contact us at EEsof, Inc., 5795 Lindero Canyon Rd., Westlake Village, CA 91362. Phone: (818) 991-7530 FAX: (818) 991-7109

CIRCLE NO 111

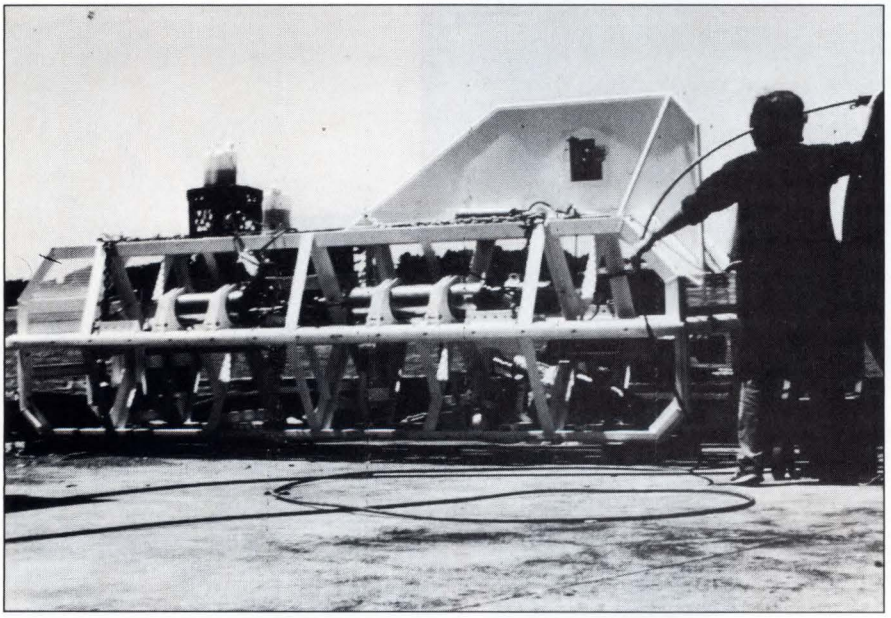
EEsof®

Not all kernel designers make use of powerful, built-in processor facilities for context switches.

an unusual manner not envisioned by its designer.

Similarly, an experienced assembly-language programmer can pore over the instruction set of a new processor to find which instructions he will use, in a particular order, to solve a particular metaproblem. High-level-language programmers do the same with different high-level languages.

This notion of metasolutions underlies the saying about programming languages, "You can write bad code in any language," and its corollary, "The best language and operating system for your project are the language and operating system that your best programmer likes best."



Undersea robot thinks with real-time brain
(Ready Systems)

Without a clear idea of appropriate metasolutions, you can get lost in a welter of seemingly meaningless and unrelated characteristics of any particular field, be it a logic family, a μP's instruction set, a high-level-language's reserved words and constructs, or a real-time operating system's service calls.

Take, for example, the specification for a real-time kernel's context switch. This specification measures how long the kernel takes to respond to a request from a task. One real-time kernel could have a much faster context switch than another. But suppose that the former's system calls were less powerful than the latter's. In this case, a task might have to issue more kernel calls to the faster, but less-powerful kernel, than to the slower one, to solve a metaproblem. In the final analysis, the "faster" kernel could end up being slower.

Consider a common real-time metasolution, the server task. A typical application for a server task is shepherding a shared resource such as a disk memory. Such a task will have to accept requests from several tasks, prioritize the requests, manage memory buffers, move data to and from the buffers and the disk, and notify requesters when their service call has been completed. Implementing and operating a server task can use a sizable fraction of the service calls that a real-time kernel provides. The overall efficiency and robustness of the server task will be an amalgam of the characteristics of *all* the service calls that the task uses and responds to. Looking atomistically at a given real-time kernel's service calls will not tell you how well they can work together to realize a metasolution such as a server task.

EDN

Article Interest Quotient
(Circle One)
High 509 Medium 510 Low 511

How To Win The Real-Time Clock Game

Developing software for real-time applications can be a challenging game.

Dealing with a separate compiler, assembler, linker, loader, executive and debugger, each with its own procedures, can really slow you down. Just think of all the time you spend accessing files and conversing with all those tools, plus the time waiting for them to run.

There's a better solution—polyFORTH®. It's a complete, fully integrated, interactive programming environment that's designed specifically for real-time applications. It supports single-chip microprocessors, 16- and 32-bit processors, DSP processors, and minis like the VAX.

The editor, compiler, assembler and debugger are always resident and ready to use. There's only one program to learn and no separate procedures to bog you down. You can move directly from thinking and editing to testing, with no distractions. It's an integrated approach that can dramatically improve your productivity and creativity.

Fact is, polyFORTH is far and away the most consistent, effective way to go from "design" to "done". Whether you do it yourself or have us design a turnkey system for you, expect to finish your real-time embedded applications 4 to 10 times faster than ever before.

After all, isn't that the name of the game?

Call 1-800-55-FORTH today for your free-for-the-asking "Real-Time Clock Game" poster and brochure with real-life programming solutions from FORTH.

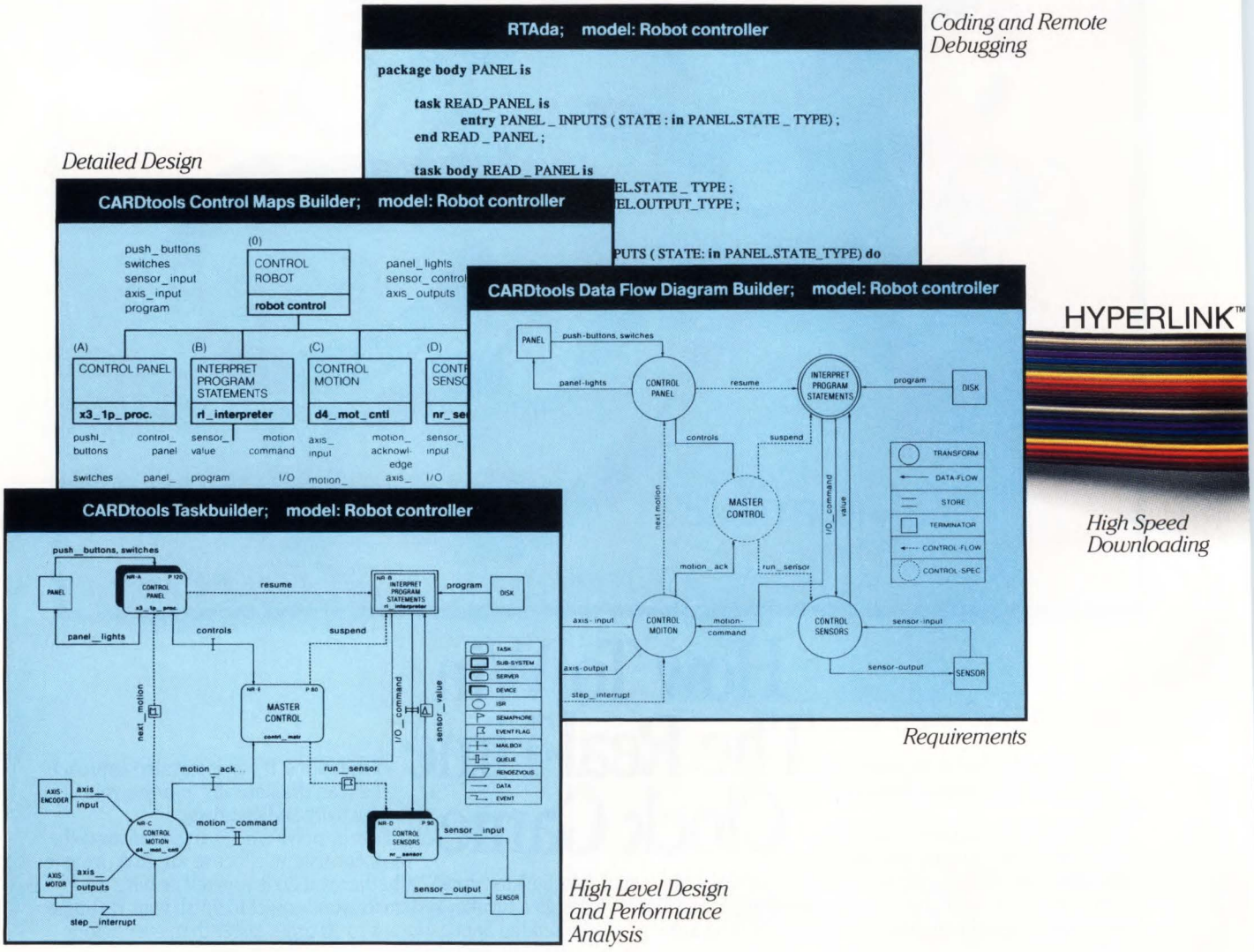
FORTH, Inc., 111 N. Sepulveda Blvd., Manhattan Beach, CA 90266, 1-800-55-FORTH, (213) 372-8493

VAX is a trademark of Digital Equipment Corporation polyFORTH is a trademark of FORTH, Inc.

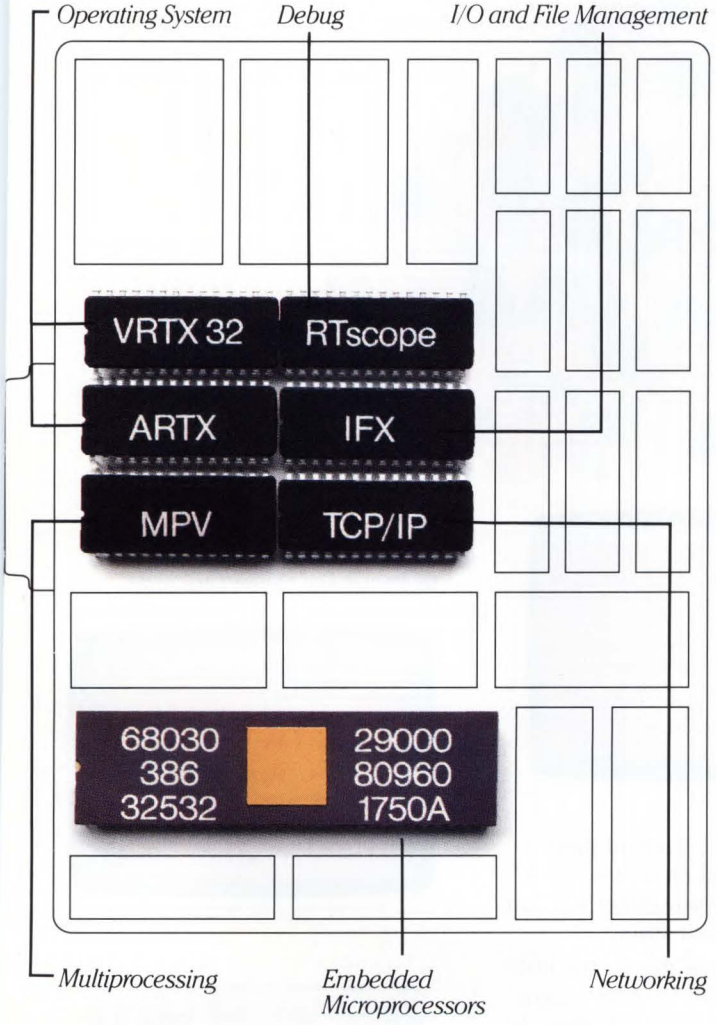
FORTH, Inc.

CIRCLE NO 112

Do you have to design in



what it takes real-time?



TARGET

Successful real-time design for embedded systems takes more than extraordinary helpings of craft and creativity. It also takes the right tools. Which may explain why our CARD (Computer-aided Real-time Design) technology is behind the development of well over fifty million lines of real-time code.

We're not talking about ordinary tools spruced up with a few real-time extensions. CARD technology was created exclusively for the real-time world specifically for integrating run-time and software development environments.

We are talking about tools such as reusable software components like VRTX,® the real-time operating systems standard. Real-time implementations of C and Ada. Automated analysis tools for verifying system performance. Our CARDtools™ product gives you everything you need including specifically tailored design aids to manage software organization and data flow.

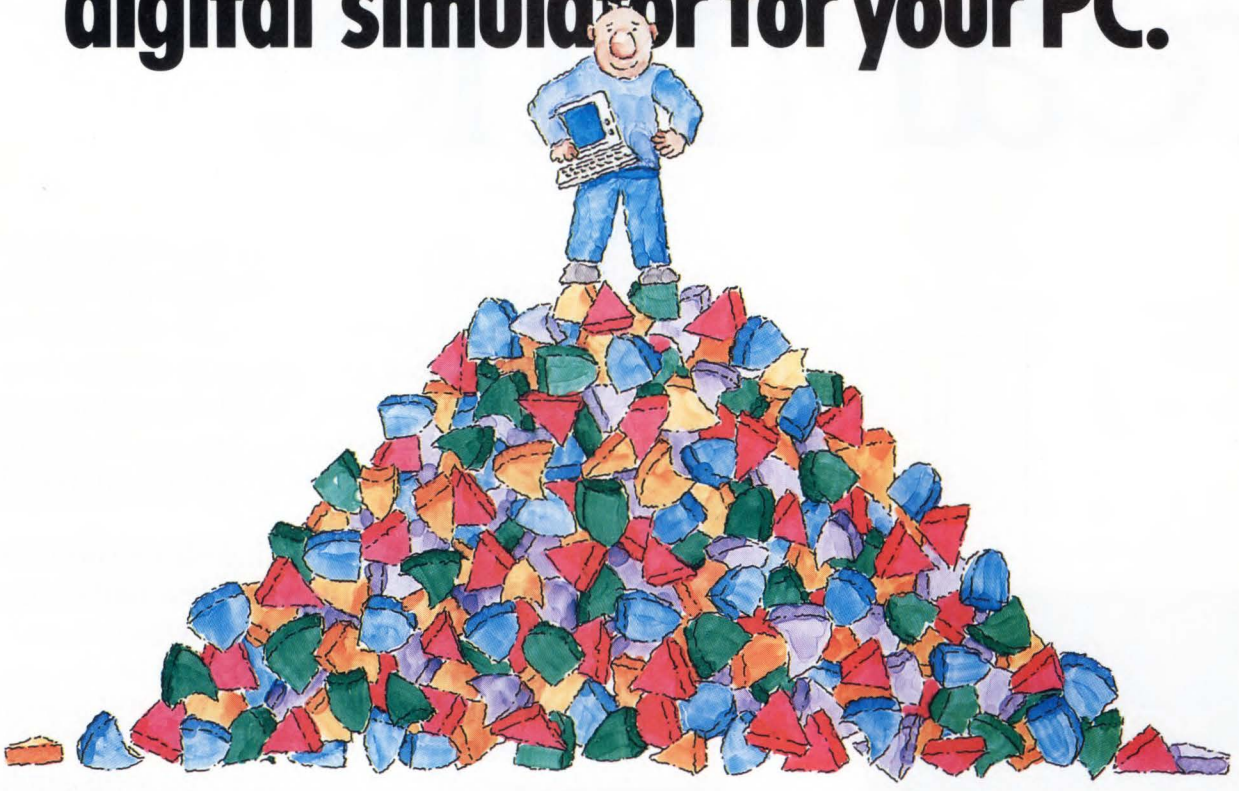
And automated documentation so complete, so accurate, it satisfies even the DoD's rigid 2167A specs. Not to mention the demands of our hundreds of exacting commercial customers.

So if you'd like to have what it takes to make your next real-time project run more efficiently call us, toll free, at (800) 228-1249. Or (214) 661-9526 in Texas.

Because you can only be a success in real-time design if you've got the right stuff.

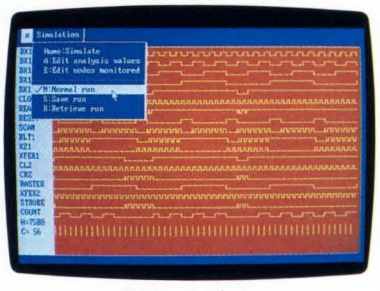
READY SYSTEMS

MICRO-LOGIC II.™
The CAE tool with a 10,000-gate digital simulator for your PC.



Spectrum Software's MICRO-LOGIC II® puts you on top of the most complex logic design problems. With a powerful total capacity of 10,000 gates, MICRO-LOGIC II helps engineers tackle tough design and simulation problems right at their PCs.

MICRO-LOGIC II, which is based on our original MICRO-LOGIC software, is a field-proven, second-generation program. It has a high-speed event-driven simulator which is significantly faster than the earlier version.



Timing Simulator

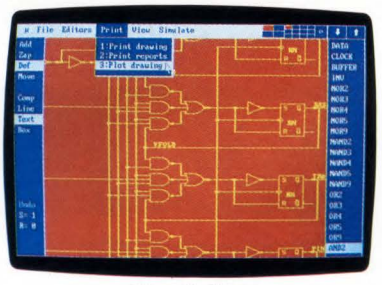
The program provides you with a top-notch interactive drawing and analysis environment. You can create logic diagrams of up to 64 pages with ease. The software features a sophisticated schematic editor with pan and zoom capabilities.

Shape Editor

A 200-type library of standard parts is at your fingertips. And for a new high in flexibility, a built-in shape editor lets you create unique or custom shapes.

MICRO-LOGIC II is available for the IBM® PC. It is CGA, EGA, and Hercules® compatible and costs only $895 complete. An evaluation version is available for $100. Call or write today for our free brochure and demo disk. We'd like to put you in touch with a top digital solution.

- Total capacity of 10,000 gates
- Integrated schematic editor
- Fast assembly language routines
- Standard parts library of 200 types
- Event-driven timing simulator
- Built-in shape editor
- Multiple delay models
- Printer and plotter hard copy



Schematic Editor

spectrum

1021 S. Wolfe Road, Dept. E
Sunnyvale, CA 94087
(408) 738-4387

CIRCLE NO 114

Real-time operating system assists in development of DSP-chip applications

Spox, a real-time operating system/development environment for the TMS320C30, is avalable to assist you in the development of applications for this DSP chip. As a real-time operating system, Spox provides a kernel that contains the executive and modules for memory management, stream I/O, and DSP math functions.

The kernel performs the task handling, scheduling, and message passing; consumes only 2k words of memory; and can switch a task in only 10 μsec. The stream I/O module provides real-time device-independent stream I/O to ease the acquisition of data. The kernel, memory-management module, and stream I/O module can all fit within the 4k-word memory on the TMS320C30.

Spox also includes various math functions and the hooks that allow any C program to use these functions. These math functions allow you to easily perform most common DSP applications.

As a development environment, Spox interacts with a host computer. You can write your algorithms in C and then test them on the host computer using a simulator that simulates the operation of Spox to verify timing and memory requirements.

You can run Spox in a C environment on an IBM PC or on a Sun workstation to develop and evaluate your application code. The IBM PC version costs $1000, and the Sun Workstation version sells for $2000. It's also available bundled with the Texas Instruments XDS development system that lets you run your application using native code in real time. The development system is priced at $16,000 with no additional costs. Later in 1989, Spox will be available as a linkable library for production use at a negotiable price.

Spectron Microsystems Inc, 600 Ward Rd, Suite B-2, Santa Barbara, CA 93111. Phone (805) 967-0503.

Circle No 434

Real-time kernel written in C lets you port applications to different processors

RTXC (Real-Time eXecutive in C) is a real-time kernel for embedded systems that features multitasking, preemptive scheduling, intertask communication, partitioned memory, resource management, and timer management. Except for a small portion that handles interrupt processing, the executive is written entirely in C, so that you can use it for many different processors. You get the source code; therefore, you can modify it to suit the needs of a particular target system. The code is optimized for fast execution; on an 80286 μP, a context switch requires only 50 μsec. The complete package consists of the kernel, an interactive system-generation program (RTXCgen), and a system-level debugger (RTXCbug).

RTXCgen, which runs on an IBM PC/XT, PC/AT, or compatible, lets you define all system components

such as tasks, semaphores, queues, memory partitions, and timer data. When you've completed all definitions, the program generates C source code of all required system tables; you compile these tables and link them with the RTXC library and your application code.

RTXCbug can provide you with snapshots of system tables and components so that you can see how they interact with the application. The program can also display performance statistics, showing you how much memory has been used, the worst-case stack usage, how many entries were made to a queue, and other helpful information.

The vendor distributes RTXC, RTXCgen, and RTXCbug in the form of C source code, together with a demonstration application, an executive function library, sample drivers, and a user's manual. A 1-time licence costs $2995, and there are no royalties associated with continued use of the package by the licensee.

A T Barrett & Associates, 11501 Chimney Rock, Houston, TX 77035. Phone (713) 728-9688. FAX 713-728-1049.

Circle No 435

Software tools provide comprehensive test facilities for scan-path ASIC designs

ASIX-Scan is a menu-driven software package that lets you create test strategies for ASIC devices that you develop with scan paths. The package is intended for use with both the ASIX-1 development system and the ASIX-2 production test system, and it supports the IEEE P1149 bus-interface standard.

The program provides a large reconfigurable memory for storing scan vectors, and it includes sequencer instructions that let you shift the scan vectors into and out of the device under test. The program transmits the serial input data to the selected data-input pins, and receives device output for comparison with the expected result. Mode

1 uses a single scan vector, which can have 60M bits or more; this mode is helpful in applications in which test-bus pins have test-mode functions that are different from their normal-operation functions. In Mode 2, the program stores all the scan vectors in the scan-test module and can switch between scan mode and normal mode.

ASIX-TMP (ASIX Test Macro Processor) provides advanced program features that let you algorithmically derive device time, as well as stress-test CMOS ICs. Other features give you close control of the supervoltage test modes and let you implement tests for low-accuracy, mixed-signal devices. In addition, the macro processor lets you customize the menus and test programs. Both modules are available as options to the ASIX-2 test system. The ASIX-Scan Test Module cost $50,000, and the ASIX-TMP macro processor costs $8000.

ASIX Systems Corp, 47338 Fremont Blvd, Fremont, CA 94538. Phone (415) 656-8664.

Circle No 436

Math package gives you extensive range of symbolic and numerical capabilities

PC MACSYMA runs on 80386-based computers under MS-DOS. It is a full implementation of MACSYMA, the mathematical-modeling software package that has hitherto been available only for mainframes. The package combines symbolic and numerical analysis to automate complex mathematical modeling applications such as symbolic solution techniques, symbolic approximation methods, symbolic preparation for numerical analysis, and the graphical representation of symbolic expressions and numerical data. The package is particularly suited for use in applications such as mechanical and electrical-circuit design, control theory, accoustics research, and plasma and atomic physics.

The capabilities fall into five major categories: arithmetic and algebra; calculus; foreign language interfaces; on-line help; and plotting. The arithmetic and algebraic functions include user-defined functions as well as 12 predefined functions such as Euler, gamma, psi, and zeta; both exact and approximate symbolic equation solutions; algebraic and trigonometric simplification; sums and products of series; and sets.

The calculus capabilities include differentiation and limits; integration; ordinary differential equations; Laplace and Fourier transforms; and vector and tensor analysis.

The foreign-language interface capabilities let you generate Fortran or C source code that implements your mathematical expressions or equation solutions. You can also generate TeX code that will cause a graphics-printer subsystem to produce clean and accurate images of your mathematical expressions.

More than 1500 documented commands and options allow you to automate computations that are not practical using traditional methods. To run the program, you'll need an 80386-based computer that has at least 4M bytes of RAM and 40M bytes of free space on a hard disk. It costs $2900 for single copies; qualified academic institutions can buy 10 copies for $510 each.

Symbolics, 8 New England Executive Park, Burlington, MA 01803. Phone (617) 221-1250. FAX 617-221-1099.

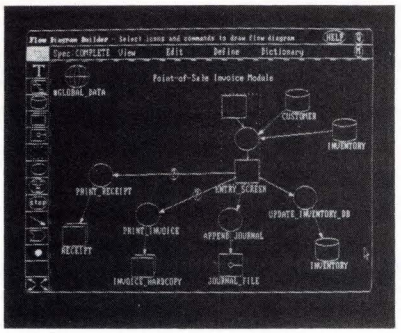
Circle No 437

Oops... You Just Keyed The Transmitter Into Your Spectrum Analyzer

Costly and time consuming repairs due to accidental overload of your spectrum analyzer are now history. Rest easy...Marconi's 2382 uniquely features 50 watt front end protection. It also features full automatic self calibration, providing the industry standard for total level accuracy of ±1 dB... including the integral tracking generator. That's right — you can count on this level of accuracy anywhere on the screen. To find out all the features of the 400 MHz and 4.2 GHz 2380 series spectrum analyzers, or to arrange for a demo, call toll-free 800 233-2955, in NJ (201) 934-9050 or write Marconi Instruments, 3 Pearl Ct., Allendale, NJ 07401.

CIRCLE NO 115

Marconi
Instruments



C-CODE CASE TOOL

MicroStep is a CASE tool that produces 100% C source code and executable programs directly from graphics specifications. The tool features an interactive graphics-design environment, automatic specification analysis, generation of executable code, and production of technical documentation. You can interactively create a system specification using five sets of seamlessly integrated tools to build the data flow diagrams, specify the data structures, lay out the screens, format the reports, and describe the applications computations and processing logic. Additionally, you can copy and store elements in the data dictionary for use in other specifications. Currently, MicroStep accepts .DBF and both fixed and delimited ASCII files. It runs on IBM PCs and compatibles running DOS 3.1 through 3.3. $5000.

SysCorp International, 9420 Research Blvd, Suite 200, Austin, TX 78759. Phone (512) 338-0591.

Circle No 572

INTERNATIONAL OS

The DR DOS single-user, single-tasking operating system can reside in ROM. Release 3.4 provides many of the features of IBM PC-DOS 4.0 and maintains compatibility with applications written for PC-DOS 3.3. Special features of release 3.4 include a menu-driven installation procedure that provides simplified on-line help, full support for PC-DOS 4.0 disk partitioning, and full support for LIM 4.0 expanded memory. Earlier versions provided support for double-byte Kanji character sets; this version also allows you to customize the standard text messages by editing text files that are supplied in the Redistribution Kit. English, French, and German versions of these files are available from the vendor and require no extra work.

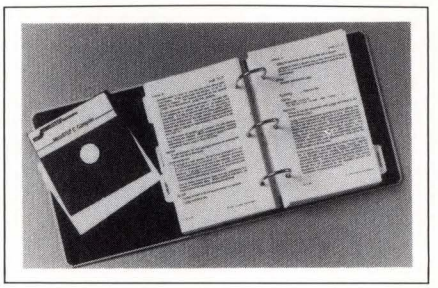
In a RAM-based system, the operating system, including 15 disk buffers and 512 fast-open entries, occupies approximately 72k bytes; in a ROM-based system, the main components of the operating system occupy 88k bytes of ROM, leaving 8k bytes free for other purposes. If you also execute the kernel from ROM, the amount of RAM available for a user's program and data is 604k bytes out of the 640k-byte address space. The advantage of the ROM-based system is that the complete operating system becomes available at power-up time without any disk access. Available only to OEMs and corporate resellers; price depends on volume.

Digital Research Inc, Box DRI, Monterey, CA 93942. Phone (800) 443-4200; in CA, (408) 649-3896. FAX 408-649-0750. TWX 910-360-5001.

Circle No 573

C COMPILER

The MetaStep Microprogram C Compiler lets you define the architecture of the target system by means of machine-definition statements. You can then write your program in C. The compiler works with an augmented version of the vendor's MetaStep microprogram language and performs machine-independent optimizations such as recognition of duplicated expressions, strength reduction, live/dead-code analysis, elimination of common subexpressions, loop rolling and unrolling, and management of constants. The MetaStep micro-



program language system then performs all machine-dependent optimizations and tailors the microcode to the custom architecture that you define. The package runs on a variety of host computers, including MS-DOS machines, Sun/Unix workstations, and VAX/Unix minicomputers. Single-user MS-DOS machine, from $4995.

Step Engineering, Box 3166, Sunnyvale, CA 94088. Phone (408) 733-7837. FAX 408-773-1073.

Circle No 574

C DEVELOPMENT KIT

The Transputer Toolset provides a complete C and assembly language development environment for the INMOS Transputer family. The tool set works with a single Transputer or in a Transputer network. The tool set offers optimization facilities and close conformance to the emerging ANSI C standard. The Transputer Toolset includes a C compiler, an assembler, a linker, a librarian, and both a single processor and a network loader. The compiler supports in-line assembly language and can generate in-line code for the C functions, which map into the Transputer instruction set. The compiler can generate code for the 64-bit/32-bit ANSI floating-point model, or the 32-bit-only floating-point model. The tool set is portable across MS-DOS, Apple Mac II, and SYS5/BSD4.3 Unix systems, including Apollo, Sun, and DEC. $995.

Logical Systems, Box 1702, Corvallis, OR 97339. Phone (503) 753-9051.

Circle No 575

LINEAR TECHNOLOGY

DESIGN NOTES

Number 24 in a series from Linear Technology Corporation *July, 1989*

Complex Data Acquisition System Uses Few Components

Richard Markell

Introduction

Sophisticated filter system designs frequently demand expensive printed circuit boards chock-full of operational amplifiers and precision capacitors. Digital filters require fewer but more expensive devices and a lot of software. However, advances in switched capacitor filters have made the design of elegant filter systems cheaper, easier and much smaller. The system shown in block diagram form in Figure 1 is a good example. It is a typical system for filtering transducer signals. Its input is a DC-to-20kHz signal; its output allows signals to be analyzed in three frequency bands.

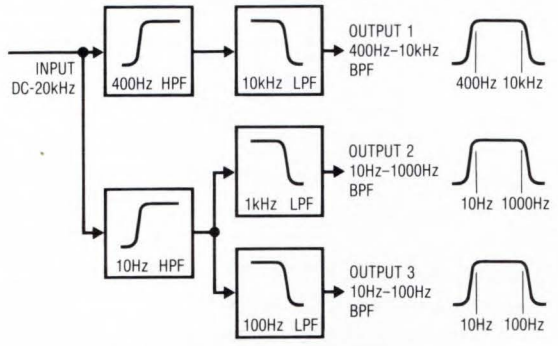


Figure 1. Filter System Block Diagram

Implementation

A system implemented using switched capacitor filters is shown in schematic form in Figure 2. This implementation uses two LTC1064 quad switched capacitor building blocks and one LTC1062 5th order Butterworth lowpass filter. The system requires the use of one operational amplifier, an LT1007.

Filter Design Specifications and Test Results

Filter 1 — a 400Hz-to-10kHz bandpass filter, with passband ripple of 1dB and passband noise of 200μV_{RMS}, Figure 3.

Filter 2 — a 10Hz-to-100Hz bandpass filter, with passband ripple of 1dB and passband noise of 500μV_{RMS}, Figure 4.

Filter 3 — a 10Hz-to-1kHz bandpass filter, with passband ripple of 1dB and passband noise of 390μV_{RMS}, Figure 5.

These wideband filters are made by cascading 4th order elliptic lowpass and highpass filters. The single exception is the 5th order Butterworth lowpass filter used in the 400Hz-to-10kHz section.

System Considerations

The LTC1064 quad switched capacitor filters used are building blocks capable of implementing up to 8th order filters. One LTC1064 implements both a 4-pole elliptic 400Hz highpass filter and a 4-pole elliptic 1kHz lowpass filter. The other LTC1064 implements a 4-pole elliptic 100Hz lowpass filter and a 4-pole elliptic 10Hz highpass filter. The LTC1062 is a 5-pole Butterworth lowpass filter set at 10kHz.

Resistors R_{11A} to R_{H2A} implement the 400Hz elliptic highpass filter in Device A. The 1kHz elliptic lowpass filter in Device A is implemented by R_{13A} to R_{44A}. Resistors R_{11B1} to R_{42B} implement the 10Hz elliptic highpass filter in Device B. The 100Hz elliptic lowpass filter in Device B is implemented by R_{13B} through R_{44B}. The LTC1062 is hardware programmed for 10kHz by R_{50} and C_{50}.

The 8th order LTC1064 devices allow the use of two sections in the 100:1 clock-to-center frequency mode and two sections in the 50:1 mode. (Resistor programming can then be used to further extend the clock-to-center frequency range to 25:1 for two sections and 250:1 for the other two sections.) This allows decade-wide bandpass filters to be built using only one LTC1064 at one clock frequency.

Conclusion

This is only one use of the new switched capacitor building blocks, the LTC1064 family of quad switched capacitor filters. These filters have wide flexibility. For example, the 10Hz-to-100Hz filter could be used at 20Hz-to-200Hz simply by doubling the clock, which sets the filter frequency. Similarly, bands of interest could be inspected by sweeping the clock. The devices work with center frequencies as high as 100kHz in circuits with similar simplicity.

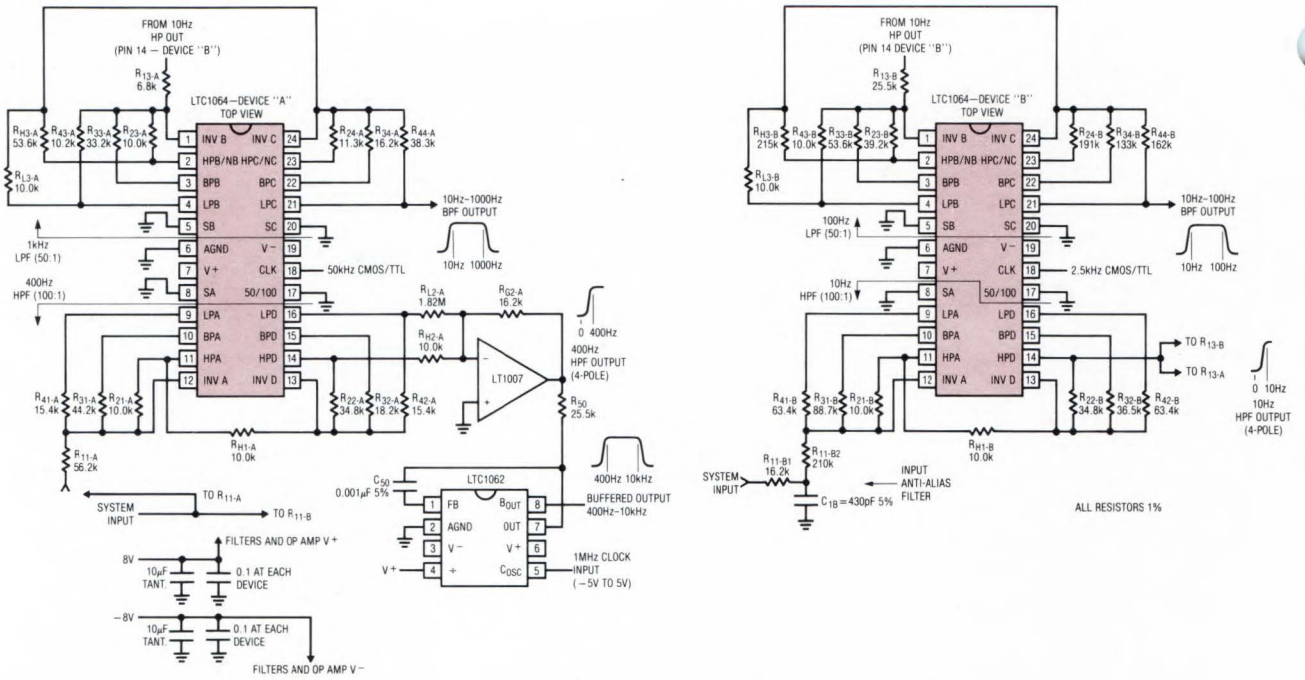


Figure 2. Schematic Diagram

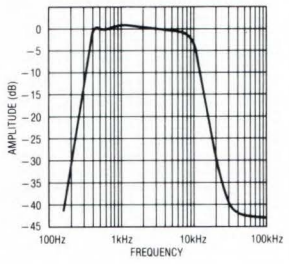


Figure 3. 400Hz–10kHz BP Filter Amplitude Response

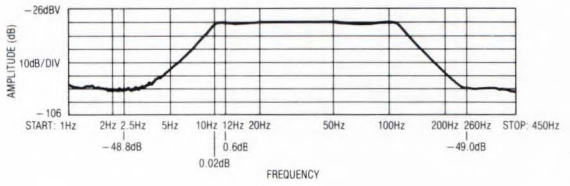


Figure 4. 10Hz–100Hz BPF Amplitude Response

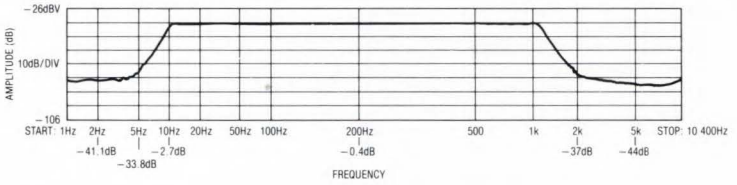
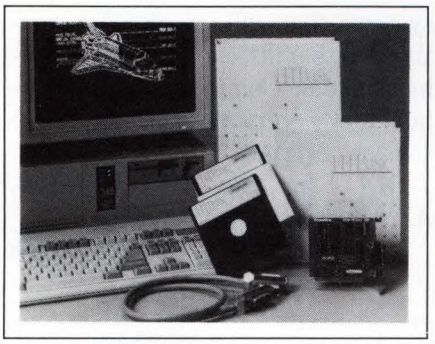


Figure 5. 10Hz–1000Hz BPF Amplitude Response

For literature on our complete filter line, call **(800) 637-5545**. For applications help, call (408) 432-1900, Ext. 453.

Linear Technology Corporation
1630 McCarthy Blvd., Milpitas, CA 95035-7487 • (408) 432-1900
FAX: (408) 434-0507 • TELEX: 499-3977

IM/GP 689 165K



ENGINEER'S BASIC

The HTBasic integrated set of IBM PC and PS/2 programming tools is compatible with Hewlett-Packard's Rocky Mountain Basic for the HP 9000 Series 200/300 computers and has features that make it valuable for process-control, instrumentation, and other complex engineering applications. The package consists of a full-screen, syntax-sensitive editor; the Basic interpreter; and an interactive debugging facility.

Special features include more than 40 graphical statements to control screen displays and plotters; 16 statements for the control of IEEE-488 interfaces; extensive mathematical functions for integer and real data types, as well as matrix operations for matrices with as many as six dimensions and 32,767 elements per dimension; and 12 statements that allow you to define soft-key macros. A Configure statement lets you customize the HTBasic environment to match that of a Series 200/300 computer, so you can run many existing programs, written in Rocky Mountain Basic without alteration. The package includes utilities that let you copy files from HP LIF format disks to DOS disks. PC versions, $500; 80386-based machines running PC-DOS, $800. IEEE-488 drivers and the vendor's IEEE-488 interface card are available as options at additional cost.

TransEra Corp, 3707 N Canyon Rd, Provo, UT 84604. Phone (801) 224-6550. FAX 801-224-0355. TLX 296438.

Circle No 563

CASE TOOL

Sylva Foundry MS/DOS is an IBM PC-based workbench that contains tools for creating and modifying techniques, interfacing open architecture with other tools, and generating diagrams from external data. Once you create modeling objects, you can store them in technique-specific Icon Drums for use in creating system models. A diagram editor provides a rule-based drawing capability through an intuitive interface. The Foundry Diagram Generator lets you generate diagrams from external data, and the Foundry Screen Maker lets you create active menus and panel-to-panel relations and control other screen functions. An optional Starter Kit enables you to modify or blend DeMarco Data Flow, Gane and Sarson Data Flow, Ward-Mellor Control Flow, Entity Relationship, State Transition, Constantine Structure, and three other techniques. $8500. Starter Kit, $3000.

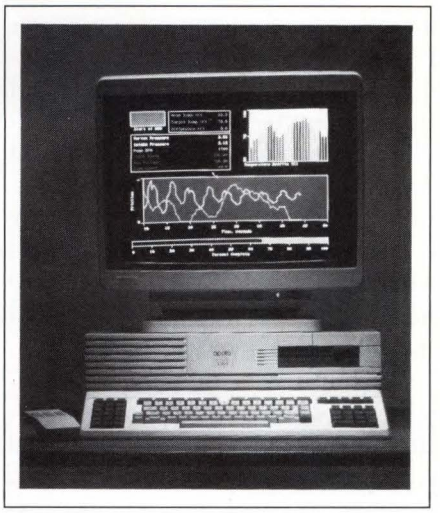
Cadware, 869 Whalley Ave, New Haven, CT 06515. Phone (800) 223-9273; in CT, (203) 397-2908.

Circle No 564

LABTECH FOR UNIX

LabTech NoteBook, a scientific data-acquisition package, was formerly available only for IBM PCs and compatibles. Now it's available to run on Apollo workstations under the Apollo Domain/OS, a Unix implementation that supports both the Berkeley 4.3 and the AT&T System V release 3 standards. The program is menu-driven and lets you acquire real-time data of many types, such as analog, digital, thermocouple, strain-gauge, and counters.

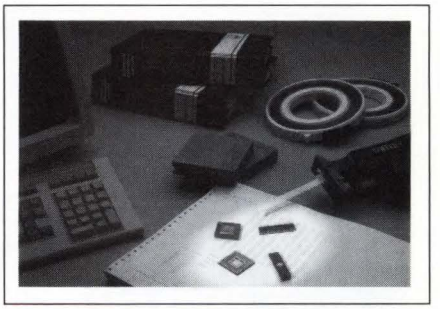
You can collect data from as many as 16 devices at rates as slow as one point every three years or as fast as your hardware allows; the program continuously writes the data to a disk file during acquisition. You can also perform real-time calculations, analysis, and signal



processing on the incoming data. The processing capabilities include fast Fourier transforms of real and complex waveforms. An application interface lets you store data in, or retrieve it from, spreadsheets such as Lotus 1-2-3, RS/1, or user-written programs. Control features allow you to customize the instrumentation interface so that any operator can run experiments. 3500 Series workstations, $2000; 4500 Series workstations, $5500.

Laboratory Technologies Corp, 400 Research Dr, Wilmington, MA 01887. Phone (508) 657-5400. FAX 508-658-9972.

Circle No 565



LANGUAGE EDITOR

The BSO/LSE+ user-interface package integrates the vendor's Pascal and C compilers, assembler, and symbolic debugger with the VAX Language-Sensitive Editor (LSE) and with other VAX software-development tools. The package also provides comprehensive

on-line help for general language-related questions or for specific inquiries about LSE templates and their elements. The VAX LSE provides C and Pascal programmers with a fast and efficient way to enter source code, while automatically eliminating many routine errors such as a missing semicolon, unmatched parentheses or braces, and many common syntax errors.

Without leaving BSO/LSE+, you can then compile, assemble, link, and debug your program. You can also execute normal VAX DCL commands, and a dual-window feature lets you edit a file in one window, while executing DCL commands or reading MAIL in the other; it also lets you execute your program in one window, while viewing the associated source code in the other. BSO/LSE+ runs on any VAX model under version 4.4 or higher of the VMS operating system; you also need version 2.2 or higher of the VAX LSE. From $500.

Boston Systems Office, 411 Waverly Oaks Rd, Waltham, MA 02154. Phone (800) 458-8276; in MA, (617) 894-7800. FAX 617-642-5762. TWX 710-324-0760.

Circle No 566

SOFTWARE SCOPE

Snapshot Storage Scope Release 3.0 is a greatly enhanced version of the vendor's real-time analog data-acquisition, -display, and -storage program. You can now acquire as many as 80 channels of analog data at sampling rates as high as 1M samples/sec, depending on the performance of your analog I/O boards. The program runs on IBM PC/XTs, PC/ATs, and compatibles, and works with analog I/O boards from Acrosystems, Analog Devices, Burr-Brown, Contec, Data Translation, and MetraByte. The program can display as many as eight channels simultaneously, define different units and labels for each channel, and average trigger-synchronized waveforms. You can define a title for each frame of data, and optionally write data to disk in a special format that occupies less than one-eighth the space of standard ASCII files. Other capabilities include real-time acquisition with 12-, 14-, or 16-bit accuracy. $495.

HEM Data Corp, 17336 Twelve Mile Rd, Suite 201, Southfield, MI 48076. Phone (313) 559-5607. FAX 313-559-8008.

Circle No 567

ADA FOR 80386/UNIX

DACS-386/UNIX is a fully validated Ada software-development system that meets all of the Ada and Unix requirements mandated by the Department of Defense. The complete package consists of an Ada compiler, a symbolic debugger, and a set of cross-compilation extensions (DARTS) that includes an Ada runtime system for embedded systems. The compiler runs on 80386-based Unix machines and provides all the standard features of Ada, including tasking, generics, exception handling, elaboration, overloading, and in-line expansion.

The compiler also provides the optional features of Ada that are intended for real-time embedded systems; these features include bit-level representation clauses and fast-tasking context switches. The DARTS (DDC-I Ada Run-Time System) extensions provide cross-compilation, linking, and downloading facilities for real-time embedded systems that will use the Ada runtime system instead of a full operating system. Compiler, $3995; symbolic debugger, $1995; DARTS extension, $19,995.

DDC-I Inc, Box 37767, Phoenix, AZ 85069. Phone (602) 944-1883.

Circle No 568

RISC TOOL SET

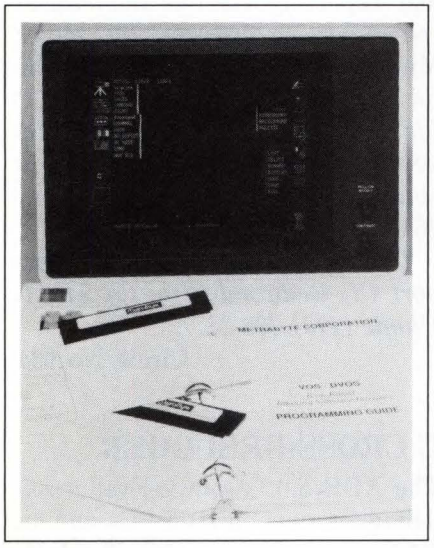
The 29000 RISC Support Tools package contains software development tools that work in conjunction with the vendor's Adapt29K hardware-development and prototyping tool for AMD's 29000 RISC processor. The package consists of a C compiler, a source-level debugger, and a cross-assembler. The C29K is a globally optimizing C compiler that conforms to the proposed ANSI C standard and includes runtime libraries, an assembler, a linking loader, and an object-module librarian. The XRay29K debugger lets you set breakpoints at C statements or line numbers, or at assembly-language instructions or memory references. The Step29K cross assembler is a relocating macroassembler, which comes with a linking loader, object-module librarian, and math support. Both the debugger and the cross-assembler run on a variety of host computers such as IBM PCs and compatibles, engineering workstations, and VAX minicomputers. You can download object files to the 29000 target in hex formats and other structures via a serial link.

The Adapt29K hardware prototyper provides a 4096×128-bit

trace buffer that captures 29000 bus signals at speeds as high as 40 MHz. ROM-resident monitor software in the Adapt29K lets you set and display registers, disassemble and display captured bus activity, and trace instruction execution in single or multiple steps. XRay29K source-level debugger, $1780; Step29K cross-assembler, $1000; Adapt29K prototyper, $8500; C29K compiler, $1850; 29000 RISC Support Tools package, $12,130.

Step Engineering, Box 3166, Sunnyvale, CA 94088. Phone (408) 733-7837. FAX 408-773-1073.

Circle No 569



VISION OS

The VOS/DVOS icon-based operating system runs on the IBM PC, PC/XT, PC/AT, and compatibles and gives you full control of microcomputer-based imaging applications. The icon-based user interface lets you set up hardware, manage the screens, define touch zones, and, using DVOS, lets you create or change icons. The system provides camera functions, frame-grabber functions, disk functions, and access to user-defined functions written in C. The imaging functions let you define the kernel and perform convolution, and define and execute bit-mapped operations. The on-line help facility provides a guide to all VOS functions. In the Record mode, the system stores all point-and-click operations in a disk file that you name; you can repeat the same sequence of operations by recalling and executing this file. VOS, $99; DVOS, including VOS, libraries, and icon-editing facilities, $499.

MetraByte Corp, 440 Myles Standish Blvd, Taunton, MA 02780. Phone (508) 880-3000. FAX 508-880-0179. TLX 503989.

Circle No 570

REAL-TIME KERNEL

MTOS-UX/386 is a multiprocessing, multitasking, real-time operating system for 80386-based computers. This OS normally runs in the 32-bit, protected mode of the 80386 and protects system resources such as block and memory pools, message buffers, controlled shared variables, and task resources. Also available is a version that uses the multisegmented memory model to run MS-DOS software. This model protects the kernel and the system resources by means of task privilege levels. You can increase the computing power of the system merely by adding as many as 16 CPUs; changing the number of CPUs does not require any change to the application programs. The development kit includes test facilities, debugging tools, validation programs, configuration programs, a RAM-disk driver, a Unix interface, and a C-portable library. The symbolic debugger provides task-level debugging facilities. Because all versions of MTOS-UX have the same programmer interface, programs written in a high-level language will run under any version of MTOS-UX, regardless of the processor type. Development kit, from $5000.

Industrial Programming Inc, 100 Jericho Quadrangle, Jericho, NY 11753. Phone (516) 938-6600. TLX 429808. FAX 516-938-6609.

Circle No 571

Software

MODELING LANGUAGE

GAMS (General Algebraic Modeling System) is a high-level programming language that lets you formulate complex optimization problems by means of concise algebraic statements. When constructing models, you can use arithmetic and relational operators, indexing, functions, and exception-handling logic. You can enter data in basic forms, either by direct assignment or in table form. You can specify data transformations in algebraic form, and the program will perform the calculations. The complete package consists of the GAMS compiler, which has extensive error-checking and -reporting facilities and built-in report-writing features; the solver Minos for large linear and nonlinear problems; and the solver Zoom-XP for mixed-integer problems. PC version, $1600; workstation version, $3200; mainframe version, $6400.

The Scientific Press, 507 Seaport Ct, Redwood City, CA 94063. Phone (415) 366-2577.

Circle No 634

C CROSS-DEBUGGER

The XDB 5.0 C source-level cross-debugger runs on IBM PCs and on VAX, Sun, Apollo, and Hewlett-Packard workstations. Using the host—with or without an in-circuit emulator—you can debug C programs for target systems that are based on the Intel 8086, Motorola 68000 and 6800, NEC V, and Zilog Z80 family processors, or on the Am29000 RISC processor. Ten new windows allow you to view source code, XDB commands, registers, monitored variables, stack contents, and simulated input and output; you can also view the active breakpoints and all user-defined functions.

If you're using the XDB with an in-circuit emulator (ICE) in the target, you can interrogate the ICE's trace buffer and obtain an execution

history. The simulated-I/O feature lets you debug your own input and output routines before the actual hardware devices are connected to the target system. The user-defined-function feature lets you store and recall complex commands and expressions with only a few keystrokes. IBM PC versions, from $1500.

Intermetrics Inc, 733 Concord Ave, Cambridge, MA 02138. Phone (617) 661-0072. TWX 710-320-7523.

Circle No 635

WINDOWING TOOL

The Xsight windowing system runs on 80386-based computers under Unix System V, release 3. The package lets you divide your screen into multiple windows, each of which runs a different Unix application program. The package works with the vendor's Merge 386, which allows you to run DOS applications and Unix applications concurrently on 80386-based systems. If your personal computer is networked to a Unix host, Xsight lets you call up, monitor, and control multiple DOS and Unix applications on any node in the network. $695.

Locus Computing Corp, 9800 La Cienega Blvd, Inglewood, CA 90301. Phone (213) 670-6500. FAX 213-670-2980.

Circle No 636

C LIBRARY

/*resident_C*/ is a library of C routines for building terminate-and-stay-resident (TSR) programs. The C routines let you build interrupt-service routines, such as timers that schedule a program to run at a particular time. You can also build resident shared libraries that can be accessed by any number of programs. The library also allows you to convert existing C programs to TSR status by adding a few function calls.

Other routines included in the library let you save screens or windows so your TSR program won't disrupt the program that it interrupts. Versions of the library are available for the Microsoft (QuickC and C 5.0), Borland (Turbo C), and Lattice C compilers that run on IBM PCs and compatibles. The distribution disk includes demonstration programs that show you how to use the library and how to build shared libraries. Binary version, $99; binary and source code, $198.

Essential Software Inc, 76 S Orange Ave, Suite 3, South Orange, NJ 07079. Phone (201) 762-6965.

Circle No 637

ADA TOOL KIT

The ADADL (Ada Design Language) set of 25 integrated software-development tools helps you meet DoD standards. The program-design-language (PDL) tools allow you to create high-level abstractions (pseudocode) in a structured form of English, then compile them. The rule-checking tools can detect and flag omissions, contradictions, and inconsistencies in the pseudocode so that you can correct these errors before they become embedded in formal Ada code. The tools also include a certified Ada compiler and comply with DoD mandate 3405.2.

Analytical tools can quantify the complexity of the overall design and the executable Ada code derived from it. Other analytical tools can produce an audit trail that allows you to trace requirements from the system specifications to the individual program units that satisfy these requirements, and vice versa. The tool kit also provides project-management and documentation facilities. From $7150 for workstation versions to $15,700 for mainframe versions.

Software Systems Design Inc, 3627 Padua Ave, Claremont, CA 91711. Phone (714) 625-6147.

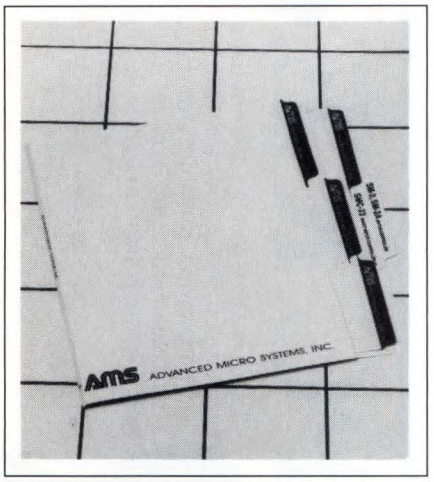
Circle No 638

Handbook features data-acquisition interfaces

The vendor's product handbook No 19 surveys the complete line of data-acquisition, industrial-control and monitoring, signal-conditioning, and communications products for IBM PC/XT, PC/AT, PS/2, Apple II, and VME Bus computers. The 260-pg publication also features application notes, selection guides, and price information.

MetraByte Corp, 440 Myles Standish Blvd, Taunton, MA 02780.

Circle No 599



Guide focuses on motion control and vision systems

The 10th anniversary edition of the vendor's product guide contains comprehensive data and price information on single-board computers, memory I/O cards, intelligent motor controller ICs and boards, dual-axis chopper design, and high-power driver cards. Also described are video cross-hair generators and digitizers, programmable cross-hair generators, and high-power driver cards.

Advanced Micro Systems Inc, 31 Flagstone Dr, Hudson, NH 03051.

Circle No 600

Personal-computing tools cataloged

The Catalog of Personal Computing Tools for Scientists and Engineers

contains product reviews by the vendor's technical staff. Most of the products have special ratings, indicating "the best" available for features and performance, and "the only" way to do a job. The catalog offers a 60-day risk-free return period. Featured in this 40-pg 10th edition are the Acquisition Engine; an intelligent 8-port data communications board and an 8-port board for the PS/2; a 3-D CADD system; an "at-speed" individual RAM chip tester; 3-D graphics software; and an expanded line of computer security products.

Personal Computing Tools Inc, 17419 Farley Rd, Los Gatos, CA 95030.

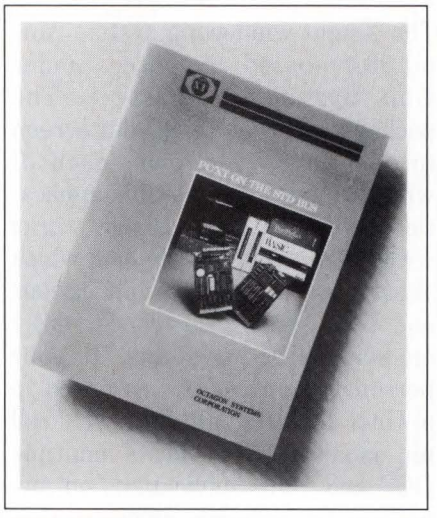
Circle No 601

Extensive catalog of board-level devices

According to the vendor, the 1989 product catalog presents the largest selection of board-level products in the industry, as well as the most diversified array of hardware and software components. The main product categories are Intel- and Motorola-based processors; static and dynamic memories; serial, parallel, and analog interfaces; controllers for disks, graphics, data communications, networking, and motor control; and accessories such as card cages, cables, and backplanes. A new product category offers linear scan cameras and controllers. In the software section, you'll find a library of software drivers for most of the vendor's boards, software development utilities, real-time operating systems, and high-level languages. Another important section deals with ready-to-use development systems and OEM computers.

Gespac Inc, 50 W Hoover Ave, Mesa, AZ 85210.

Circle No 602



STD Bus development system

The vendor's 36-pg catalog *PC/XT on the STD Bus* outlines the STD-XT line of microcontrollers, peripherals, and accessories. The publication provides technical information about the STD-XT CPU card, support card, floppy-disk card, and hard-disk drive. It also discusses STD-XT development systems and related accessories.

Octagon Systems Corp, 6510 W 91st Ave, Westminster, CO 80030.

Circle No 603

Brochure comments on single-board computer

This 6-pg brochure illuminates the vendor's Intel-compatible Multibus I 80386 single-board computer. The

One Of A Kind.

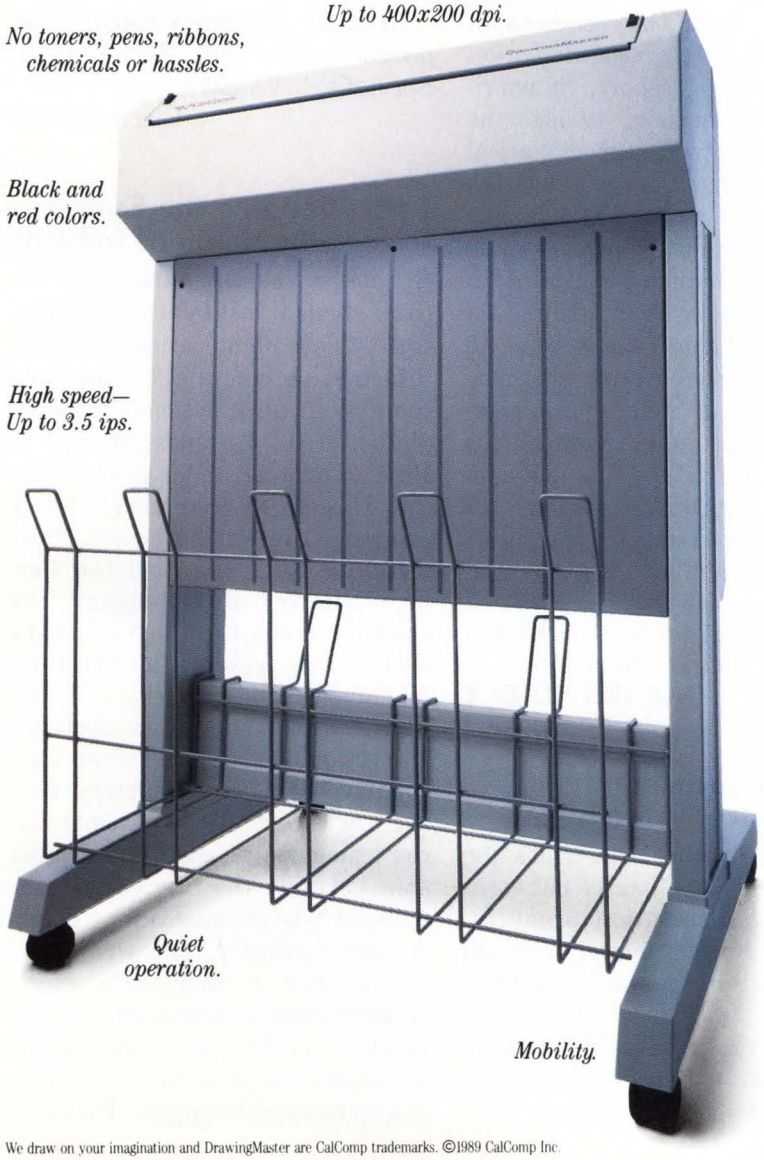
Introducing DrawingMaster™

High resolution—
Up to 400x200 dpi.

No toners, pens, ribbons, chemicals or hassles.

Black and red colors.

High speed—
Up to 3.5 ips.



Quiet operation.

Mobility.

This one-of-a-kind raster plotter from CalComp breaks all the rules—making it our total output solution for your every design requirement.

In one word, performance. With four modes of operation to choose from, this dynamo will produce A to D size plots in no time at all.

Sharp, clean plots and unattended operation in any environment increases your productivity. Add to that shared resource plotting with a 4 to 1 mux and you've got complete versatility.

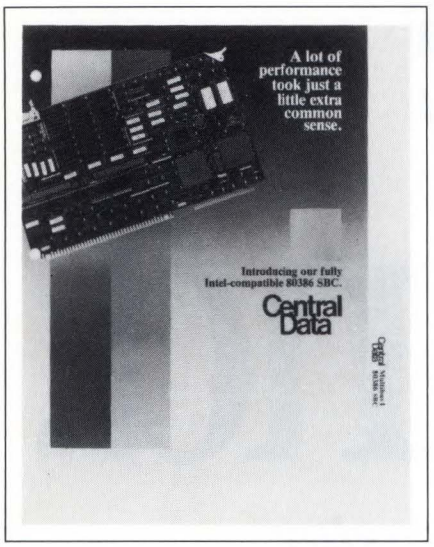
Top it off with quick installation, the reliability of virtually no moving parts, and you'll agree—it's the only one-of-a-kind you'll ever need.

With DrawingMaster also comes CalComp's 30 years of expertise, support and service, complete with an 800 helpline, which, because of the solid performance of DrawingMaster, you'll probably never need.

Like more on this no-fuss wonder?
Call 1-800-CALCOMP or write us at CalComp, P.O. Box 3250, Anaheim, CA 92803.
In Canada, call (416) 635-9010.

We draw on your imagination.™

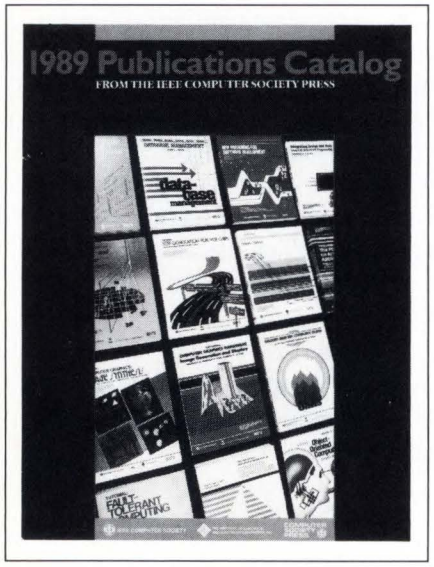
CalComp



4-color publication features photographs, a technical description, and complete specifications for the CD21/8386 SBC, which features items not found on Intel's board, such as two SBX connectors, onboard sockets for both the 80387 and Weitek 1167 numeric processors, and onboard DMA.

Central Data, 1602 Newton Dr, Champaign, IL 61821.

Circle No 604



Inventory of technical books for engineers

The *1989 Publications Catalog of the IEEE Computer Society* provides a voluminous listing of professional-level technical books for computer scientists and engineers. Sixty new books have been added to the list since the publication of the 1988 catalog. The 28-pg publication is divided into sections entitled Coming Soon from CS Press, Monographs (a new category), Tutorials by Subject, Conference Records & Proceedings, Special Book Packages, ANSI/IEEE Standards, Master Publications Listing & Price List, and Membership Information.

The IEEE Computer Society, 1730 Massachusetts Ave NW, Washington, DC 20036.

Circle No 605

Computer numerical control for factory-floor environment

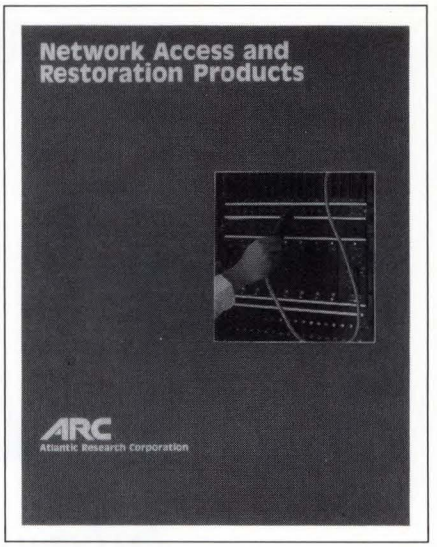
Excerpted from the vendor's 5-volume *Manufacturing Automation Series,* the 42-pg report, "Numerical Control Overview," reviews the use of CNC (computer numerical control) systems in factory-floor environments. Comparison columns cover applications; control, operating, and programming features; diagnostics; and physical attributes of 47 numerical controllers from 18 vendors. The publication also outlines numerical control programming languages and systems, helps you select a CNC system, and analyzes how CAD/CAM systems affect a CNC system in a computer-integrated manufacturing environment. $35.

Datapro Research, 1805 Underwood Blvd, Delran, NJ 08075.

INQUIRE DIRECT

Brochure presents network-access products

This 24-pg brochure describes the vendor's complete line of network-access and restoration products. The booklet covers digital, VF, and coaxial patching and switching equipment; interface converters; the Restorer multiline dial-backup system; NTS network management systems for data; the Artacs PBX



Management system for voice; and Interview Series test instrumentation.

Atlantic Research Corp, Teleproducts Div, 7401 Boston Blvd, Springfield, VA 22153.

Circle No 606

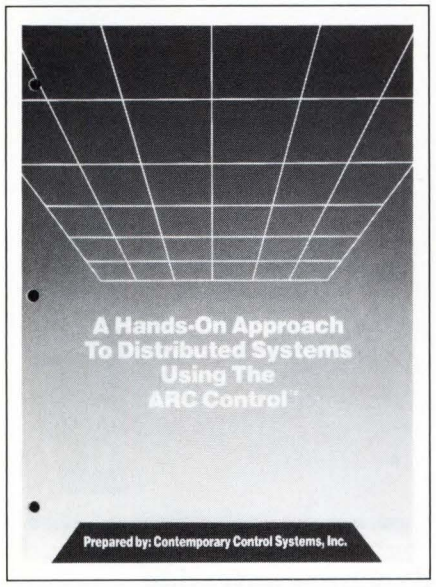
Understanding the European telecommunications industry

European Telecommunication Organisations is a study that provides basic telecommunications-industry information about 10 European countries in anticipation of the completion of the European market in 1992. Conducted under a grant from the European Commission's FAST program, the Anglo-German Foundation, Alcatel NV, and the German Ministry of Technology, the study includes an introductory chapter that presents the structure, functioning, and evolution of European telecommunications systems. In section 1, an expert from each country discusses regulatory bodies, the extent of the national carrier's monopoly, and the relationship between the carrier and the national telecommunications manufacturing industry. The second section attempts to analyze the effects of the current institutional arrangements. Finally, the third section comments on probable regulatory and institutional changes. The docu-

ment includes a glossary of technical terms.

Nomos, Box 610, 7570 Baden-Baden, West Germany.

Circle No 607



Discussion of distributed control systems

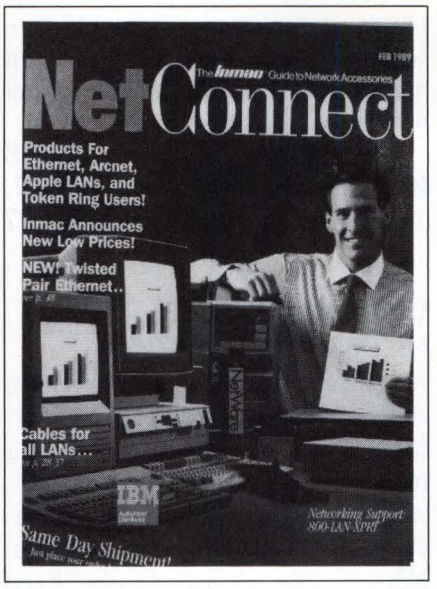
A Hands-On Approach to Distributed Systems Using ARC Control discusses the design and application of ARC Control, an IBM PC or compatible bus-based intelligent I/O subsystem. The 74-pg handbook provides figures, photos, and tables and concludes with four appendixes containing an acronym guide, answers to ARC-control questions, references, and a component list that provides power-consumption requirements.

Contemporary Control Systems Inc, 2500 Wisconsin Ave, Downers Grove, IL 60515.

Circle No 608

Catalog for LAN users

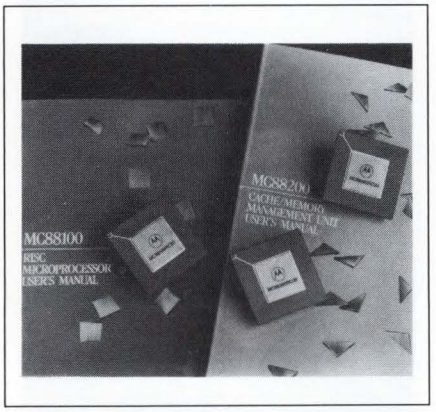
NetConnect is a 48-pg direct-mail catalog that features more than 500 computer networking products for LAN users. The 4-color publication provides product diagrams, illustrations, and cross-reference charts (where appropriate) to ensure customers that the products they order



will connect with their intended peripherals. The catalog also provides useful hints, such as comparing the merits of twisted-pair with fiber-optic cabling, or Ethernet with token-ring networks.

Inmac, Box 58031, Santa Clara, CA 95052.

Circle No 609



User's manuals for RISC μP family

These two user's manuals provide technical information about the vendor's 88100 CPU and 88200 cache/memory-management unit, which are part of the vendor's 88000 RISC (reduced-instruction-set computer) μP family. The two publications serve as references for system designers and software developers. They feature explanations of the addressing modes and instruction sets, analyses of bus operations and register usage, data about electrical characteristics, and outlines of minimum system configurations. $2.65 each.

Motorola Inc, Literature Distribution Center, Box 20912, Phoenix, AZ 85036.

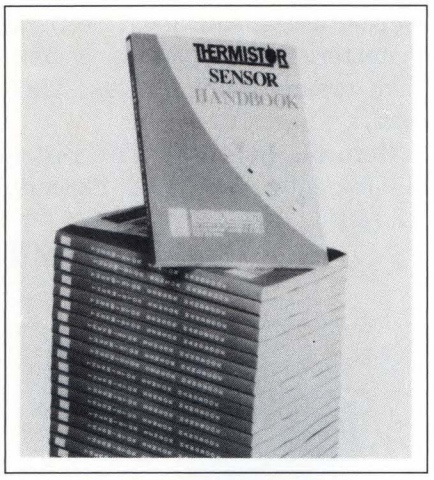
INQUIRE DIRECT

Specs on Transputer-based parallel-processing products

This 24-pg catalog, *Performance by Paracom,* details a complete line of parallel-processing products. The publication describes all of the company's boards and systems based on the Inmos Transputer chip. Categories in the catalog include bus-based boards, boards without buses, systems, software compilers, and development systems. The catalog also presents tutorials on Transputer technology, system architecture, and integration and applications. The three levels of products described are MultiCluster units, MegaCluster, and SuperCluster.

Paracom Inc, Bldg 9, Unit 60, 245 W Roosevelt Rd, West Chicago, IL 60185.

Circle No 610



Guide to thermistor housings and mounts

The *Thermistor Sensor Handbook* is a comprehensive guide to selecting protective housings and mounts for negative-temperature-coefficient thermistors. The 202-pg book provides technical data on materials and configurations, and gives you the information needed to measure or control the temperature-related parameters on almost any substance or process.

Thermometrics Inc, 808 US Highway 1, Edison, NJ 08817.

Circle No 576

Assortment of EMI filters

This 20-pg catalog surveys a series of EMI filters, including ac, dc, 3-phase, special-application, and custom-design devices. Application notes, a filter-selection guide, and ordering information are included.

Filter Concepts Inc, 2624 S Rousselle St, Santa Ana, CA 92707.

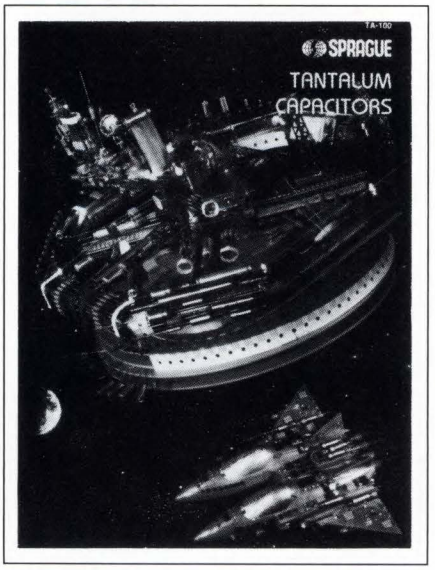
Circle No 577

Catalog presents surface-mount devices

A comprehensive, 4-color brochure sums up the vendor's full line of surface-mount devices, including monolithic ceramic capacitors; tantalum-and aluminum-electrolytic capacitors; thick-film and precision MELF (Metal Electrode Face Bonding) resistors; and surface-mount trimmers. The leaflet includes cutaway illustrations and application notes.

Mepco/Centralab, Box 10330, Riviera Beach, FL 33404.

Circle No 578

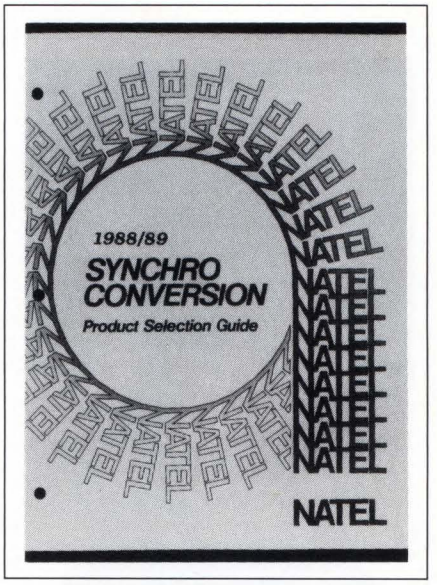


Tantalum capacitor specs

This listing of part numbers and ratings for the company's 27 solid, wet, and foil tantalum-capacitor types also describes 27 styles covered by MIL-C-39003 and MIL-C-39006. The 220-pg manual includes an introduction, parameter comparison charts, and cross-reference tables by type number.

Sprague Electric Co, Technical Literature Services, Box 9102, Mansfield, MA 02048.

Circle No 579



Synchro-conversion product selection

The *1988/89 Synchro-Conversion Product Selection Guide* focuses on the vendor's line of synchro-conversion components and instruments. The booklet presents synchro/resolver-to-digital and digital-to-synchro/resolver converters, and synchro/resolver instruments such as the L200 dynamic-angle synchro/resolver simulator. The publication includes a reader service card for ordering product data sheets or for inquiries.

Natel Engineering Co Inc, 4550 Runway St, Simi Valley, CA 93063.

Circle No 580

Data sheet explains synchro/resolver converter

This data sheet deals with the company's HSRD1056RH synchro-/resolver-to-digital converter. The 4-pg publication describes the converter and presents its specifications, features, and applications.

Natel Engineering Co Inc, 4550 Runway St, Simi Valley, CA 93063.

Circle No 581

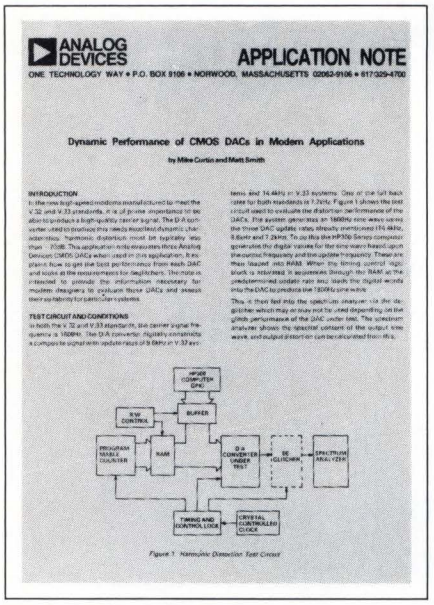
Commitment to Technology

News Edition
The electronics industry's only technical newspaper

Magazine Edition
The electronics industry's leading design publication

EDN Magazine Edition / News Edition

A Partnership in Power and Prestige Worldwide


ANALOG DEVICES
APPLICATION NOTE
ONE TECHNOLOGY WAY • P.O. BOX 9106 • NORWOOD, MASSACHUSETTS 02062-9106 • 617/329-4700

Dynamic Performance of CMOS DACs in Modem Applications

by Mike Curtin and Matt Smith

INTRODUCTION

TEST CIRCUIT AND CONDITIONS

Figure 1. Harmonic Distortion Test Circuit

Selecting DACs for high-speed modem designs

The 6-pg application note describes how you can select, use, and evaluate CMOS D/A converters in high-speed modem designs. The note gives examples of test setups and an analysis of measured characteristics. The discussion also examines the harmonic distortion test circuit, methods of generating test signals, appropriate sampling rates, filtering, and the need for a deglitcher in some tests. Oscilloscope photos show the overall spectral response of the DACs under various test conditions.

Analog Devices Inc, Literature Center, 70 Shawmut Rd, Canton, MA 02021.

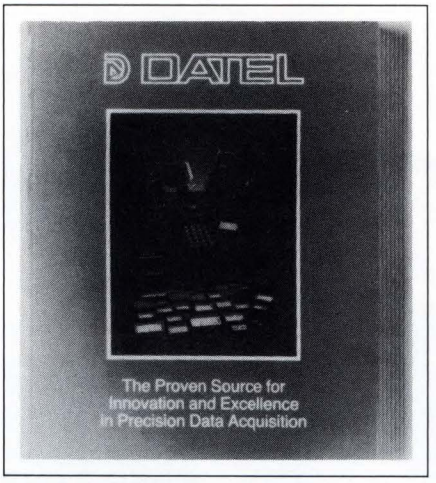
Circle No 582

Synchro handbook

The Synchro Conversion Handbook provides both a practical tutorial and a reference source for designers, systems engineers, and systems users who are involved with synchro products. The publication presents synchro-conversion techniques, data sheets, and a range of topics from the fundamentals of angle-sensing transducers to design constraints and selection criteria for typical applications. In addition, the book explores not only the company's approach to synchro conversion but also other generally accepted techniques. Charts, diagrams, and tables supplement the text.

ILC Data Device Corp, 105 Wilbur Pl, Bohemia, NY 11716.

Circle No 583



Wide selection of data-acquisition products

Presented in a complete data-sheet format, the company's 864-pg catalog describes more than 750 data-acquisition products including data-conversion components; thermal printers; calibrators; digital panel meters; filters; power products; process monitors and controllers; and data-acquisition boards. The book highlights MIL-STD-883B and BS9000 products and features application notes.

Datel Inc, 11 Cabot Blvd, Mansfield, MA 02048.

Circle No 584

Booklet on technology of polymer thick film

The 38-pg booklet entitled *"PTF," A Review of Polymer Thick Film Technology* begins with a historical and technical overview. It emphasizes that PTF materials and processes should not be regarded as a separate and distinct technology but should be used in a supportive role in relation to printed-circuit etched-copper and thick-film cermet technologies. The booklet advocates the combination of various interconnection technologies to meet the demands of rapidly developing microelectronic assemblies. £8.90.

Patintel, 14 Woodlands, Gosforth, Newcastle upon Tyne, NE3 4YL, UK.

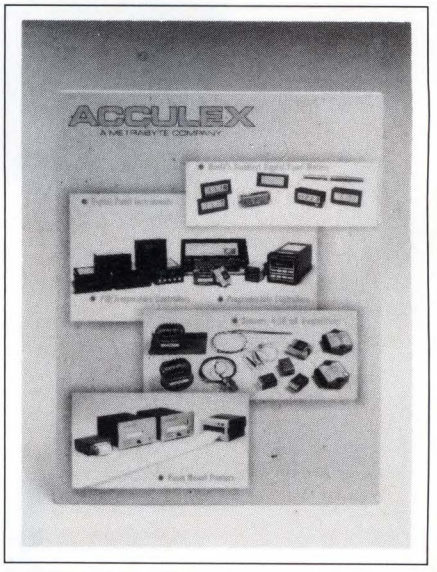
INQUIRE DIRECT

Catalog lists trimmers on a floppy disk

The company's SpecTrim electronic catalog lists more than 8600 standard trimmer part numbers, providing a software solution to trimmer selection. To find the trimmer data you need, you either define performance parameters or enter the part number. The catalog disk is compatible with IBM PCs, and you can transfer it to a hard disk on a workstation.

Bourns Inc, 1200 Columbia Ave, Riverside, CA 92507.

Circle No 585



Handbook for industrial design engineers

Intended for industrial design engineers and end users, this 72-pg publication describes the company's products for common industrial ap-

plications. The booklet features application notes, wiring diagrams, 4- to 20-mA process loop schemes, suggestions for use, and prices.

Acculex, 440 Myles Standish Blvd, Taunton, MA 02780.

Circle No 586

Wide choice of adhesives, gasketing, and sealants

The vendor's 60-pg catalog contains information about materials for bonding; gasketing; pipe, thread, and hydraulic sealants; retaining cylindrical assemblies; threadlocking devices; electronic assembly aids; solvents, primers, and activators; dispensing systems; and maintenance and repair of equipment. A variety of the products offered meet military specifications, as well as standards set by USDA, USP Class VI for medical applications, Underwriters' Laboratories, and the Nuclear Regulatory Commission. The product selector guide summarizes basic technical information about each item.

Loctite Corp, 705 N Mountain Rd, Newington, CT 06111.

Circle No 587

Report on surface treatment

The vendor's 4-pg report explains Ionguard, an innovative approach for changing the mechanical and chemical surface properties of metals, composites, ceramics, glass, and plastics. The 4-color publication outlines the applications, advantages, and features of the process and lists the services provided by the vendor. Photographs and charts enhance the brochure's discussion.

Spire Corp, Patriots Park, Bedford, MA 01730.

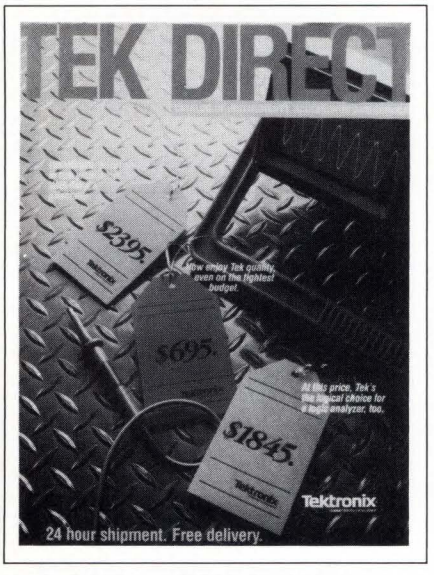
Circle No 588

Directory of electronic measuring devices

The company's *1988/89 Electronic Measuring Instruments* catalog provides a comprehensive listing of 14 instrument categories, including oscilloscopes, logic analyzers, signal generators, modulators, wow and flutter meters, analog and digital voltmeters, and frequency counters/timers. The 213-pg catalog introduces the VP-5516A, a 100-MHz, 4-channel, 10-trace analog oscilloscope featuring a 3-D video display for analyzing complicated waveforms; and the VP-5741A, a DSO featuring a 100-MHz sampling clock and three 10,000-word memories for high-speed transient signals. Divided into product categories that contain general product descriptions, the publication lists specifications and cross references. Diagrams illustrate specific functions.

Panasonic Industrial Co, 50 Meadowlands Pkwy, Secaucus, NJ 07094.

Circle No 589



Direct purchase service for test instruments

The *Tek Direct Catalog for Instruments, Accessories, and Services* is a quarterly, 4-color publication. Describing a sampling of test-instrument products, this catalog tells you how to make direct purchases of the vendor's highest volume products. Products highlighted in the latest edition are the vendor's 200 and 2200 Series portable oscilloscopes, the 1205 logic analyzer, accessories, software, and training aids.

Tektronix Inc, Box 500, Beaverton, OR 97077.

Circle No 590

Supplement supplies instrument information

This catalog supplement provides a broad selection of brand-name test and measurement instruments, including Tektronix and Fluke. Among the products for testing, repairing, and assembling electronic equipment are DMMs, oscilloscopes, EPROM programmers, probes, breakout boxes, precision hand tools, and tool kits. The source book provides specifications, 4-color photographs, and discount pricing.

Contact East, Box 786, North Andover, MA 01845.

Circle No 591

Troubleshooting metastable events

Locating and eliminating component failures caused by random transitions in logic levels is the subject of the vendor's application note, *Troubleshooting Metastable Events Using the Gated Totalize Counter Feature of the Tektronix 11300A Series Oscilloscope (47W-7008).* Targeted at people who perform component testing, digital design, and computer peripheral testing, the note explains how to make use of the 11300A Series oscilloscope's writing speed, 750-MHz counter/timer, and oscilloscope functions. Also included are step-by-step instructions on how to set up the oscilloscope and tips on the best way to probe the circuit under test.

Tektronix Inc, Box 1700, Beaverton, OR 97077.

Circle No 592

Primer explains use of 11300A Series scopes

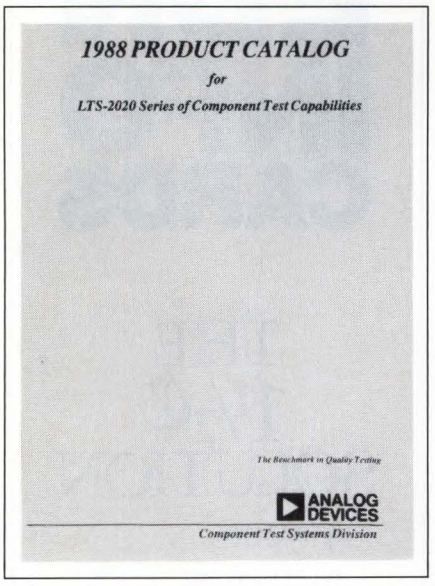
The *11300A Series Timing Measurement Primer (47W-6783)* instructs you on how to make 10 timing measurements, including propagation delay, pulse interval, and total (event counting) measurements using the company's 11300A counter/timer oscilloscopes. The 24-pg publication also has a reference page that shows how to set up the oscilloscope for different measurements, as well as a glossary and a troubleshooting checklist.

Tektronix Inc, Box 500, Beaverton, OR 97077.

Circle No 593

Component test system for data-conversion devices

Published in the last quarter of 1988, the company's *Product Catalog for LTS-2020 Series of Component Test Capabilities* deals with the LTS-2020 benchtop component test system, which tests linear and data-conversion devices, and both ac and dc digital and discrete components. The publication describes the LTS system configuration, console specifications and features, and



the LTS-2020 development station. An options and supplies section lists peripherals, family boards, socket assemblies, software, interface equipment, and documentation. The book includes specifications, diagrams, photographs, and charts.

Analog Devices, 181 Ballardvale St, Wilmington, MA 01887.

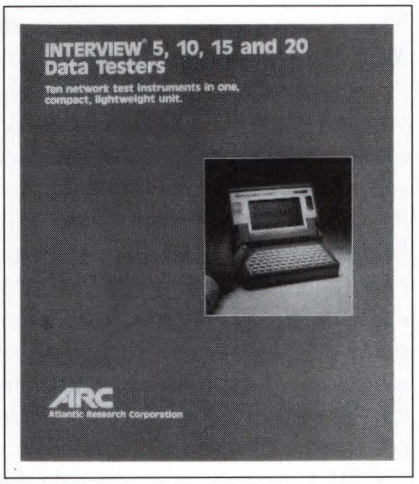
Circle No 594

Brochure depicts fixed and mobile test equipment

The vendor's 6-pg brochure describes the 1400 Test Facility in its three configurations—mobile, rack-mount, and desktop. The pamphlet also discusses the chassis, modules, and option cards that are available for use with the test facility. A separate section summarizes information about the various test instruments that can be mounted with a 1400 Test Facility.

ADC Telecommunications Inc, 4900 W 78th St, Minneapolis, MN 55435.

Circle No 595



Brochure describes data testers

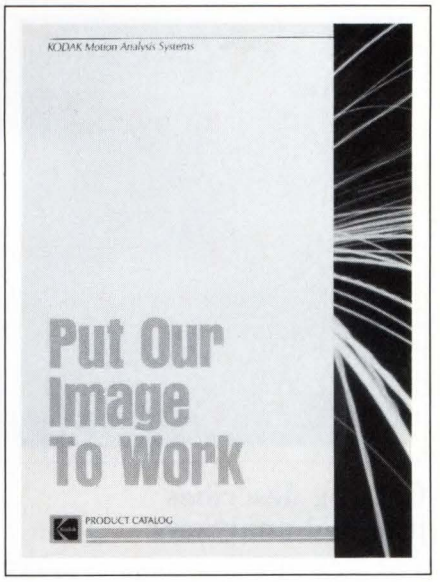
The company's brochure highlights the features and specifications of the Interview 5/10/15/20 Series of compact, multifunction data testers. The publication summarizes the units' applications for field-service personnel, data-communications technicians, and installation crews, and describes how a single unit performs the functions of 10 different test instruments, such as data-line monitors and protocol analyzers/emulators.

Atlantic Research Corp, Teleproducts Div, 7401 Boston Blvd, Springfield, VA 22153.

Circle No 596

Booklet details high-speed motion-analysis systems

In-depth descriptions and applications data for the EktaPro 1000 motion analyzer and the SP2000-C motion-analysis system are the focus of this 22-pg, 4-color catalog. With the help of product photographs, charts, and diagrams, the publication describes each unit's features and applications, which include automated manufacturing, transportation systems, aerospace hardware development, packaging, biomechanics, and fluid mechanics. A summary of accessories, sales and delivery terms, and training and service information completes the publication.



Eastman Kodak Co, Spin Physics Div, 11633 Sorrento Valley Rd, San Diego, CA 92121.

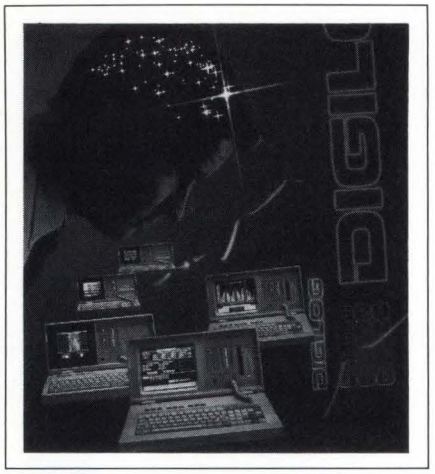
Circle No 597

Brochure on microwave energy generators

This brochure describes the vendor's full line of high-power microwave energy generators for EW/ECM (electronic warfare/electronic countermeasure) emitter simulation. The publication discusses how the generators are used in testing electromagnetic compatibility, EMI, and electromagnetic susceptibility, as well as breakdown testing of antennas and waveguides and evaluation of circulators and electronic components.

Cober Electronics Inc, 102 Hamilton Ave, Stamford, CT 06902.

Circle No 598



Catalog describes protocol analyzers

The New Wave of Digilog Automatic Protocol Analyzers presents a wide range of protocol analyzers and applications for field service, data-communications operations, and protocol development, including the vendor's recent models for ISDN analysis/emulation. The 20-pg catalog has display-screen pictures of protocol decodes, response times, and statistical charts that show how you can use the equipment for a variety of needs. Also included are a variety of turnkey applications for automatic monitoring, testing, and analysis of dataline performance. A specifications list completes the catalog.

Digilog Inc, 1370 Welsh Rd, Montgomeryville, PA 18936.

Circle No 630

Bulletin introduces EPROM programmer

The company's Product Bulletin No P-1287 depicts the Model 7128 EPROM programmer as a high-performance device equipped with microprocessor-based intelligence for ease of use and interface. The bulletin highlights two useful features of the programmer: the compare mode, which allows you to compare source files with programmed devices, and the algorithm-only feature, which programs cells that are different from the source code. A specification table, a list of commands, and an explanation of diagnostic error codes round out the bulletin.

Entertron Industries Inc, 3857 Orangeport Rd, Gasport, NY 14067.

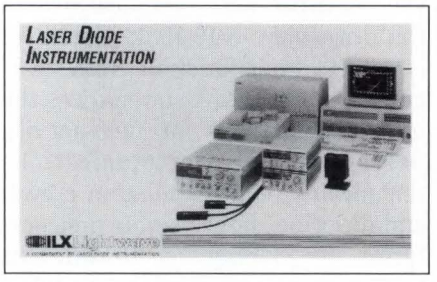
Circle No 631

Modular system for measuring pc-board copper

This 4-pg brochure introduces the MR 4000 modular-coating thickness-measuring system that helps you select the components that are most suitable for pc-board surface-copper or plated through-hole quality-control requirements. The publication provides complete component specifications and a list that explains the functions of each component. Further, it specifies two statistical packages, standard and "Stats-Plus" for customized header software.

CMI International, 2301 Arthur Ave, Elk Grove Village, IL 60007.

Circle No 632



Fold-out focuses on laser-diode instruments

The vendor's 6-pg fold-out brochure features three recently released products for laser-diode instrumentation and highlights its expansion into custom-built laser-diode test systems. The pamphlet provides specifications, illustrations, and prices.

ILX Lightwave Corp, Box 6310, Bozeman, MT 59771.

Circle No 633

Paperback deals with 3-D capabilities of AutoCAD

The AutoCAD 3D Book, the 4th volume in the AutoCAD Reference Library, acquaints AutoCAD users with the 3-D capabilities of Release 10. The book explains how the 3-D function works and covers new commands, perspective, multiple viewports, surface modeling, and rendering. Also included is a special library of 3-D AutoLisp routines. $29.95.

Ventana Press, Box 2468, Chapel Hill, NC 27515.

INQUIRE DIRECT

Answers to questions about pc-board CAD

This 36-pg booklet, *Answers to the Most Commonly Asked Questions on PCB CAD*, provides answers to more than 100 questions about pc-board CAD, compiled from hundreds of conversations with CAD users and potential buyers. Some of the topics include advantages of turnkey vs unbundled systems, pros and cons of different hardware-platform configurations, ways in which training requirements affect the CAD investment, and how to set up a system for maximum efficiency.

Personal CAD Systems Inc, 1290 Parkmoor Ave, San Jose, CA 95126.

Circle No 629

Starter kit and book for first-time CADD users

The CADD (computer-aided design and drafting) Starter Kit for DOS-based microcomputers and the book, *Converting to CADD: The Generic Software Guide for Businesses*, are easy-to-understand guides that help you learn CADD. The starter kit, which contains a step-by-step tutorial workbook, a symbol library, and a disk of sample drawings, teaches you how to create floor plans, elevations, product drawings, flow charts, graphs, charts, and other graphical drawings. The book addresses such issues as the transition from manual to electronic drafting, customizing the CADD system to a particular design discipline, and the benefits of using CADD compared with the use of manual drafting. Starter kit, $159.95; book, $24.95.

Generic Software Inc, 11911 North Creek Pkwy S, Bothell, WA 98011.

INQUIRE DIRECT

Update on device modeling

The version 1.1 report on automated device characterization and modeling (ADCM) is a 300-pg update to the version 1.0 ADCM report. The report serves as a product-selection guide and reviews current trends in the field of CAE tools and systems used in semiconductor electrical test and characterization, statistical process control, and device modeling for Spice simulation at the board level and the IC level. Version 1.1 includes two volumes: *Commercial Parametric Test Systems and Data Acquisition Software* and *SPICE Model Parameter Extraction Software*. The publications are based primarily on the authors' experience and extensive vendor interviews, complemented by reviews of product documentation and related publications. First-time purchasers: each volume, $1300; set, $2400; version 1.0 owners can purchase each volume for $395.

Mosec, 10212 Parlett Pl, Cupertino, CA 95014.

INQUIRE DIRECT

Two training videos for graphics

These two instructional video programs, #D14 *AutoCAD Release 10: For the Beginner* and #D15 *AutoCAD Release 10: Advanced Operations*, provide the materials for self-instruction at the beginning and advanced levels. The elementary level focuses on the display features and 3-D graphics capabilities of Release 10, and it compares the viewing capabilities of the User Coordinate System with the World Coordinate System. The advanced program also explores 3-D graphics capabilities and introduces Lisp programming and some of Lisp's special features. Both programs include a study guide. $299 each.

Bergwall Productions Inc, Box 238, Garden City, NY 11530.

INQUIRE DIRECT

Publication deals with AutoCAD release 10

AutoCAD: A Concise Guide to Commands and Features, the most recent publication in the vendor's AutoCAD Reference Library, consists of 40 chapters of AutoCAD's basic features and commands with accompanying exercises for beginning users. The 330-pg softcover book also serves as a reference for seasoned users. More than 200 illustrations complete the issue. $19.95; with optional disk, $39.

Ventana Press, Box 2468, Chapel Hill, NC 27515.

INQUIRE DIRECT

OUR μP DEVELOPMENT TOOLS HELP PROJECTS GET ON THEIR FEET.

The "creature" shown above doesn't depict a futuristic lunar landing. Rather, it represents a *polar* landing of a sophisticated weather monitoring device. A new parachute-deployed device that instantly transmits vital environmental data to waiting scientists. And whose Antarctic installation and erection now happen automatically, in a matter of minutes, allowing critical data collection in remote areas that were impossible to reach before.

This "Self-Erecting Weather Station," sponsored by the National Science Foundation and designed and developed by Polar Research Lab, was made possible by Avocet and AVSIM™, Avocet's unparalleled simulator/debugger.

The AVSIM Full-Screen Display

Unequaled capability

Polar Research needed AVSIM's sophistication to control the sensors in the weather station's "legs" and to create its transmitter. AVSIM's detailed on-screen CPU simulation, unlimited breakpoint facility, and unique "undo" capability gave their engineers the ease of use and flexibility that allowed them to *execute and test the software even before the hardware was ready.* Saving crucial time and frustration in both the programming and testing phases of development. And money, too: at only $379, AVSIM is a fraction of the cost of additional hardware.

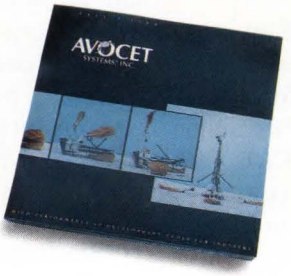
Complete compatibility: from the ground up

Best of all, AVSIM is completely compatible with our AVMAC™ macro assemblers and our AVOCET C™ cross compilers – the ideal combination of tools which gives you a comprehensive development solution.

Get your own project off the ground: try before you buy

Try the AVSIM demo yourself for 30 days. If you're not satisfied for any reason, return the unopened program disk for a full refund – less $35 for the demo disk and manual, which are yours to keep.

Free Catalog



Call Toll-Free 1-800-448-8500*

For your free catalog, to order, or for more information about AVSIM and other Avocet products.

Call Avocet today and ask about our complete line of affordably priced software and hardware μP development tools. Discover how we can help you get *your* next project on its feet, too.

AVOCET SYSTEMS, INC.

THE SOURCE FOR QUALITY μP DEVELOPMENT TOOLS

Avocet Systems, Inc., 120 Union St., P.O. Box 490BW, Rockport, ME 04856 / *In Maine, or outside U.S., call (207) 236-9055 / TLX: 467210 Avocet CI / FAX: (207) 236-6713

EDN PRODUCT MART

This advertising is for new and current products.

Please circle Reader Service number for additional information from manufacturers.

PLD/MICRO PROM/EPROM/EEPROM

SAILOR: The most dependable and affordable programming instrument

S/W driven by PC/XT/AT/PS2 or laptop computers, powerful and expandable.

Sailor-PAL: supports PALs, GALs, PLDs, EPLDs, PEELs, ECLs, PLAs, PLSs, PROMs, EPROMs, EEPROMs and MICROs. JEDEC file input and output. $1095–$1895.

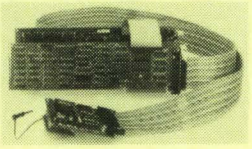
Sailor-2, Sailor-8: set/gang high speed EPROM programmers. $545– $1995.

ADVIN SYSTEMS INC. Sunnyvale, CA 94086
(408) 984-8600 • FAX (408) 736-2503
(800) 627-2456 Please call for free demo disk

CIRCLE NO 325

68HC11

PC-based emulator for 68HC11



- PC plug-in or RS-232 box.
- Pull-down menus with full window support, combined with command-driven User Interface.
- Up to 3.3mHz real time emulation.
- No intrusions to the 68HC11's resources.
- 48 bit wide 16K deep trace. All functions usable without disturbing emulation. Time stamping. Two level trigger.
- Symbolic and C Source Level Debugging, including in-line assembler and disassembler.

PRICES: 64K Emulator and pod $2590;* 4K Trace $1995*

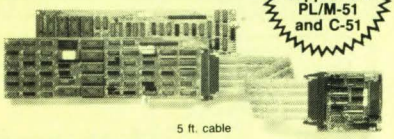
CALL OR WRITE FOR FREE DEMO DISK!

nohau CORPORATION
51 E. Campbell Avenue
Campbell, CA 95008
FAX (408) 378-7869
(408) 866-1820
*US only

CIRCLE NO 326

☆ ☆ ☆ ☆ *"The Best 8051 Emulator"*

NEW Source Level support for PL/M-51 and C-51



5 ft. cable

8051

See EEM 88/89 Page D-1304

PC based emulators for the 8051 family
(8051/51FA/52/31/32/44/152/451/452/535/552 + CMOS + more . . .

- PC plug in boards or RS-232 box
- Pull-down menus combined with Command-Driven User Interface. Context sensitive help and On-Screen Editing of data
- 20 MHz real time emulation
- 128K emulation memory
- 48 bit wide, 16K deep trace buffer with loop counter
- Program Performance analyzer
- Powerful Macros with IF-ELSE, REPEAT-WHILE structures
- Source Level debug for PL/M-51 and C-51
- Symbolic debugging with in-line assembler and disassembler
- Execution time counter
- Trace can be viewed during emulation!

PRICES: 32K Emulator for 8031 $1790;* 4K Trace $1495*
CALL OR WRITE FOR FREE DEMO DISK!
Ask about our demo VIDEO!
*U.S. only

nohau CORPORATION
51 E. Campbell Avenue
Campbell, CA 95008
FAX (408) 378-7869
(408) 866-1820

CIRCLE NO 327

UNIVERSAL/GANG PROGRAMMER

made in U.S.A.

$595.00 Includes One Year Update and Warranty

HUSKY™ programs EE/EPROMS, CMOS PLDS, and Micros. It's your best bet when low cost and quality are both important.
From the people who make CUPL and ALLPRO.

LOGICAL DEVICES, INC.
1201 N.W. 65th Place
Ft. Lauderdale, FL 33309
305-491-7404
1-800-331-7766

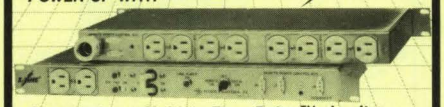
CIRCLE NO 328

Don't Get Zapped!

High inrush current can **destroy** your sensitive VAX CPUs and peripherals **in less time than it takes to flip a switch.**

THE SOLUTION?
Power up with ***Z-LINE* TPC 115-10 MTD™ the smallest** power distribution and control system available.
POWER UP WITH — — —

Z-LINE



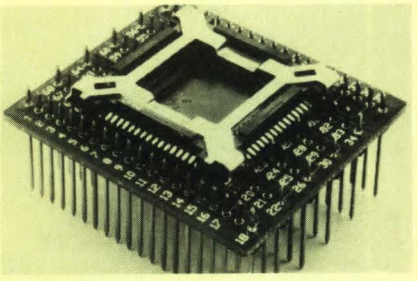
Our proprietary **Multiple Time Delay™ circuitry sequences** your power-up to **protect** your systems from the spikes and surges, EMI & RFI, that **destroy your hardware and erase your data.** And our remote on/off and emergency shutdown **gives the power control back to you.**

All Pulizzi Engineering MTD™ **controllers are compatible with DEC and UPS systems.**
PRICES FROM $436 TO $305

DON'T WAIT UNTIL IT HAPPENS, CALL TODAY!
PULIZZI ENGINEERING INC.
3260 S. Susan Street, Santa Ana, CA 92704-6865
(714) 540-4229 FAX (714) 641-9062

CIRCLE NO 329

LEADLESS CHIP TO WIRE WRAP ADAPTERS



Save prototyping time, LCC, PCC, PGA, and PQFP socket adapters provide the designer with a labeled test point for each pin and are available for 20 thru 100 pin chips. WW pin rows are on .3″ centers. Unit pricing for the 52 pin version is $41.00 delivered from stock.

ANTONA CORPORATION
1643 1/2 Westwood Blvd., L.A., CA 90024
(213) 473-8995 FAX # (213) 473-7112

CIRCLE NO 330

To advertise in Product Mart, call Joanne Dorian, 212/463-6415

Development Tools

PseudoSam Cross-assemblers $50.00
PseudoMax Cross-simulators $100.00
PseudoSid Cross-disassemblers $100.00
PseudoPack Developer's Package $200.00($50.00 Savings)

POWERFUL

- PseudoCode supports an extensive line of professional cross-development tools. Tools that speed development of microprocessor based products. Fast, sophisticated macro assemblers to generate your program code. Versatile simulators that allow testing and debugging of the program even before the hardware exists. Easy to use disassemblers to help recover lost source programs.

AFFORDABLE

- Until now, powerful tools like these have been priced from 5 to 10 times our price. Putting these time saving tools out of reach of all but large corporate engineering departments.

BROAD RANGE OF SUPPORT

- PseudoCode currently has products for the following microprocessor families (with more in development):

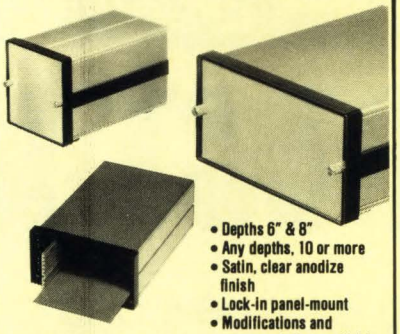
Intel 8048	RCA 1802,05	Intel 8051	Intel 8096
Motorola 6800	Motorola 6801	Motorola 68HC11	Motorola 6805
Hitachi 6301	Motorola 6809	MOS Tech 6502	WDC 65C02
Rockwell 65C02	Intel 8080,85	Zilog Z80	NSC 800
Hitachi HD64180	Motorola 68000,8	Motorola 68010	

- For more information call, write or use the reader service number below.
- To place an order, call or write:

PseudoCode
P.O. Box 1423
Newport News, VA 23601-0423
(804) 595-3703

CIRCLE NO 331

EXTRUDED ALUMINUM PANEL MOUNT ENCLOSURES



- Depths 6" & 8"
- Any depths, 10 or more
- Satin, clear anodize finish
- Lock-in panel-mount
- Modifications and screen printing available

DIN STANDARDS

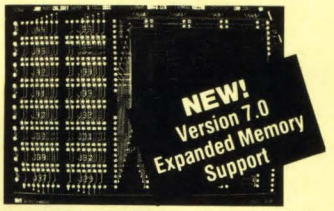
Bezel	Case
48 x 96 mm	44 x 91 mm
72 x 144 mm	67 x 136 mm
96 x 192 mm	91 x 184 mm
96 x 96 mm	91 x 91 mm
	184 x 184 mm

FREE CATALOG

Buckeye
555 Marion Road
Columbus, OH 43207
614/445-8433

CIRCLE NO 332

Schematic Capture, to PCB Layout Vertical Design Workstation - $695.00



Other Companies talk about Sophistication, but we deliver it. Our full featured CAD software sets industry standard in performance and flexibility with features such as:

- User definable Menus, macros and user interface
- User definable grid, pad and trace sizes (1 mil increments)
- DRC with Back annotation, Optimized Rat's Nest
- Comprehensive SMT Support
- Superior Analog design (Irregular filled polygons etc)
- Very large boards >500 equivalent IC's

Compare our CAD software specification with those so-called sophisticated systems, and if you are that interested, we are that good. Prices start as little as $695.00, Optimal Autorouter, GERBER interface

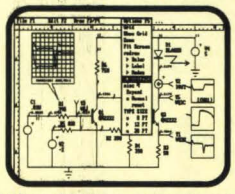
- 30 day money back guarantee
- Full function Evaluation kit with full user manual $75.00 (Creditable towards purchase of regular system)

Interactive CAD Systems
2352 Rambo Court, Santa Clara, CA 95054
(408) 970-0852

CIRCLE NO 333

Analog Circuit Simulation

Completely Integrated CAE with ICAP/2



From Schematic Capture through SPICE Simulation to Post Processing for Only $790†

†**IsSPICE $95**, the complete SPICE program that runs on all PC's. Performs AC, DC, and Transient analyses.

IsSPICE/386 $386, enhanced SPICE for 386 PC's.

†**SPICENET $295**, a schematic editor for any SPICE simulator. Generates a complete SPICE netlist.

†**INTUSCOPE $250**, a graphics post processor that performs all the functions of a digital oscilloscope.

†**PRESPICE $200**, extensive model libraries, Monte Carlo analysis and parameters sweeping.

intusoft
P.O. Box 6607
San Pedro, CA
90734-6607
(213) 833-0710
30 Day Money
Back Guarantee

CIRCLE NO 334

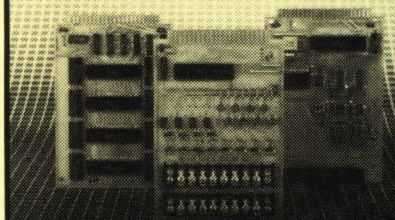
ECONOMICAL MINIATURE GEARHEAD

Sample quantities of a new series of economical precision gearheads are now available for immediate delivery. Micro Mo brand 16-22mm diameter gearheads will fit System Faulhaber brand as well as many competitive motors. Sintered and ball bearing versions are available in ratios from 9:1 to 5,752:1 with efficiencies of up to 81%. Such products are ideal for OA, instrumentation, pumps and monitoring devices, and precision modeling.

Micro Mo ELECTRONICS INC.
742 2nd Avenue South, St. Petersburg, Florida 33701 USA
Phone: 813/822-2529 / Telex: 807-982

CIRCLE NO 335

6800/6809 Micro Modules

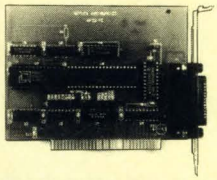


OEM 6800/6809 MICROCOMPUTER MODULES for dedicated control and monitoring. Interfaces for sensors, transducers, analog signals, solenoids, relays, lamps, pumps, motors, keyboards, displays, IEEE-488, serial I/O, floppy disks.

WINTEK
Wintek Corp.
1801 South Street
Lafayette, IN 47904
317-742-8428
800-742-6809

CIRCLE NO 336

IEEE-488 $210



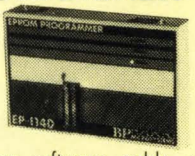
- FOR IBM PC/XT/AT OR COMPATIBLES
- USES DMA FOR HIGH SPEED OPERATION
- EASY TO USE DEVICE DRIVER COMPATIBLE WITH DOS, BASIC, C, & OTHER HIGH LEVEL LANGUAGES
- LINKABLE ASSEMBLY LANGUAGE & C INTERFACES INCL.
- TRUE SRQ CAPABILITY
- ALL SOFTWARE SPEED OPTIMIZED
- 30 DAY MONEY-BACK GUARANTEE

REFLEX INSTRUMENTS
708 S. Church, Olathe, KS 66061
913-791-2550

CIRCLE NO 337

E/EPROM & MICRO PROGRAMMER

$895



- EP-1140 includes: software, cable, user's manual, 2 free software update coupons, toll-free technical support, one-year warranty & a unconditional 30-day money back guarantee
- Programs 24-, 28-, 32- & 40-pin E/EPROMs
- Supports 874X & 875X series microcontrollers
- Connects to a standard parallel port
- Hardware to support future parts to 8 Megabit
- Software updates on floppy disk
- 32-pin model, EP-1132, available for $695

The Engineer's Programmer™

CALL TODAY 800-225-2102

BP MICROSYSTEMS
10681 Haddington, #190, Houston, TX 77043
713/461-9430 FAX 713/461-7413

CIRCLE NO 338

$249. TERMINAL

Featuring
- Standard RS-232 Serial Asynchronous ASCII Communications
- 48 Character LCD Display (2 Lines of 24 Each)
- 24 Key Membrane Keyboard with embossed graphics
- Ten key numeric array plus 8 programmable function keys
- Optional RS-422 multidrop protocol mode
- Keyboard selectable SET-UP features—baud rates, parity, etc.
- Size (5.625"W x 6.9"D x 1.75"H). Weight 1.25 lbs.
- 5 x 7 Dot Matrix font with underline cursor
- Displays 96 Character ASCII Set (upper and lower case)
- Optional Bar Code Wand (shown)

COMPUTERWISE, INC.
302 N. Winchester • Olathe, KS 66062 • 800-255-3739 • FAX (913) 829-0810

CIRCLE NO 339

To advertise in Product Mart, call Joanne Dorian, 212/463-6415

IEEE 488 Solutions.

- Hardware & software interfaces for PC, AT, 386, PS/2, Macintosh, SUN, HP & DEC
- IEEE converters to SCSI, RS-232, RS-422, modem, Centronics, digital I/O & analog I/O
- IEEE extenders, expanders & buffers
- IEEE drivers for DOS, UNIX®, Lotus 1-2-3, Symphony & Quattro.

Call or send for your FREE Technical Guide

Demo disks and application notes available

IOtech

(216) 439-4091
Telex 6502820864 • Fax (216) 439-4093
IOtech, Inc. • 25971 Cannon Road
Cleveland, Ohio 44146

CIRCLE NO 340

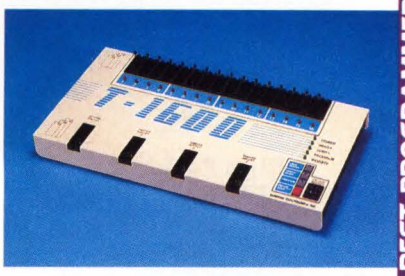
PRECISION UNIVERSAL COUNTER

- PC RESIDENT XT, AT or 386
- 100 MHz FREQUENCY RANGE 10 digits/sec. resolution
- 100 PICOSEC. TIME INTERVAL - without averaging!
- 2000 MEASUREMENTS / SEC. > 50,000 measurements.
- Plus: Period, Ratio, Width and Totalize modes
- $1495 Including virtual front panel software

GT GUIDE TECHNOLOGY INC.
(415) 961-9259

CIRCLE NO 341

T-1600 GANG/SET PROGRAMMER



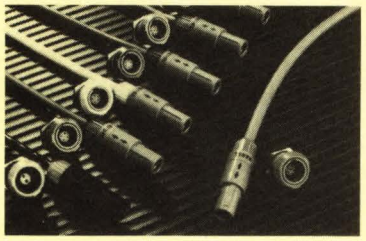
- PROGRAM 16 AT ONCE—SAME OR SET
- 24, 28 OR 32 PIN EPROM'S
- STAND ALONE AND MS-DOS DRIVEN
- INTELLIGENT DEVICE SELECTION
- SIMPLE OPERATION
- QUICK FLIP LCC AND SMT ADAPTERS

AMERICA'S BEST PROGRAMMERS

SUNRISE ELECTRONICS, INC.
524 South Vermont Avenue, Glendora, California 91740
(818) 914-1926

CIRCLE NO 342

Redel Connectors



The Plastic Choice

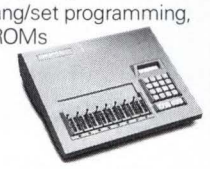
REDEL Features:
- Quick Connect-Disconnect Design
- Autoclaveable PSU Shell Material
- Lightweight and Compact
- Temperature & Corrosion Resistant
- Color Coding and Keying Exclusivity
- Variety of Shell Styles and Configurations
- 2-9 Solder or Printed Circuit Contacts
- Precision Designed and Engineered
- Cable Assemblies

Sold and distributed by
LEMO USA, INC., P.O. Box 11488, Sanata Rosa, CA 95406
Phone (707) 578-8811, FAX 707/578-0869, Telex 340-933.
Please call for the rep nearest you.

CIRCLE NO 343

FREE UV ERASER WITH DATA I/O'S 280 SET PROGRAMMER.

For $1595 the 280 gives you:
- 8 sockets for gang/set programming,
- Support for EPROMs and EEPROMs up to 512K,
- Full after-sale support from Data I/O®.

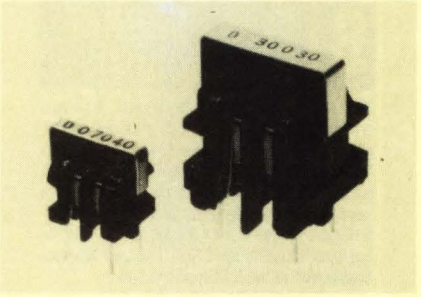


Order a 280 today and get a FREE UV eraser—a $40 value. The Datarase II erases up to 4 EPROMs in 3 minutes.

1-800-247-5700
Ext. 855

DATA I/O Corporation

CIRCLE NO 344



SU SERIES COILS COMMON MODE NOISE FILTERS

Tokin America has recently expanded their offering in the popular SU Series of line filter. These miniature filters are rated at 250 VAC with current ratings from .1 to 3.4 amps. Inductance values range from .5 to 60 mH with a minimum IR of 100 Mohms. The units are available in both vertical and horizontal mount. Most effective in switching power supplies where there is concern for FCC, VDE, CISPR, & VCCI conformity.

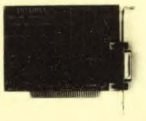
Tokin America
155 Nicholson Lane, San Jose, CA 95134
408-432-8020

CIRCLE NO 345

MICRO/Q 2000

FOR A DECOUPLING CAPACITOR THAT SAVES SPACE, DEFEATS NOISE, IS SUITABLE FOR MILITARY APPLICATIONS AND BEATS HUMIDITY, HEAT AND COLD: ROGERS MICRO/Q® 2000
Rogers Corp., 2400 S. Roosevelt,
Tempe, AZ 85282. 602/967-0624

CIRCLE NO 346



LOW COST INTERFACE CARDS FOR PC/XT/AT

RS-485/422 Card [PC485] $95/125
- Serial Async. Communication up to 4,000ft; 2 or 4 wires; NS16450 UART;
- COM1-4; Max. Baud Rate 56KB. **High speed version (256KB) - $165.**
- **Dual drivers/receivers;Handles 64 devices;Compatible with most comm. sftwr.**
- **DB9** or **phonejack.** Sample communication software available - **$50/150**

IEEE-488 Card [PC488A] $145
- Includes **INSTALLABLE DOS DEVICE DRIVERS** and support for **BASIC.**
- Additional Support for **ASSEMBLY, C, Pascal** and **FORTRAN - $ 50.**
- **IRQ (1-6). DMA** channel 1 or 2. Up to **4 boards** per computer.
- Compatible with most **IEEE-488 Software packages** for IBM-PC (e.g. **ASYSTANT-GPIB, Lotus Measure**). Compatible with NI's **GPIB-PCIIA.**

IEEE-488 Card [PC488B] With Built-In Bus Analyzer $345
- Software Support for BASICA, QuickBASIC and GWBASIC (PC488C only)
- Additional libraries for **C, Pascal, FORTRAN, Assembly** available - **$45 (all)**
- **Powerful menu-driven BUS ANALYZER** runs in the background while 488 programs or commands are executed; Features **Program Stepping, Break points,** real time **bus data capture** (4K buffer), **instant screen toggling.**
- **Complete Controller / Talker / Listener** capability. Based on TI's **TMS-9914.**
- **NEC-7210** based card (compatible with Nat. Instruments **PCII/PCIIA**) - **$445.**

A/D + D/A + DIO + Counter $295-995
- 8/16 differential/single ended Input Channels; 12-14 bit Resolution; Conversion Speed 25-110ks/sec; Input Range ±0.5V to ±10V. Programmable pacer.
- D/A: 1/2 channels, 12-14 bit Resolution; DIO: 16Out/16In, TTL compatible.
- Programmable Interval Counter/Timer; Uses Intel 8253/8254.

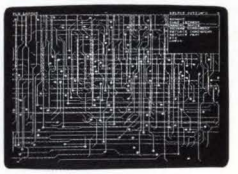
MC / VISA / AMEX *Call today for datasheets!*

B&C MICROSYSTEMS INC.
355 West Olive Ave, Sunnyvale, CA 94086
TEL: (408)730-5511 FAX: (408)730-5521

CIRCLE NO 347

POWER & PRICE... GUARANTEED

$995 PCB CAD SOFTWARE



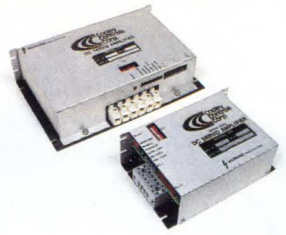
MAXI/PC is a great value! It includes schematic capture, automatic component placement, automatic and interactive routing, and manufacturing outputs. It's backed by a 30 day, money back, no risk guarantee. To order MAXI/PC, call (508) 692-4900.

MAXI/PC *PCB CAD SOFTWARE*

RACAL **RACAL-REDAC**

238 Littleton Road, P.O. Box 365
Westford, MA 01886-9984

CIRCLE NO 348



High Power 22kHz PWM Amplifiers

Model 240 ± 150 volts at ± 30 amps peak, ± 15 amps continuous

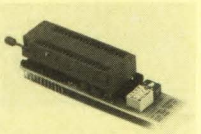
Model 241 ± 150 volts at ± 60 amps peak, ± 30 amps continuous

- 22kHz PWM
- Operating voltage: 24V to 155V

Copley Controls Corp.
375 Elliot Street
Newton, MA 02146
Tel: 617-965-2410
FAX: 617-965-7315

CIRCLE NO 349

87C51 PROGRAMMER $125.



Logical Systems brings you support for the Intel 87C51. The UPA87C51 programs this popular microcontroller on general purpose programmers that support the 2732A. With the UPA87C51 you can program the 8751 and 87C51 security bits and the 87C51 encryption array. Logical Systems, helping you get the most out of your programming equipment with our growing line of adapters. OEM inquiries welcome.

ADAPTER	PROGRAMS	PRICE
UPA8751	C8751, 8751H, AMD8753H, 8744	$95.00
UPA87C51	C8751, 8751H, AMD8753H, 8744 87C51, 87C51FA	125.00
UPA63701V	Hitachi HD63701V0	65.00
UPA451N	Signetics SC87C451 (64 pin DIP)	125.00
UPA63701X	Hitachi HD63701X0 (64 pin shrink dip)	
-L	Low insertion force socket	95.00
-Z	Textool ZIF socket	149.00
UPA63701Y	Hitachi HD63701Y0 (64 pin shrink dip)	
-L	Low insertion force socket	95.00
-Z	Textool ZIF socket	149.00
UPA63705V	Hitachi HD63705V0	65.00

CALL (315) 478-0722 or FAX (315) 475-8460
LOGICAL SYSTEMS CORPORATION
P.O. Box 6184, Syracuse, NY 13217-6184 USA, TLX 6715617 LOGS

CIRCLE NO 350

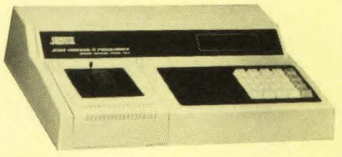
Jameco ELECTRONICS JE680 Universal IC Programmer

Programs PROMs, EPROMs, EEPROMs, PALs, GALs, RALs, EPLDs and PEELs

JE680 Features:

- Stand-alone or computer controlled modes w/ MS-DOS menu-driven software (included)
- Parallel and RS232C interface ports
- Auto-Sense™ of IC insertion
- Supports/translates between 18 data formats
- Full functional test on logic devices
- Over 400 IC definitions in ROM - no personality modules needed
- JEDEC standard supported, accepting input from virtually all major software packages
- One-Year Warranty

Listing of over 400 programmable devices and 74-page catalog available upon request!



JE680 Universal IC Programmer **$1799.95**

Jameco Electronics • 1355 Shoreway Road, Belmont CA 94002 • Phone (415) 592-8097 • FAX (415) 592-2503

CIRCLE NO 751

BIOS SOURCE CODE

The The AT BiosKit is a book with diskettes containing source code in C, plus utility programs to help you create a Bios. Now you can have a Bios with documentation for your own applications: modify boot-up, eliminate the keyboard, install security features, etc. Only $199 complete. The **XT BiosKit** is only $99, or get both BiosKits for $279. The **Intel Wildcard Supplement** for the XT BiosKit is $49.

— XT-AT HANDBOOK —

The **XT-AT Handbook** is full of hardware and software information in a shirt pocket size book. Over 70 pages covering 38 subjects, including connectors, I/O maps, controller programming, DOS and DEBUG commands, board dimensions, character codes, hard disk drive types, and much more. Only $9.95 each qty 1-4, five or more, $5 each.

Annabooks
12145 Alta Carmel Ct Suite 250-262
San Diego, California 92128
(619) 271-9526

CIRCLE NO 752

Gridless, 100% Autorouting

Create and revise schematics and PCBs quickly and simply with **HiWIRE-Plus®** and your IBM PC. With the new, gridless, multilayer autorouter (AR) for HiWIRE-Plus, creating printed-circuit layouts is even faster. AR and HiWIRE-Plus are each $895 and come with thirty-day money-back guarantees. Credit cards are welcome.

Wintek Corporation
1801 South Street, Lafayette, IN 47904
(800) 742-6809 or (317) 742-8428

CIRCLE NO 753

Facts about

400,000

ICs and Semiconductors at Your Fingertips

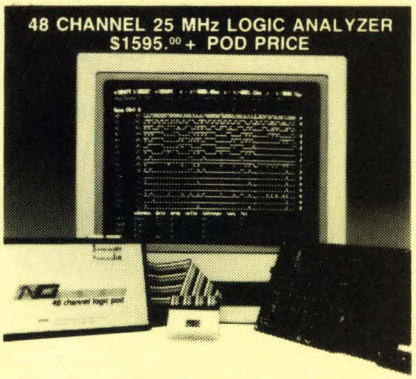
Cahners CAPS is the newest component search and selection tool for electronic design engineers:

- PC-driven, CD-ROM-based
- Includes unabridged manufacturers' datasheets
- Represents more than 250 manufacturers worldwide

Call Toll Free: 1-800-245-6696

CAHNERS CAPS Computer Aided Product Selection
275 Washington Street
Newton, MA 02158-1630
Telephone: 617-964-3030
Telex: 940573

CIRCLE NO 754

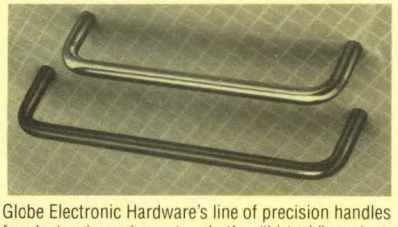


- 48 Chnnls @25MHz x 4K word deep/12 Chnnls @100MHz
- 16 Trigger words/16 Level Trigger Sequence
- Storage and recall of traces/setups to disk
- Disassemblers available for: 68000, 8088, 8086, 80286, 6801, 6811, Z80, 8085, 6502, 6809, 6303, 8031

NCI ☐ 6438 UNIVERSITY DRIVE, HUNTSVILLE, AL 35806
(205) 837-6667

CIRCLE NO 755

PRECISION METAL HANDLES

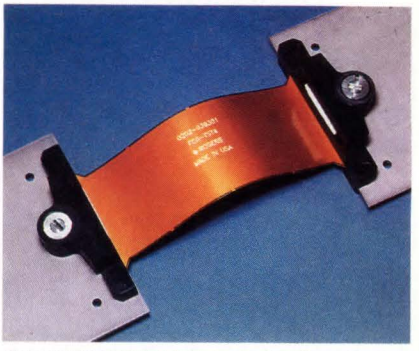


Globe Electronic Hardware's line of precision handles for electronic equipment and other "hi-tech" product applications are made in straight or offset, round or oval configurations with ferrules. The handles are fabricated of aluminum, brass, steel and stainless steel and range in length from .750" (19.05 mm) to 7.0" (177.8 mm). There are 370 available sizes in 30 protective and decorative finishes. For more information contact Globe Electronic Hardware.

GLOBE
GLOBE ELECTRONIC HARDWARE
32-02 57TH STREET • WOODSIDE, NY 11377
(800) 221-1505
IN NEW YORK STATE (718) 278-2400
FAX: (718) 726-1381

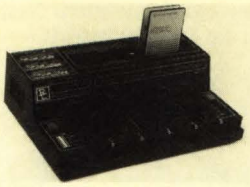
CIRCLE NO 756

QUICK 'N STABLE



RO28000 (TM) PWB Laminates from Rogers. Low effective dielectric constant (2.8) improves electrical performances in high density, very high speed digital systems. Coefficient of thermal expansion, matched to copper improves plated thru-hole reliability and dimensional stability. **Rogers Corp.**, Rogers, CT 06263 203/774-9605

CIRCLE NO 757



E(E)PROM, MEMORY CARD & MICRO PROGRAMMER **$345 - $595**

- All 24/28/32 pin **EProms/EEProms** to 4 MBit (upgr. to **32MB**).
- **Flash Eproms; Micros: 8741,-2,-8,-8H,-9,-9H,-51,-C51,-52,-55 ...**
- **Memory Cards**: Seiko/Epson, Mitsubishi, GI. **Modular design.**
- **Stand-alone** E(E)Prom & Memory Card Duplication / Verify.
- User friendly **menu - driven** driver for **IBM-PC & Macintosh.**
- Built-in **Eraser/Timer** option ($50). **Gang-Module** ready.
- Full 1 year warranty. Direct technical support. Dedicated BBS.

INTELLIGENT PROM EMULATOR **$395**

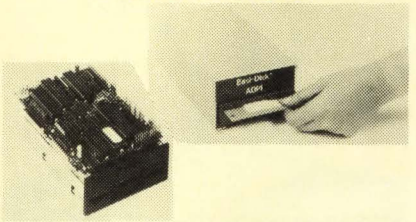
- **2716 thru 27512** (2k to 64k bytes). Binary/Hex/Intel/Motorola.
- Intelligent features include: **Reset Output, Address Compare,**
- **Address Snapshot, Trigger Input, Program Editing capabilities.**
- **FAST** data loading via parallel port **(64k bytes in less than10sec).**

MC/VISA/AMEX *Call today for datasheets!*

B&C MICROSYSTEMS INC.
355 WEST OLIVE AVE. SUNNYVALE, CA 94086
TEL: (408)730-5511 FAX: (408) 730-5521

CIRCLE NO 758

IBM COMPATIBLE RS232/488 3½ x 5¼" FLOPPY DATA STORAGE & TRANSFER SYSTEM



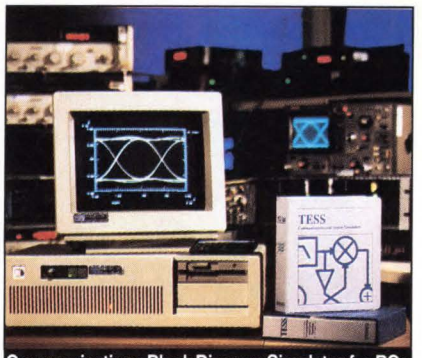
Information Transfer to/from Non IBM Compatible Systems to/from IBM & Compatibles: (Over RS-232 or 488 Interface).

- Reads & Writes MS DOS Disks
- RS-232/488 I/O
- Rugged Portable Package/battery option
- MS DOS Driver for "Plug & Run" RS-232 External Operation
- Baud Rate 110 to 38.4K Baud
- **360K/720K RAM Cartridge Option**
- Price $895 in Singles-OEM Qtys. $495.

28 other systems with storage from 100K to 42 megabytes.

ANALOG & DIGITAL PERIPHERALS, INC.
251 South Mulberry St., Troy, Ohio 45373
P.O. Box 499 TWX 810/450-2685
513/339-2241 FAX 513/339-0070

CIRCLE NO 759



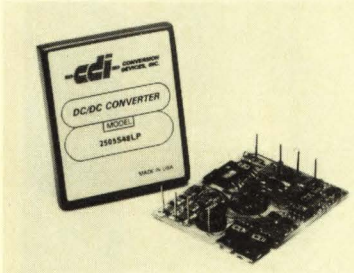
Communications Block Diagram Simulator for PCs

- **TESS**™ simulates modems, radios, & other systems
- Built-in FFT spectrum analyzer, plus over 50 models: filters, mixer, VCO, logic & PAL's, BERT and test eqmt
- Capture schematics graphically with OrCAD® & PCAD®
- Add your own models to **TESS** easily using MODGEN
- Call for 3-disk demo kit • **TESS** *is not copy protected*

TESS Simulator	$495	**TESOFT**	PO BOX 305
MODGEN™ Model Generator	$245	Roswell GA	30077-0305
OrCAD/SDT III® Part Library	$145	☎404-751-9785	FAX 404-664-5817
P-CAD® Part Library	$225	VISA, MasterCard, PO's accepted	

CIRCLE NO 760

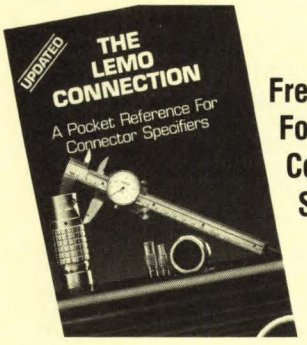
VERY LOW PROFILE, REGULATED 25-30W DC/DC CONVERTERS, 3000LP SERIES



- Input Pi Filter
- Wide Input Voltage Ranges
- Soft Start
- Over 500VDC I/O Isolation
- Output OV Protection
- Over/Under Voltage Shutdown
- Short Circuit Protection
- Thermal Protection
- Remote ON/OFF Control
- Single, Dual & Triple Output Models
- Over 350,000 Hours MTBF
- 3"×2.56"×.375" Package Size
- Two Industry Standard Pin-Outs
- From $135.00/ea. (1-9), Del. 3 Wks. ARO

CONVERSION DEVICES, INC.
101 Tosca Drive, Stoughton, MA 02072
Tel: (617) 341-3266 Fax: (617) 341-8860

CIRCLE NO 761



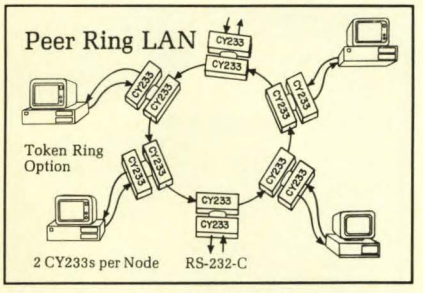
Free Catalog For Connector Specifiers

LEMO's Pocket Catalog permits connector specifiers to quickly determine which LEMO connectors meet their needs. Catalog includes tables that are organized around the main elements needed to specify connectors: number of contacts, working voltages, amps, collet ranges to accommodate cable OD, shell styles and insulating materials.

Connector families include mixed and multi contact connectors, environmentally sealed connectors, coaxial, triaxial, high voltage and plastic.

LEMO USA, INC.
P.O. Box 11488, Santa Rosa, CA 95406
phone 707/578-8811, telex 340-933, fax 707578-0869.

CIRCLE NO 762

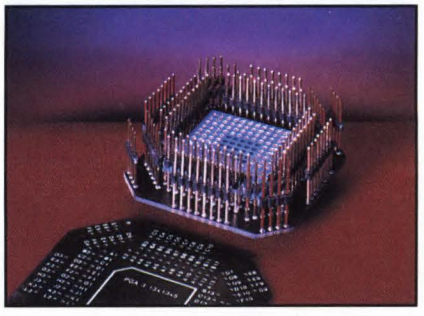


CY233-LINC Network Control

Connect computers, intelligent peripherals, or remote sites. 5v CMOS 40-pin IC. Up to 57.6K baud. Many configs such as Peer LAN shown and Host LAN with opt token; Simpler Networks allow host to control up to 255 parallel devices; UART mode with Ser/Par conversion can connect parallel devices over serial interface and save wire. $75 ea ($30/100). Box 3000, San Gregorio CA 94074. 415/726-3000.

Cybernetic Micro Systems

CIRCLE NO 763



Complete Line of Debug Tools

- **Famous Bug Katcher™ makes it easy to attach test leads to ICs in LCC, PLCC, PGA, PQFP, and DIP packages.**
- **Eliminates need for noisy cables; reduces capacitance and inductance in your test set-up.**
- **You can also quickly isolate and reconnect sections of your socketed IC with our Bug Isolator.™ (All packages.)**
- **Quick turnaround on custom engineering services, if needed. For a free catalog, contact:**

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

CIRCLE NO 764

8051 SBC $99 oem qty 1
Single Board Computer

FEATURES: 8031, RAM and ROM Sockets, 8 bit I/O, RS 232 port, optional UART, and Expansion Bus. Size: 3.5" x 6.0", +5Vdc only. OPTIONS: 8032, CMOS, 18 MHz, NV Memory, Monitor Firmware and High Level Languages.
Development Board.....$199

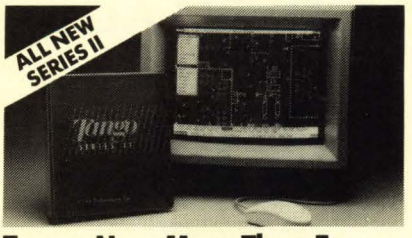
8031 ICE $199

Our emulator provides most of the features of an 8031 In-Circuit-Emulator at a significantly lower price. It assists in integration, debug and test phases of development. Commands include: disassembly, trace, breakpoints, alter register/memory, and load Intel Hex file.

8051 Simulator Program..... $99
IBM PC/XT/AT Software simulation of 8051 µC.

HiTech Equipment Corporation
9400 Activity Road
San Diego, CA 92126
(619) 566-1892

CIRCLE NO 765



Tango. Now More Than Ever, The Best Value in PCB Design.

Take a look at the all new **Tango Series II**. Our pop-up menu interface sets a new standard for ease-of-use and productivity. Lay out simple prototypes or complex, multi-layer, SMT designs with over 100 new features including user-definable tracks, pads, and grids.

For IBM-PCs and compatibles, Tango-PCB Series II, just $595. Tango-Route Series II autorouter, just $495. Both include one year's updates, free tech support, 30-day money-back guarantee. Call today.

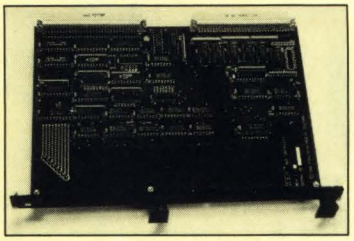
FREE EVALUATION PACKAGE
800-433-7801 619-554-1000

ACCEL Technologies, 6825 Flanders Dr., San Diego, CA 92121

CIRCLE NO 766

To advertise in Product Mart, call Joanne Dorian, 212/463-6415

960 DIGITAL I/O LINES ON A SINGLE VME SLOT



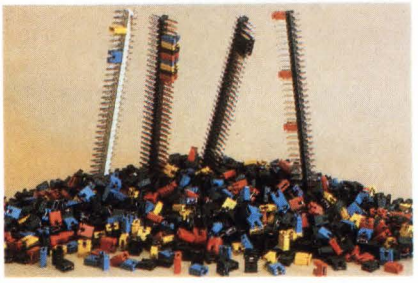
NEW! IOEX™ BUS CONTROLLER

* I/O expansion bus highly immune to EMI/RFI noise.
* Extends up to 50 feet on unshielded ribbon cable.
* 20 card slots with geographic addressing.
* Efficient slot vectored interrupts.
* Compatible with most Eurocard card cages.
* Components are available for complete sub-systems.

INDUSTRIAL DIGITAL SYSTEMS
2108 W. Freeway — Fort Worth, TX 76102
Phone (817)332-2241

CIRCLE NO 767

SAMTEC OFFERS NEW LOW COST .100″ SHUNT



A new low cost version of Samtec's .100″ (2.54MM) centerline shunt achieves cost savings without sacrificing quality. This new SNT series shunt now available in production quantities with black, orange, red, yellow or blue insulator. Gold plated versions have minimum of 10 microinches of gold. Tin plating also available. Pricing: Gold plated $.035 each in 100M lots. Tin plated $.031 each in 100M lots. For data and samples contact:

Samtec, Inc.
P.O. Box 1147, New Albany, IN 47150
Phone: (812) 944-6733, FAX: (812) 948-5047

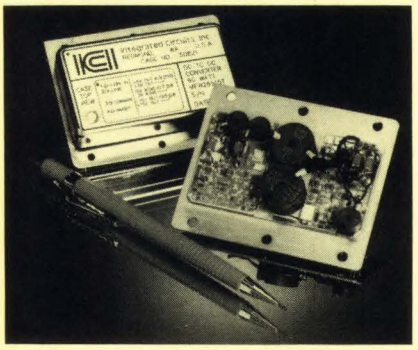
CIRCLE NO 768

Only a Specialized Manufacturer Could Provide Versatile and Economic Products

With more than 11 years' experience in this field, we proudly offer you various types of conductive silicone rubber pads, rubber pads with multicolor and screen printing, silicone rubber overlay, rubber pads with screen printing on plastic keytops, 0 rings, washers, inner caps, tubes, etc., and screen printing flexible circuit boards. Please contact us for more information.

GENERAL SILICONES CO., USA
650 W Duarte 305, Arcadia CA 91006, U.S.A.
Tel: (818) 445-6036. Telex: 3716189 GSCUI.
Fax: 818-4456084

CIRCLE NO 769



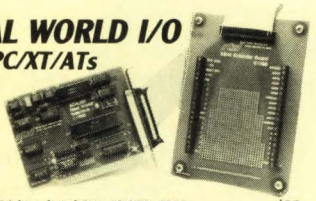
MINIATURE 70 WATT DC-DC CONVERTER

ICI announces the addition of the MFW series of 50-70 watt DC-DC converters to its line of HI-REL devices. Up to 88% efficient, these converters are avail in 5, 12, 15 V single, dual & triple output configurations. For MIL & other HI-REL applications, 125°C T_C is possible with derated power output. Additional environment screening is avail.

Interpoint, 10301 Willows RD., Redmond, WA, 98052, 800/822-8782

CIRCLE NO 770

REAL WORLD I/O For PC/XT/ATs



DG24 • 24 line digital I/O; 10 MHz 8255. **$95**
AD500 • 8 channel 12-bit (plus sign) integrating A/D; prog. gains of 1, 10 & 100; 7 digital I/O lines. **$239**
AD100 • Single channel version of AD500; 10 digital I/O lines. Same programmable gains. 700 meg input Z. **$149**
AD1000 • 8 channel 12-bit A/D; 25 uS; sample & hold; 3 5 MHz timer/counters; 24 digital I/O lines. **$295**
ADA300 • 8 channel 8-bit 25 uS A/D; single D/A sample & hold; 24 digital I/O lines. **$239**
AD200 • 4 channel 12-bit 125 uS A/D; 3 5 MHz timer/counters; 24 digital I/O lines. **$239**
DA600 • Fast settling dual bipolar D/A. **$179**
PD200 • Prototype board w/ address decoder; manual **$99**

All boards include BASIC, Pascal, C, and Forth drivers. 30 day return; 1 year warranty. Call for "Real World Interfacing" application notes.

Real Time Devices, Inc.
P.O. Box 906 State College, PA 16804
(814) 234-8087

CIRCLE NO 771

Want Attention From 137,000 Engineering Specifiers?

♦

Place your ad in EDN Product Mart.

DIGITAL VOICE MODULE

*VOICE WARNING *VOICE MEMO *VOICE GUIDING
Have Your Systems Right To

"TALK"

* Multi Channel
* Low Cost
* DRAM, SRAM, EPROM
* Best Quality

Your #1 source for voice products!

MING
Engineering & Products, Inc.

515 S. Palm Ave., #5, Alhambra, CA 91803
Tel: (818) 570-0058 • Fax: (818) 576-8748

CIRCLE NO 773

WE'RE BENDING THE RULES FOR CIRCUIT DESIGNERS

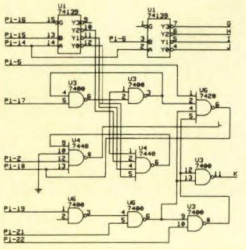
BEND/FLEX™, the bendable board material flexible enough to bend into any multi-plane shape. Eliminates stiffeners, flex-hardboard connectors. May reduce cost of two- and three-plane interconnect systems by as much as 30%!

Rogers Corporation. One Technology Dr., Rogers, CT 06263. (203) 774-9605.

CIRCLE NO 774

FREE SCHEMATIC CAPTURE DEMO DISK

SCHEMA II+: Capture More Than Ever



Incredible speed, ease of use and power have made SCHEMA a best-selling schematic capture program for engineering professionals the world over. Now, SCHEMA II+ sells for **$495** and supports most common IBM PC/XT/AT/PS2 configurations.

OMATION
In Texas Call (214) 231-5167
FREE Demo Disk: 1-800-553-9119

CIRCLE NO 775

To advertise in Product Mart, call Joanne Dorian, 212/463-6415

There are lemons and

In today's job market, there is a big difference between jobs available, and the long-term career opportunities that those jobs represent. At FMC, a job opening represents a career future with the world's leading designer/manufacturer of military tracked vehicles. Our staff works daily on the leading edge of new technologies and advanced management and accounting systems. There are plenty of "peaches" when it comes to career openings at FMC. If you qualify, why not pick one for yourself?

ENGINEERS

Analysis Engineer
Must have basic knowledge of vibration and acoustic testing, instrumentation and digital signal analysis. Experience in field testing of ground vehicles using noise and vibration test instrumentation is desirable. Experience in the area of computer-aided, dynamic structural analysis (modal analysis) is desirable. Report writing skills and good verbal communication skills are mandatory. BSME or equivalent experience required, MSME preferred.

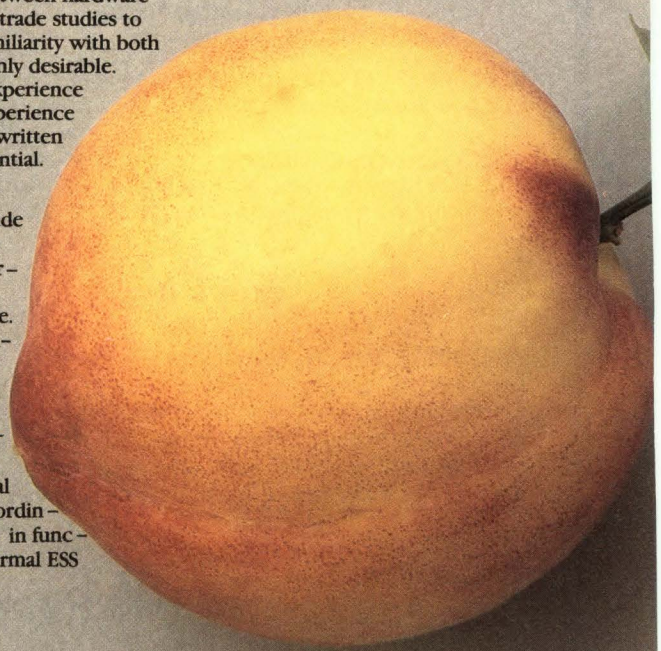
Analysis Engineer
Stress, thermal and dynamic analysis, especially using finite element methods. Must be fully proficient in and have at least five years full time immediately prior experience in engineering analysis, especially using major FEA codes. Experience in SUPERTAB and ANSYS preferred. Must be well organized and communicate clearly and interact agreeably with designers, other analysts and supervisors. Must have M.S. degree or equivalent experience in Mechanical Engineering or closely related field and five years experience or B.S. degree, or equivalent experience, and eight years experience. M.S., Ph.D and/or additional experience preferred.

CAE-CAM Engineer
Position provides technical expertise and support for computer application projects within the Manufacturing environment. Position requires B.S. Degree, or equivalent experience in Mechanical, Industrial, Manufacturing Engineering, or Computer Science, plus a minimum of five years experience in manufacturing, computer systems, and product management as well as a working knowledge of FORTRAN programming, VAX systems, and Computer-Aided Design systems. Experience with ORACLE, N/C programming, Networks, Robotics, DNC, and IBM systems is desirable. An MSCS or MBA degree would be an asset.

Electrical Engineer
Will perform system level analysis on microprocessor based control systems. Will determine and document requirements, requirement allocations between hardware and software, and perform trade studies to make design decisions. Familiarity with both hardware and software highly desirable. BSEE, BSCS, or eqivalent experience with three to five years experience is required. Good oral and written communication skills , essential.

Electrical Engineer
Major responsibilities include developing procedures for thermal and vibration Environmental Stress Screening (ESS)of electronic hardware. Individual will become familiar with the methodology and techniques of ESS as applied to military electronics and supervise development thermal ESS at out side laboratories. Additional responsibilities include coordination of personnel involved in functional testing, vibration, thermal ESS and failure analysis associated with ESS process development. Position will provide Electrical Engineering expertise to ESS project and write thermal ESS technical reports from Laboratory data and have familiarity with personal computer data bases and engineering problem analysis. The successful candidate should have a BSEE or equivalent experience, two to four years electrical engineering/manufacturing process experience, preferably with some background knowledge of environmental testing.

Industrial Engineer
The Industrial Engineer will be primarily responsible for forging/casting development; optimize forging/casting drawings to increase productivity; help vendors metallurgically; troubleshoot problems; assist Purchasing and Quality Engineering; certain



here are peaches...

amount of travel will be required; and will assist in Steel Welding areas. Candidate will have Materials/metallurgical or related Engineering degree, or equivalent experience, with minimum 3 years experience in forging/casting/welding related environment. Manufacturing Engineering experience with heavy component manufacturers is a plus.

Industrial Engineer
Responsible for performing full range of N/C Programming; Analyze the methods tool request for an N/C program; Set up the detailed program according to N/C standard requirements; Employee must be able to visually analyze part and fixture prints, write an N/C program using the APT language, have knowledge of machine shop practices and terminology, select cutting tools, and determine feeds/speeds. Formal programming training or equivalent experience required. and the preparation of Documentation. Team work is an absolute necessity. Shop Coverage. Must have experience in process (machining, N/C punching, plasma burning). Five years of experience preferred. Good communication skills. Working knowledge of the PC environment.

Mechanical Engineer
This position is needed to serve as a Supervisor for the BFV Engineering Support Group. The assignment involves liason and coordination between Engineering Test, BFV Engineering, BFV Systems Engineering, and various government test agencies. Familiarity with the processes, planning scheduling, and costs associated with vehicle, weapons, and component testing is required. Familiarity with processing modification kits and other vehicle preparations is desired. The applicant must be a U.S. citizen. Good written and oral communication in English is required. The applicant must be able to travel occasionally. BSME or equivalent experience. Minimum five years experience in engineering R&D or Design Engineering.

Quality Engineer
Review policies and procedures for compliance with quality requirements. Responsible for discrepant material processing through Control Areas. Requires college degree or equivalent job experience and the ability to communicate instructions and procedures verbally and in writing. Must be familiar with computerized data base systems (IMS, TSO, RAMIS and PC software) to perform defect trend analysis and reporting. Knowledge of assembly and testing processes a must. Working knowledge of: MIL-STD-9858A; MIL-STD-1520B; MIL-STD-1050; Shop Math; Basic Blueprint Reading; and Inspection Techniques and Equipment reqired.

Software Engineer
Develop requirements to analyze, design, test and document embedded applications software to support contract R&D efforts. Working knowledge of assembly level languages, ADA, Pascal and military software. Must have experience with real-time embedded systems. A BSAA or BSCS or equivalent experience is required.

System Safety Engineer
This position is responsible for ensuring that system safety requirements are met through selective application of system safety analysis, design evaluation and test verification techniques/documentation. The safety engineer prepares system/subsystem hazard analysis for concept, development and production programs in accordance with MIL-STD-882, using both qualitative and quantitative safety analysis methods. The demonstrated ability to read mechanical and electro-mechanical engineering drawings is essential. A BS in Engineering discipline, or eqivalent experience, is required. MS in Safety highly desirable.

FMC offers an excellent salary and a comprehensive benefits package. For prompt consideration please send resume, including your salary history and requirements to FMC Corporation Ground Systems Division, 328 W. Brokaw Road, Box 58123, Dept. 31-89-03-EV, Santa Clara, CA 95052. We are an Equal Opportunity Employer.

There are jobs and there are careers.

FMC

Engineers

NCR

Develop the systems that others only imagine.

NCR now has one of the broadest lines of PCs in the industry. As a recognized pacesetter in the computer industry, our $6-billion success can add more momentum to yours. That's because we'll expose you to the latest technologies, put you to work on the most startling new developments and help you realize your ambitions working side-by-side with some of the industry's best talents. When you're thinking of opportunity, think NCR and look into one of the following challenges:

Systems Integration Project Leader

You will direct integration and testing for new PC systems, as well as develop hardware compatibility/reliability tests and performance analysis tools for benchmarking. Requires BSEE plus 3-5 years' hardware experience, strong knowledge of microprocessor-based systems and a solid background in system integration and testing.

Software Quality Engineer

You will plan and supervise activities of the Testware Development group to produce compatibility benchmarking software. Applying state-of-the-art software engineering concepts, you'll work to improve the overall software engineering process. Requires BSEE/CS plus a minimum of 3 years' related experience in PC software development, 8086/80286/80386 Assembly, "C" language and software QA.

Systems Software Engineer

You will design and develop new device drivers for the following operating systems: MS-DOS, MS-OS/2, UNIX* and NOVELL netware. Requires a BS degree in either Computer Science or Engineering plus 3-5 years' experience with 8086/80286/80386 Assembly and "C" language programming.

Software Engineer

Ideal for a Programmer who wants to develop and maintain innovative PC system firmware. You must be experienced with 80286/386 Assembly language and have at least 3 years' experience with PC BIOS code or other PC hardware driver software. Knowledge of keyboard controllers or 8042 Assembly desirable.

Our division is located near Clemson University in the beautiful foothills of the Blue Ridge Mountains in South Carolina. We offer a rewarding work environment, excellent salaries and extensive benefits. For immediate, confidential consideration, forward your resume with salary history to:

Manager, Personnel Resources
Dept. 82R
NCR Corporation
Personal Computer Division
1150 Anderson Drive
Liberty, SC 29657

NCR...people working together to create value.

An equal opportunity employer.

*Registered trademark of AT&T.

PROJECT GROUP LEADER, MECHANICAL

SAN FRANCISCO BAY AREA

Bio-Rad is a world leader in the fields of clinical diagnostics, chemical separations and analytical instrumentation, and offers a rare environment of stability and growth. In fact, we were recently rated as one of the *fastest* growing companies in California. Our success has led to this unique opportunity for an individual with a BS/MS in Mechanical Engineering and 10 years' experience designing scientific instrumentation.

The successful candidate will lead a motivated group of engineers and scientists in the design of a new generation of equipment for the biotechnology marketplace, and should have a proven ability to manage multidisciplinary projects involving electronics, software, sensors and plastic molding, and complex mechanical systems.

At Bio-Rad, you'll enjoy a progressive enviroment where new ideas are encouraged *and* rewarded. For consideration, please send your resume to Bio-Rad Laboratories, Inc., Human Resources, Dept. 181/86-EDN76, 1000 Alfred Nobel Drive, Hercules, CA 94547. EOE.

BIO-RAD *Bio-Rad Laboratories*

First, there was the vision...

History-Making Opportunities: Space Station & Mars Observer... in Princeton, New Jersey

Space exploration began with a vision. The fire of imagination - fused with superior technical proficiency - leading the way to limitless possibilities. A special vision that creates the kind of breakthroughs that characterize GE Astro Space.

With over 150 satellites currently circling the globe, and long-term, history-making projects such as the ***Space Station and Mars Observer***...GE Astro Space can offer Engineers the kind of rare opportunities that few are destined to realize.

If you're the visionary Engineer we're seeking, join us in fulfilling an array of project requirements...paving the way for a new generation of emerging space technology. Our mission requires the technical proficiency of Engineers with a minimum of 3 years experience, specifically in the following areas:

- **Propulsion Systems**
- **Launch Vehicle Integration**
- **Power Systems**
- **Spacecraft Attitude Control**
- **Spacecraft Harness Design**
- **Solar Arrays**
- **Electro Optics**
- **Microwave/RF Design**
- **Antenna Mechanical Design**
- **Systems Integration & Test**
- **System Definition & Requirements**
- **System Safety Engineers**
- **Materials Engineers**

The Rewards

As the largest employer of engineers and scientists in the world, GE provides highly competitive salaries and exceptional benefits including tuition refund and continuing education programs, providing constant training in new technologies and systems...so your expertise is always current and expanding.

The Time is Now

We're a company anxious to meet Engineers who want to cross the engineering frontier. Rush your resume, in professional confidence, to: Employee Relations, Dept. EDNM, GE Astro Space, P.O. Box 800, Princeton, New Jersey 08543-0800.

GE Astro Space
Cross the engineering frontier.

An Equal Opportunity Employer

EDN's INTERNATIONAL ADVERTISERS INDEX

Abbott Transistor Laboratories Inc 73
ACCEL Technologies Inc 229
Advance Power Supplies Inc . . . 77
Advanced Micro Devices 12-13, 144-145
Advanced Power Tech 229
American Automation 193
Amoco Performance Products Inc 158-159
AMP 165
Amphenol 179
Anaheim Automation 89
Analog Devices Inc 125
Ancot Corp 219
Annabooks 228
Antona Corp 225
Apex Microtechnology Corp 58
Applied Microsystems Corp 136-139
Augat 16-17
Avocet Systems Inc 224
B&C Microsystems 227, 229
BEI Computer Products Div . . . 143
Bertan Associates Inc 89
BP Microsystems 226
Buckeye Stamping Co 226
Burr-Brown Corp 111
Cadre Atron Div 20
Cahners CAPS 228
Calcomp 213
Computerwise Inc 226
Condor 63
Connector Corp 143
Conversion Devices Inc 229
Copley Controls Corp 228
Cybernetic Micro Systems 112, 229
Cypress Semiconductor 48
Dale Electronics Inc 31
Data I/O Corp C4, 227
Datel 89
Du Pont Electronics 146-147
Duracell 82
EEsof 195
Elantec 113
ELCO 80
Electronic Measurements Inc 92-93
Electronic Solutions 56
Emcor Products 172
Emulation Technology Inc 229
Endicott Research Group 80
Ericsson Components 79
E-T-A Circuit Breakers 94
Farnell International Ltd** 6
Finlux** 168
Forth Inc 197
Franklin Software Inc 210
Fujitsu Microelectronics Inc C2
General Silicones 230
Gespac Inc 43
Glassman High Voltage Inc 81
Globe Electronic Hardware Inc . . 228
Guide Technology 227
Hammond Mfg Inc 219
Harris Semiconductor 100-101, 134-135
Hewlett-Packard Co . 18-19, 155, 157
Hirose Electric 44
Hitachi America Ltd/Semiconductor and IC Div* 50-51
HiTech Equipment Corp 229
Honeywell 30
Industrial Digital Systems 230
Integrated Device Technology Inc 123
Intel Corp 209, 211
Interactive CAD Systems 226
International Rectifier C3
Interpoint 230
Intusoft 226
ITT Cannon 173
Jameco Electronics 228
John Fluke Manufacturing Co Inc* 6
Kepco Inc 87-88
Leader Instruments Corp 116
Lemo USA Inc 227, 229
Linear Technology Corp . . . 205-206
Littelfuse 25
Logical Devices Inc 225
Logical Systems Corp 228
Lorain Products 96-97
LSI Logic Corp 114-115
3M Co 119
Magnetek 41
Magnetek/Triad 40
Marconi Instruments 203
Mascot Electric** 121
Maxell 85
Mentor Graphics Corp 10-11
Micro Linear 8
Micro Mo Electronics 226
Ming Engineering & Products Inc 230
Mini-Circuits Laboratories . 26, 27, 238
Molex Inc 167
MWS Wire Industries 169
National Instruments 2
NCI 228
NCR Microelectronics Div . . 128-129
NEC Corp 162, 176-177
NMB Technologies 42
Nohau Corp 225
Noritake Electronics Inc 160
OKI Electronics 60-61
OKI Semiconductor 38-39
Omation Inc 230
OrCAD Systems Corp 45
Panduit Corp 161
Philips Components** . . . 52-55, 90
Philips T&M** 51, 217
Pioneer Magnetics 62
PLX Technology 141
Powertec 99
Precision Connector* 168
Precision Interconnect 170
Precision Monolithics Inc. 33
Prime Computer Inc 182-183
Pseudo Code 226
Pulizzi Engineering 225
Racal-Redac 227
Ready Systems 198-199
Real Time Devices 230
Reflex Instruments 226
Reliability Inc 80
Rogers Corp . . . 98, 227, 228, 230
Rohde & Schwarz** 50
Saft* 90
Samtec Inc 230
SGS-Thomson Microelectronics* 14-15, 127
Siemens Munich 127
Siemens Optoelectronics** . . 120A-B
Siemens Semi* 121
Silicon Systems 131-132
Siliconix Inc 4
Sonnenschein Batteries Inc 98
Spectrum Software 200
Sprague Electric Co 175
Stanford Research Systems Inc 32
Sunrise Electronics Inc 227
Tektronix Inc 34-37
Teradyne Connection Systems 28-29
Tesoft 229
Texas Instruments Inc* 52-55
Thomas and Betts Corp 181
Tokin Corp 130, 227
Toshiba America Inc 46-47
TRW LSI Products Inc 23
Wavetek 3
Wintek Corp 226, 228
Xentek 95
Ziatech Corp 1
Zilog Inc 59

Recruitment Advertising . . . 231

Judge Inc
NCR Corp — Personal Computer Div
Rockwell-Telecommunications

*Advertiser in US edition
**Advertiser in International edition

EDN's CHARTER

EDN is written for professionals in the worldwide electronics industry who design, or manage the design of, products ranging from circuits to systems.

EDN provides accurate, detailed, and useful information about new technologies, products, design techniques, and careers.

EDN covers new and developing technologies to inform its readers of practical design matters that will be of concern to them at once or in the near future.

EDN covers new products

- that are immediately or imminently available for purchase
- that have technical data specified in enough detail to permit practical application
- for which accurate price information is available.

EDN's Magazine Edition also provides specific "how to" design information that its readers can use immediately. From time to time, EDN's technical editors undertake special "hands on" engineering projects that demonstrate EDN's commitment to readers' needs for useful design information.

EDN's News Edition also provides comprehensive analysis and news of technology, products, careers, and distribution.

EDN

275 Washington St
Newton, MA 02158
(617) 964-3030

BUSINESS/CORPORATE STAFF

Peter D Coley
VP/Publisher
Newton, MA 02158
(617) 964-3030; Telex 940573
Ora Dunbar, Assistant/Sales Coordinator

Mark J Holdreith
Advertising Sales Director
Newton, MA 02158
(617) 964-3030
Heather McElkenny, Assistant

Deborah Virtue
Business Director
Newton, MA 02158
(617) 964-3030

NEW ENGLAND
Chris Platt, Regional Manager
Clint Baker, Regional Manager
199 Wells Ave
Newton, MA 02159
(617) 964-3730

STAMFORD 06904
George Isbell, Regional Manager
8 Stamford Forum, Box 10277
(203) 328-2580

NEW YORK, NY 10011
Daniel J Rowland, Regional Manager
249 West 17th St
(212) 463-6419

PHILADELPHIA AREA
Steve Farkas, Regional Manager
487 Devon Park Dr, Suite 206
Wayne, PA 19087
(215) 293-1212

CHICAGO AREA
Greg Anastos, Regional Manager
Jack Johnson, Regional Manager
Holli Gronset, Telemarketing
Cahners Plaza
1350 E Touhy Ave, Box 5080
Des Plaines, IL 60017
(312) 635-8800

DENVER 80206
John Huff, Regional Manager
44 Cook St
(303) 388-4511

DALLAS 75243
Don Ward, Regional Manager
9330 LBJ Freeway, Suite 1060
(214) 644-3683

SAN JOSE 95128
Walt Patstone, Regional Manager
Bill Klanke, Regional Manager
Philip J Branon, Regional Manager
James W Graham, Regional Manager
3031 Tisch Way, Suite 100
(408) 243-8838

LOS ANGELES 90064
Charles J Stillman, Jr
Regional Manager
12233 W Olympic Blvd
(213) 826-5818

ORANGE COUNTY/SAN DIEGO 92715
Jim McErlean, Regional Manager
18818 Teller Ave, Suite 170
Irvine, CA
(714) 851-9422

PORTLAND, OREGON 97221
Pat Dakin, Regional Manager
Walt Patstone, Regional Manager
1750 SW Skyline Blvd, Box 6
(503) 297-3382

UNITED KINGDOM/BENELUX
Jan Dawson, Regional Manager
27 Paul St
London EC2A 4JU UK
44 01-628 7030
Telex: 914911; FAX: 01-628 5984

SCANDINAVIA
Stuart Smith
27 Paul St
London EC2A 4JU UK
01-628 7030
Telex: 914911; FAX: 01-628 5984

FRANCE/ITALY/SPAIN
Alasdair Melville
27 Paul St
London EC2A 4JU UK
01-628 7030
Telex: 914911; FAX: 01-628 5984

WEST GERMANY/SWITZERLAND/AUSTRIA
Wolfgang Richter
Sudring 53
7240 Horb/Neckar
West Germany
49-7451-7828; Telex: 765450

EASTERN BLOC
Uwe Kretzschmar
27 Paul St
London EC2A 4JU UK
01-628 7030
Telex: 914911; FAX: 01-628 5984

FAR EAST
Ed Schrader, General Manager
18818 Teller Ave, Suite 170
Irvine, CA 92715
(714) 851-9422; Telex: 183653

HONG KONG
John Byrne & Associates Ltd
1613 Hutchison House
10 HGarcourt Road
Central Hong Kong
Tel: 5-265474
Tlx: 61708 WEDIN HX
Fax: 5-8106781

JAPAN
Kaoru Hara
Dynaco International Inc
Suite 1003, Sun-Palace Shinjuku
8-12-1 Nishishinjuku, Shinjuku-ku
Tokyo 160, Japan
Tel: (03) 366-8301
Telex: J2322609 DYNACO

KOREA
Kim Kyong-Hae, BK International
Won Chang Bldg, 3rd Floor 26-3
Yoido-dong, Youngdungpo-ku
Seoul 150, Korea
Tel: 785-6665; FAX: 784-1915
Telex: K32487 BIZKOR

SINGAPORE/MALAYSIA/INDONESIA/THAILAND/ THE PHILIPPINES/AUSTRALIA/NEW ZEALAND
Asia Pacific Media House PTE Ltd
Peter Cheong
100 Beach Rd
#24-03 Shaw Tower
Singapore 0718
Tel: 2915354; Telex: RS 50026 MESPLY

TAIWAN
Acteam International Marketing Corp
6F, No 43, Lane 13
Kwang Fu South Rd
Mailing Box 18-91
Taipei, Taiwan ROC
760-6209 or 760-6210
Telex: 29809; FAX: (02) 7604784

PRODUCT MART
Joanne Dorian, Manager
249 West 17th St
New York, NY 10011
(212) 463-6415

INFO CARDS
Donna Pono
Newton, MA 02158
(617) 558-4282

CAREER OPPORTUNITIES/CAREER NEWS
Roberta Renard, National Sales Manager
103 Eisenhower Parkway
Roseland, NJ 07068
(201) 228-8602

Janet O Penn, Eastern Sales Manager
103 Eisenhower Parkway
Roseland, NJ 07068
(201) 228-8610

Paula Compton, Western Sales Manager
18818 Teller Ave, Suite 170
Irvine, CA 92715
(714) 851-9422

Diane Philipbar, Sales Assistant
103 Eisenhower Parkway
Roseland, NJ 07068
(201) 228-8608

Wendy A Casella, *Advertising/Contracts Coordinator*
Nan E Coulter, *Advertising/Contracts Coordinator*
Aileen B Turner, *Advertising/Contracts Coordinator*
(617) 964-3030

William Platt, Senior Vice President, Reed Publishing USA

Cahners Magazine Division
Terry McDermott, President, Cahners Publishing Co
Frank Sibley, Senior Vice President/General Manager, Boston Division
Tom Dellamaria, VP/Production & Manufacturing

Circulation
Denver, CO: (303) 388-4511
Eric Schmierer, Group Manager

SPDT & SP4T SWITCHES

WITH BUILT-IN DRIVERS

SPECIFICATIONS

	TOSW-230 ZSDR-230		TOSW-425 ZSDR-425	
Freq. Range(MHz)	10-3000		10-2500	
Insert. Loss (dB)	typ.	max.	typ.	max.
10-100MHz	1.3	1.9	1.3	1.7
100-1500MHz	1.1	1.9	1.1	1.7
1500-3000MHz	1.8	2.7	1.8	2.5
Isolation(dB)	typ.	min.	typ.	min.
10-100MHz	60	40	60	40
100-1500MHz	40	28	40	30
1500-3000MHz	35	22	35	22
1dB Compression(dBm)	typ.	min.	typ.	min.
10-100MHz	17	6	17	6
100-1500MHz	27	19	27	19
1500-3000MHz	30	28	30	28
VSWR(ON)	typ.	max.	typ.	max.
	1.3	1.6	1.3	1.6
Switching Time (μsec) (from 50% TTL to 90% RF)	typ. 2.0	max. 4.0	typ. 2.0	max. 4.0
Oper. Temp.(°C)	-55 to +100		-55 to +100	
Stor. Temp.(°C)	-55 to +100		-55 to +100	
Price (10-24)	$39.95		$59.95	
(1-9)	$89.95		$109.95	

10 to 3000MHz from $39.95

Now, high-speed, high-isolation switches with with built-in drivers, tough enough to pass stringent MIL-STD-202 tests. There's no longer any need to hassle with the complexities of designing a TTL driver interface and then adding yet another component to your subsystem... it's already included in a rugged, low-cost, compact assembly. Available in the popular hermetically-sealed TO-8 package or a small EMI-shielded metal connectorized case, these tiny PIN-diode reflective switches, complete with driver, can operate over a 10 to 3000MHz span with a fast 2μsec switching speed.

Despite their small size, these units offer isolation as high as 40dB(typ), insertion loss of only 1.1dB(typ), and a 1dB compression point of +27dBm over most of the frequency range. All models are TTL-compatible and operate from a dc supply voltage of 4.5 to 5.5 V with 1.8mA quiescent current. Switch to Mini-Circuits for highest quality innovative products... and leave the driving to us.

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

WE ACCEPT AMERICAN EXPRESS

CIRCLE NO 121

F126 REV.A

IR announces a new direction for Schottkys.

As power supply frequencies go higher and higher, power diodes need faster and faster recovery times.

International Rectifier is there with a new family of high-voltage, high-frequency Schottky diodes, from 100-160 volts with virtually no recovery time.

As efficiency demands go higher and higher, forward voltage drop must go lower.

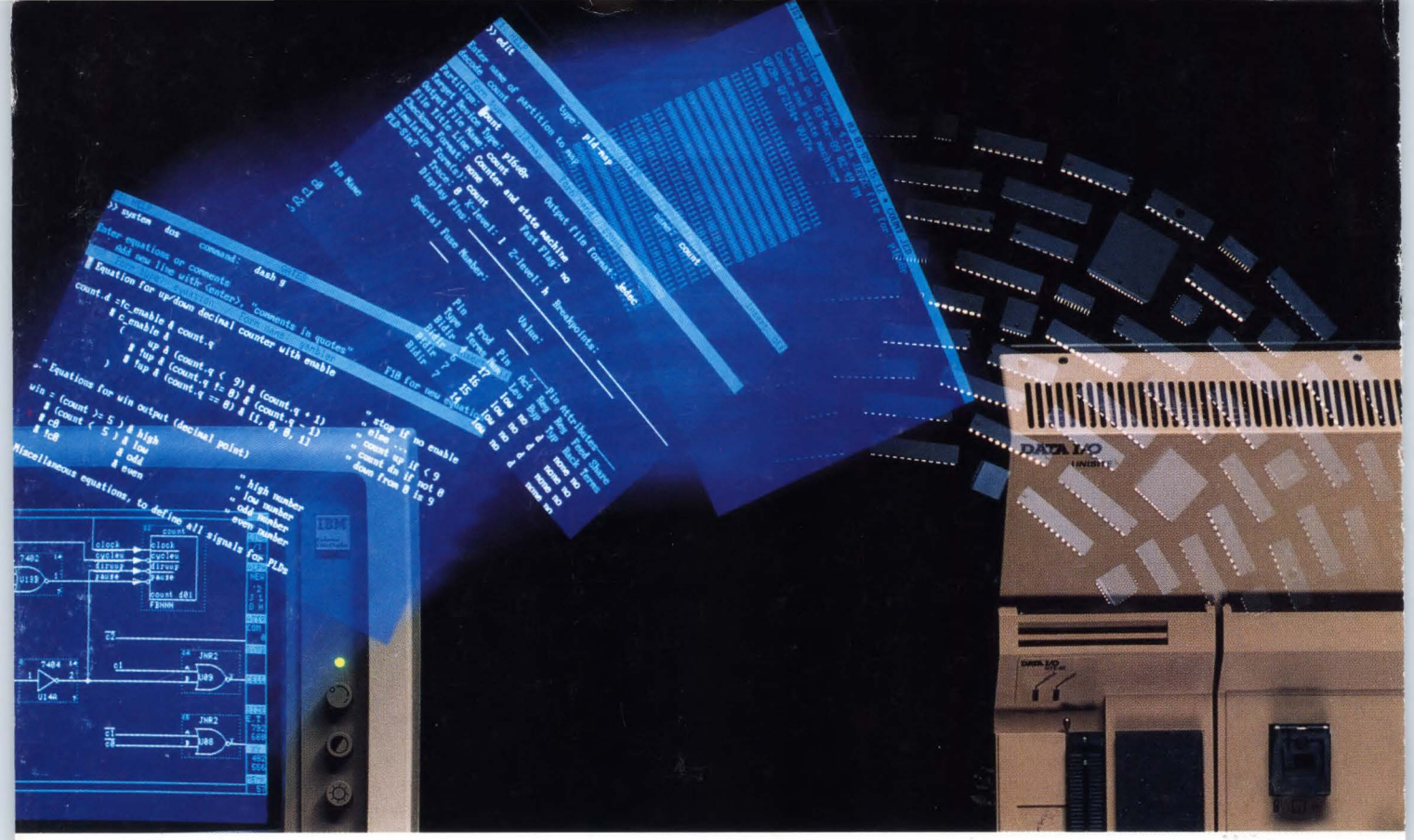
And International Rectifier is there with a new family of ultra-low V_f Schottky diodes with forward voltage drops as low as 0.25 volts.

Whatever your application, now you can pair up HEXFET® power MOSFETs with IR Schottkys. With the quality and reliability that are benchmarks of the industry.

Talk Schottkys with IR. Higher or lower, we have some pretty far reaching ideas about the future.

IOR INTERNATIONAL RECTIFIER

WORLD HEADQUARTERS: 233 KANSAS ST., EL SEGUNDO, CA 90245, U.S.A. (213) 772-2000. TWX 910-348-6291, TELEX 472-0403 • EUROPEAN HEADQUARTERS: HURST GREEN, OXTED, SURREY RH8 9BB, ENGLAND TELEPHONE (0883) 713215, TELEX 95219



SEAMLESS SOLUTIONS FOR PLD DEVELOPMENT.

THREE FULLY-INTEGRATED PERSONAL SILICON FOUNDRY SYSTEMS. Only Data I/O® has all the high-performance design software and programming tools you need to support virtually every PLD on the market. And only Data I/O makes those PLD tools work together as a system—seamlessly integrated, without capability gaps. Our three Personal Silicon Foundry™ (PSF™) systems offer integrated solutions for the complete range of PLD development needs.

CHOOSE THE PSF THAT'S RIGHT FOR YOU. The PSF 700 is for leading-edge designers using the newest devices to achieve maximum performance. It gives you state-of-the-art capabilities—like technology independence, interactive partitioning and device selection, and support for field programmable gate arrays (FPGAs).

The PSF 500 gives you both structural and behavioral design entry, and the powerful simulation and reduction capabilities you need for complex designs utilizing a broad range of devices and architectures.

Choose the PSF 300 for behavioral design entry and dependable programming of popular devices, all at a surprisingly modest cost.

DATA I/O PROVIDES ALL THE STEPS YOU NEED FROM CONCEPT TO SILICON.

- Design Entry
- Design Verification
- Logic Synthesis
- Programming
- Device Test

THE BROADEST PLD SUPPORT ON THE MARKET. Data I/O supports the largest number of devices with the broadest selection of PLD tools on the market. From ABEL™, GATES™, and FutureNet® DASH™ software, to UniSite™ and 60A programmers, our universal tools set the industry standard. So you won't have to learn a new tool for every new device architecture you try. And when you're ready for a more sophisticated toolset, your files are upwardly compatible.

ONE CALL SUPPORTS IT ALL. Only Data I/O gives you the security of complete PLD development support from one source. A single call gives you access to hardware, software, and systems engineers, ready to help you with your total PLD application.

Call today, and we'll show you how one of our seamless PSF solutions can solve all your PLD tool needs.

1-800-247-5700
Ext. 381

Data I/O Corporation 10525 Willows Road N.E., P.O. Box 97046, Redmond, WA 98073-9746, U.S.A. (206) 867-6899/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 Japan Sumitomoseimei Higashishinbashi Bldg., 8F, 2-1-7, Higashi-Shinbashi, Minato-Ku, Tokyo 105, Japan
(03) 432-6991/Telex 2522685 DATAIO J

DATA I/O Corporation

CIRCLE NO 123